

ITS 323 – ASSIGNMENT 1

Due Wednesday 15 August 2007, 5pm

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. 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 the necessary calculations to the Answer Sheet.
4. Failing to show your calculations for a question may result in reduced or 0 marks, even if the answer is correct.
5. Your explanations of answers for Question 5 can be short (e.g. using bullet points), but must be clear. Space is given on the Answer Sheet – if you need more, then attach further sheets.
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 the speed of light: 3×10^8 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*.

- a) The last 3 digits of your ID number will be referred to as X. Record the value in both decimal and as a 10-bit binary number on the answer sheet. Pad the binary number with zeros on the left.

Example:

If your ID is 4822771234, X = 234. In binary, this is: 0011101010.

Question 1 [21 marks]

You want to create a wireless connection from your dormitory building at Thammasat Rangsit to your friend's house nearby. You are lucky that the antenna on the dormitory building and the antenna on your friend's house are within line-of-sight. Both antennas that you buy are the same. The antennas:

- Are circular, with a radius of 0.2 metres
- Have a receive power threshold of -60dBm (that is, it can only successfully receive a signal with power above this threshold)

The distance between the two antennas is, $d = 5000 + X$, where X is the value generated from your ID in Question 0. The distance is measured in metres.

Since they are cheap, you decide to use IEEE 802.11g wireless LAN cards for the wireless transmission system. This operates at a frequency of 2.4GHz and provides a Physical layer data rate of 54Mb/s.

- a) Assuming the free-space loss model, determine the minimum power you need to transmit at in order to successfully receive at your friend's house. Give a final answer in milliWatts (mW), rounded to the nearest mW. [9 marks]
- b) How much power is lost between transmitter and receiver due to free-space propagation? Give your answer in decibel milliWatts (dBm), rounded to three decimal place (e.g. 23.456dBm). [6 marks]

You transmit at the power calculated and discover your friend *cannot* receive your transmission. After further measurements, you realise that, in addition to the free-space loss, there is another loss of 10dBm (due to for example, imperfections of the antenna, loss over cables and so on).

- c) Given the 10dBm of power loss in addition to the free-space propagation loss, what is the transmit power required to reach your friends house? Again, give a final answer in mW. [6 marks]

Question 2 [12 marks]

So now you can communicate with your friend over the wireless link. The main application you will use is file sharing. Your friend has many home DVDs burnt to their hard drive, and you want to copy them to your hard drive, via the wireless link.

Your computer is setup to use a set of simple protocols at each layer in the Internet layered model. The protocols only add headers; they perform no retransmissions and send no control messages. The header sizes are:

- Application protocol: 40 bytes
- Transport protocol: 30 bytes
- Network protocol: 20 bytes
- Data link protocol: 25 bytes
- Physical protocol: 10 bytes

The only complexity is at the Network layer, where the network protocol fragments packets into a maximum size of 2000 bytes (and then adds its header to each fragment).

- a) What throughput can be achieved when transferring a single 4.7GB DVD movie with the simple set of protocols? Ignore any propagation, queuing or processing delays. Give the answer to the nearest tenth of a Mb/s (e.g. 23.1Mb/s) [7 marks]

Now assume that there is a propagation delay, as well as a processing delay of 0.01 seconds at both transmitter and receiver. There is no queuing delay.

- b) How many seconds does it take to transmit 1 DVD? Give your answer to the nearest second. [5 marks]

Question 3 [17 marks]

The simple set of protocols you used in Question 2 performed no error or flow control. But you know that all physical links (and especially wireless links) are prone to bit errors.

Lets assume you use a single-bit even parity check to perform error detection at the data link layer. The parity check is applied to 7-bit characters. Assume the 7-bit character being transmitted is the last 7-bits of X (where X is generated from your ID). If X as a 10-bit binary number is $x_1 x_2 x_3 x_4 x_5 x_6 x_7 x_8 x_9 x_{10}$ then the character will be $x_4 x_5 x_6 x_7 x_8 x_9 x_{10}$

- a) What is the sequence of bits sent by the transmitter? [2 marks]
- b) If the middle bit of the 7-bit character (x_7) is in error on transmission (that is, it is changed from 1 to 0 or from 0 to 1), then explain what the receiver does? [5 marks]
- c) If the middle bit of the 7-bit character and the bit to the right (that is, bits x_7 and x_8) are in error, then explain what the receiver does? [5 marks]
- d) If the middle bit of the 7-bit character and the bit to the right and the parity bit are in error (that is, bits x_7 , x_8 and the parity bit), then explain what the receiver does? [5 marks]

Your explanations of what the receiver does should answer: is the error detected? If yes, then how? If no, then why not? Provide your explanations on the answer sheet.

