National University of Computer & Emerging Sciences,
Islamabad, Pakistan

Name: ________________________________ Roll No: _________________

Data Communication & Networks

Summer 2007

Midterm Solution

Saturday, 21st July 2006

Total Time: 2 Hour
Total Marks: 100

Course Instructor: Waleed Ejaz

You are advised to READ these notes:

1. There are total 10 questions, each question carry equal marks.
2. The marks for each part are written in brackets [ ]
3. Exam is closed books, closed notes. Please see that the area in your threshold is clean. You will be charged for any material which can be classified as ‘helping in the paper’ found near you.
4. Calculator sharing is strictly prohibited.
5. The invigilator present is not supposed to answer any questions. If you have any queries please wait for the appropriate person who may visit your exam room once in the initial half an hour or so.
6. If there is any missing parameter, write down your assumption and continue.
7. Answers to all the questions should be written in the same order on the answer sheet. Answer to each question should be started from a new page.
8. Do not write anything on the question paper, except for your name and roll number on the top.

Question 1 [3+3+4]

Consider a 100 Mbps point-to-point link being set up between the Earth and a new lunar colony. The distance between the moon and the Earth is approximately 385000 km, and data travels over the link at the speed of light (3×10^8 m/s).

(i) Calculate the minimum RTT for the link.

(ii) Calculate the delay-bandwidth product for the link. Take RTT as the link delay.

(iii) A camera on the lunar colony takes pictures of its surroundings and sends these to earth on request from earth. If the image size is 25 MBytes, what is the minimum amount of time that will elapse between when the request for data goes out and the transfer is finished.

Solution:

(i)

RTT = $2 * T_{prop} = 2 \times (385000 \times 1000/(3 \times 10^8)) = 2.56$ sec

(ii)

Bandwidth-Delay = BW*RTT = $100 \times 10^6 \times 2.56 = 256$ Mbits

(iii)

$D_t = RTT + D_{tx} = 2.56 + ((25 \times 8)/100) = 2.56 + 2 = 4.56$ sec

Question 2 [3+3+4]

PART A

Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Would a packet-switched or a circuit-switched network be more appropriate for this application? Motivate your answer.

Solution:

A circuit-switched network would be well suited to the application described, because the application involves long sessions with predictable smooth bandwidth requirements. Since the transmission rate is known and not bursty, bandwidth can be reserved for each application session circuit with no significant waste. In addition, we need not worry greatly about the overhead costs of setting up and tearing down a circuit connection, which are amortized over the lengthy duration of a typical application session.

PART B

Consider sending a message from a source host to destination host over the Internet using a fixed route. The source and destination host are separated from each other by four hops. Assume the message from the source host is sent using one packet at each layer. How many transport layer headers, network layer headers and link layer headers are used in the transfer of this message to the destination?

Solution:

1 Transport Layer Header
1 Network Layer Header

4 Link Layer Headers

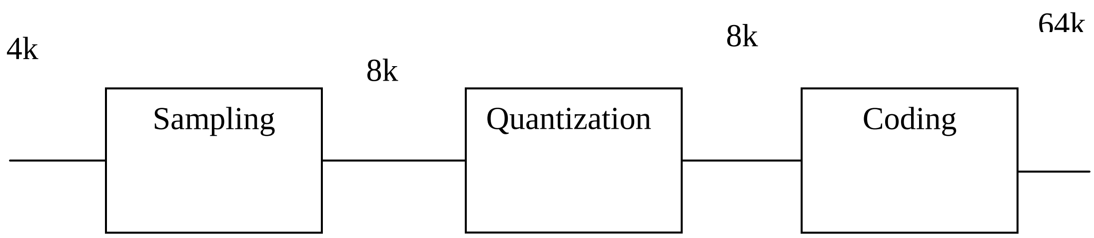
PART C
A router has four interfaces so how many IP addresses it will have?
Solution:
Four IP addresses

Question 3 [3+7]

PART A
We measure the performance of a telephone line (4 KHz of bandwidth). When the signal is 20V, the noise is 6mV. What is the maximum data rate supported by this telephone line?
Solution:
$4{,}000 \log_2 (1 + 20 / 0.006) = 43{,}866$ bps

PART B
Draw the block diagram of Pulse Code Modulation (PCM). Also indicate number at each input and output if a voice signal is fed to the converter.