Question 4 [26 marks]

Of course, detecting errors is not enough – you must also do something to fix the errors once detected. After investigation of different Forward Error Correction schemes, you find one that works well for your link. In fact, after applying Forward Error Correction, the number of errors that will be uncorrected is very small, and those undetected and uncorrected even smaller. So in the following, lets assume there are no errors on the link (all possible errors are detected and corrected).

But you still have a problem: the computer at your friends house is a high performance Pentium Quad Core computer, while your computer receiving the files is an old Intel 486. Data is sent too fast for your computer to handle, so you need some flow control. You have two options:

- Stop and Wait Flow Control
- Sliding Window Flow Control

Although we said in Question 2 that each layer adds a header, lets simplify things and look only at the performance of the Data Link layer. That is, ignore the headers and operations from all the other layers (Physical, Network, Transport, Application).

You should make the following assumptions:

- The size of each message to be sent by the Data link layer is: $1000 + X$ bytes, where X is generated from your ID number
 - Each data message has a 25 byte header added to it to create the DATA frame (so the size of the DATA frame is $1025 + X$ bytes)
 - The total size of an ACK frame is 25 bytes
 - When using Sliding Window, the window size used is: $W = 2^{(1+\text{mod}(X,6))}$ where $\text{mod}(X,6)$ is the remainder when X is divided by 6.
 - The transmitter always has data ready to send.
 - There are no processing delays at the transmitter or receiver.
- a) What is the utilisation (or efficiency) of the Stop and Wait flow control protocol? [10 marks]
 - b) What is the throughput of the Stop and Wait flow control protocol? [3 marks]
 - c) What is the utilisation (or efficiency) of the Sliding Window flow control protocol? [10 marks]
 - d) What is the throughput of the Sliding Window flow control protocol? [3 marks]

For utilisation, give your answers as percentages, rounded to two decimal points (e.g. 63.78%). For throughput, give your answer in Mb/s, rounded to one decimal point (e.g. 23.5Mb/s).

Question 5 [24 marks]

So now we can transfer our video files across our wireless link in an efficient manner. Lets consider some of the design decisions made, and other issues that need to be considered.

- a) We assumed Forward Error Correction was used for error control in our link. Lets assume it was the algorithm described in the lecture, where we took 2 bits of data and sent a 5 bit codeword.
 - i. Explain the advantages and disadvantages of this algorithm compared to the Go-Back-N ARQ protocol. [6 marks]
 - ii. If the number of errors on the link is very small, then which scheme is more efficient? Explain your choice. [Hint: do not perform detailed calculations; instead consider the approximate efficiency of the FEC scheme, and note Go-Back-N uses a sliding window scheme] [6 marks]
- b) Not everyone is as lucky to have their friend's house within line-of-sight of their house for wireless LAN to work. If you could not use wireless LAN to connect, two common alternatives may be to: 1. use a land-based ADSL Internet connection at both houses or 2. use a dedicated satellite connection (e.g. satellite dish at your dorm, and satellite dish at friends house). Compare the three different alternatives for the intended application (that is, transferring large video files). [12 marks]

ASSIGNMENT 1 – COVER AND ANSWER SHEET

ID:

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First name: _____

Last Name: _____

Section: IT / CS

Mark (max 100): _____

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) Last 3 digits of ID in decimal

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b) Last 3 digits of ID in binary

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Question 1

a) Transmit power (mW)

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b) Lost power (dBm, 3 decimal places)

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c) Transmit power (mW)

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Attach your calculations for parts (a), (b) and (c)

Question 2

a) Throughput (Mb/s, 1 decimal place)

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b) Delay (seconds)

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Attach your calculations for parts (a) and (b).

Question 3

a) Transmitted bits

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b) Middle bit in error

Received bits

Explanation

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c) Middle 2 bits in error

Received bits

Explanation

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d) Middle 2 bits and parity bit in error

Received bits

Explanation

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Question 4

a) Stop and Wait Utilisation (% , 2 decimal places)

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b) Stop and Wait Throughput (Mb/s, 1 decimal place)

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c) Sliding Window

Window value (W)

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Utilisation (% , 2 decimal places)

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d) Sliding Window Throughput (Mb/s, 1 decimal place)

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Attach your calculations for parts (a), (b), (c) and (d).

Question 5

a) i. Advantages of FEC (as used in lecture) compared to Go-Back-N ARQ

Disadvantages of FEC (as used in lecture) compared to Go-Back-N ARQ

ii. Choose between FEC or Go-Back-N when small number of errors. Explain the choice.

- b) Comparison between wireless LAN, ADSL Internet and satellite connection when transferring movies from your friend's house.