Solution:

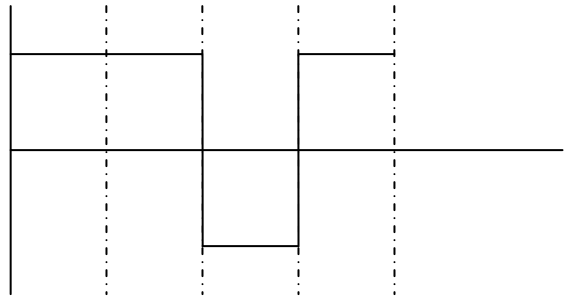


Question 4 [10]

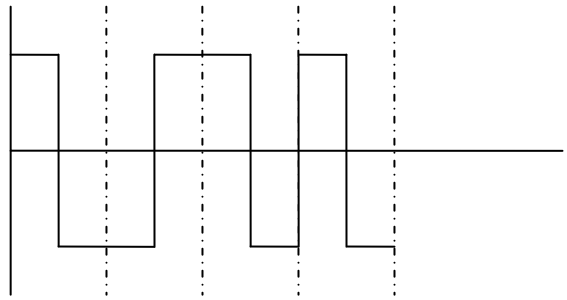
Imagine you wish to transmit your student ID number over some form of wired medium. First you will need to convert your student ID from its decimal (base 10) representation into binary (base 2) representation.
For example, your student ID is 11. Using clearly labeled diagrams, show an encoding of your student ID using:
(a) a NRZ-I signal,
(b) a Manchester signal,
(c) a bipolar-AMI signal

Solution:

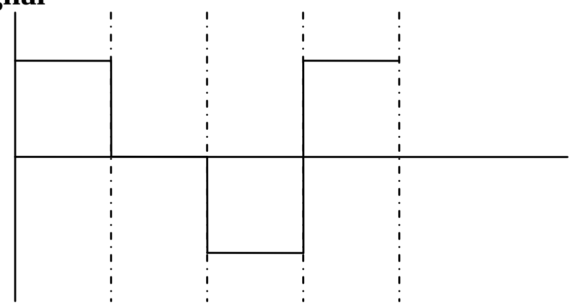
1011
NRZ-I Signal



Manchester Signal



Bipolar AMI Signal

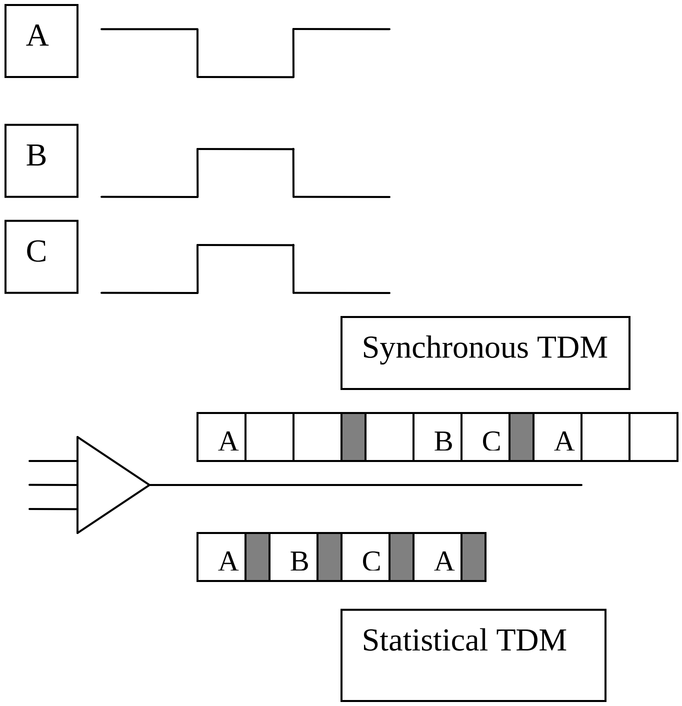


Question 5 [6+4]

PART A

Draw output frames for a synchronous TDM and statistical TDM for the following input signals. (A: 101 B: 010 C: 010)

Solution:



PART B

An analog signal has a bit rate of 8000 bps and a baud rate of 1000 baud. How many data elements are carried by each signal element? How many signal elements do we need?

Solution:

In this example, S = 1000, N = 8000, and r and L are unknown. We find first the value of r and then the value of L.

$$S = N \times \frac{1}{r} \quad \rightarrow \quad r = \frac{N}{S} = \frac{8000}{1000} = 8 \text{ bits/baud}$$

$$r = \log_2 L \quad \rightarrow \quad L = 2^r = 2^8 = 256$$

Question 6 [7+3]

PART A

What is the Total Delay for a frame of size 5 million bits that is being sent on a link with the following physical characteristics?

- 5 Mbps Bandwidth
- 2000 Km long
- 2.4 X108m/s propagation speed
- Have 10 routers, each with the queuing time of 2us and processing time of 1 us.

Total Delay:

$$d_{\text{nodal}} = d_{\text{proc}} + d_{\text{queue}} + d_{\text{trans}} + d_{\text{prop}}$$

D_{proc}=1 us*10=10us
D_{queue}=2us*2=20us
D_{trans}=$5X10^6/5X10^6$=1 sec
D_{prop}=$2000X10^3/2.4X10^8$=8.33ms

So Total Delay=

PART B

Punjab Archeology Department has recently discovered remains of an old city in suburbs of Taxila. Research revealed that people of this city had three fingers per hand and thus their whole accounting system was based on system with base '3'. Suppose you belong to such a community and happened to take network course at NU. You are to transmit a data stream with flag 2222222

2222222 1012222 2222210 0120121 2222222

what would be the output after bit stuffing (flags are already appended) ?
Solution:
2222222 1012222 22022210 0120121 2222222

Question 7 [10]

A receiver receives the code 11001100111. Using the Hamming encoding algorithm, what is the original code?

Solution:
Using Hamming Encoding Algorithm, the result is 0000.
There is no error. The correct code is 1101101.

Question 8 [3+7]

PART A

Using 5-bit sequence numbers, what is the maximum size of the send and receive windows for each of the following protocols?

a. Stop and Wait ARQ
b. Go-Back-N ARQ
c. Selective Repeat ARQ

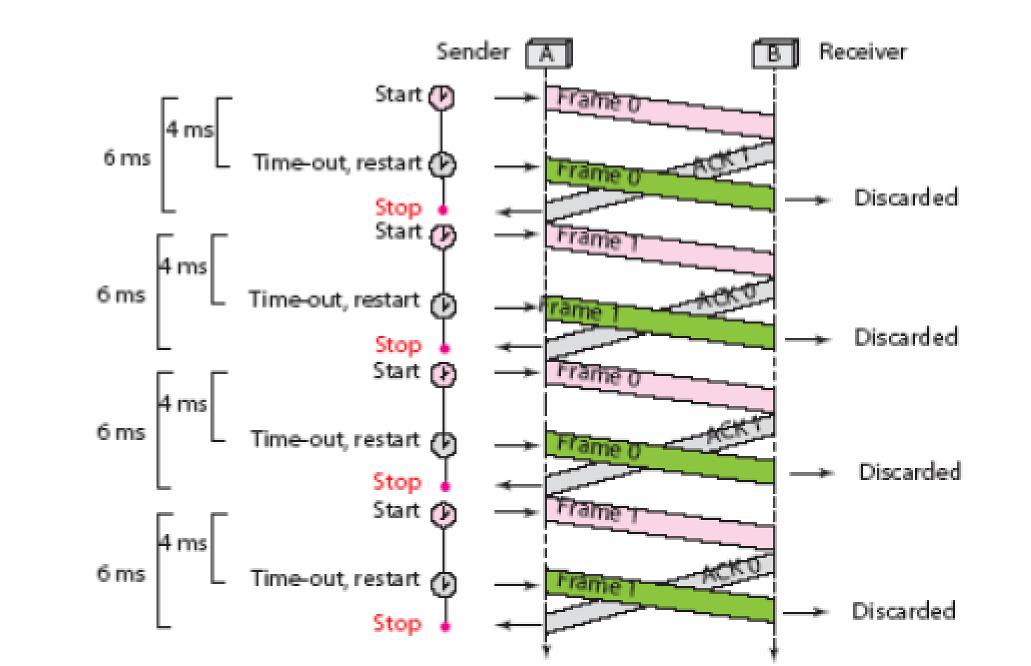
Solution:

Stop-And-Wait ARQ	send window = 1	receive window = 1
Go-Back-N ARQ	send window = $2^5 - 1 = 31$	receive window = 1
Selective-Repeat ARQ	send window = $2^4 = 16$	receive window = 16

PART B

The timer of a system using the Stop-and-Wait ARQ Protocol has a time-out of 4ms. Draw the flow diagram for four frames if the round trip delay is 6ms. Assume no no data frame and control frame is lost or damaged.

Solution:



Question 9 [7+3]

PART A

Four stations share the link during a 1-bit interval. We assume that station 1 and station 4 are sending a 0 and 1 respectively, station 2 and 3 are silent. Show graphically whole process at transmitter and receiver side?

Solution:

Code for Station A: [-1 -1 -1 -1]
Code for Station B: [-1 1 -1 1]
Code for Station C: [-1 -1 1 1]
Code for Station D: [-1 1 1 -1]

Now as Station A sends 0 so its code will be [1 1 1 1]
Now as Station A sends 0 so its code will be [0 0 0 0]
Now as Station A sends 0 so its code will be [0 0 0 0]
Now as Station A sends 0 so its code will be [-1 1 1 -1]

So transmitted signal is: [0 2 2 0]

Now at receiver we have to multiply chip with received signal and then add it. If it will be 4 then it means it receives 1 or if it will be -4 then it means it receives -1 or if it will be 0 then it means it receives nothing (0).

PART B

Compare and contrast CSMA/CD and CSMA/CA?

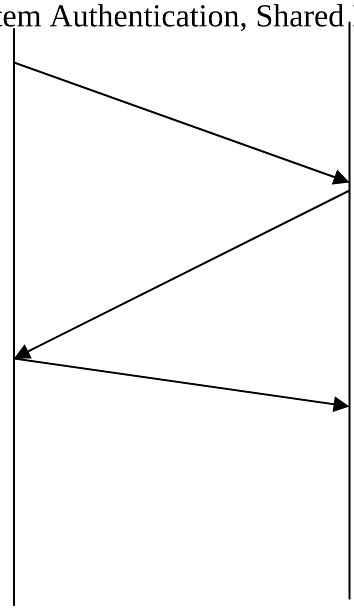
Solution:

In CSMA/CD, the protocol allows collisions to happen. If there is a collision, it will be detected, destroyed, and the frame will be resent. CSMA/CA uses a technique that prevents collision.

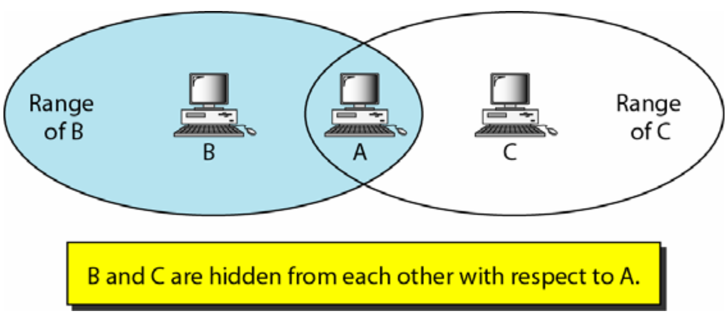
Question 10 [10]

a. What is the length of Bluetooth AM address?
Solution:
3 bits

b. What are two modes of authentication in 802.11? Draw the frame exchange sequence for 802.11 authentication procedure for shared key authentication?
Solution:
Open System Authentication, Shared Key Authentication



c. What is hidden node problem in 802.11 networks?



d. What is exposed node problem in 802.11 networks?