CSCI 4273/5273: Network Systems
Fall 2014
Midterm Exam

Date: 11/05/2014; Time: 4:00 – 5:15 PM

This is a closed-book, closed-notes exam.
Answer all questions in the space provided.
You may use a calculator.
State clearly any assumptions you make.
Show all details.

You may use any of the following conversions in your calculations (be consistent in using these conversions):

1 Byte = 1 B = 8 bits = 8 b.
1 K = 2^{10} for data; 10^3 for bandwidth.
1 M = 2^{20} for data; 10^6 for bandwidth.
1 G = 2^{30} for data; 10^9 for bandwidth.
1 ms = 10^{-3} s.
1 μs = 10^{-6} s.

Grade: 20% of your final grade is allocated for this exam.

1. **[10 Points]** Give a short answer for each of the following:

(a) Why are cookies needed in HTTP?

HTTP is a stateless protocol. Cookies enable an HTTP server to keep track of clients earlier access to the server

(b) What is the key difference between mail access protocols and SMTP?

Mail access protocol is a pull-based protocol where a client pulls data from the server. SMTP is push-based where a client pushes data to the server

(c) Explain the role of cipher block chaining (CBC) in cryptography.

CBC ensures that ciphertext corresponding to a plaintext is different depending on what proceeds the plain text. This prevents an adversary from maintaining a mapping between plaints and ciphertex

(d) Error checking using CRC is typically done at the datalink layer. Explain why there is additional error checking done at higher layers such as IP and TCP via checksums.

CRC may not catch all possible bit errors In addition, errors may be introduced after the data is passed to upper layer from datalink layer.

(e) Give an example of an application where you will use Piconet and another example of an application where you will use ZigBee.

Piconet : Connecting desktop with its peripherals like keyboard, mouse, headphone etc.

Zigbee : Monitoring a wilderness area using sensors

2. **[24 Points]**

(a) Describe two differences between packet switching and circuit switching. Give an example of an application that is suitable for circuit switching and another application that is suitable for packet switching.

In packet switched networks nodes send discrete block of data and ~~est~~ do not establish a connection beforehand. In circuit switched network, nodes send stream of bits and establish a connection beforehand.

Packeteswitch: computer networks

Circuit switch: Telephone networks

(b) Consider a protocol such such as TCP. For each of the following functionalites/operations, explain whether they are part of TCP's peer-to-peer interface or service interface:

i. Use sliding window algorithm for reliable message delivery Peer to peer

ii. Send a message using TCP service

iii. Connect with a remote server service

iv. Implement congestion control peer to peer

v. Check if a message is available to be received from TCP service

vi. Use monotonically increasing sequence numbers to implement FIFO message delivery peer to peer

(c) Why are authentication protocols different from digital signatures? Explain with an example.

Digitital signatures authenticate that a document is prepared by ~~the~~ the entity whose ~~sign~~ digital signature is on the document. Authentication protocols on the other hand authenticate the identity of the user.

Example: A document signed by Alice may have been sent by Trudy. Bob can verify that the document was prepared by Alice but cannot verify Trudy only through

(d) Provide two advantages and two disadvantages of using BitTorrent for distributing software updates when compared with a client-server architecture.

BitTorrent: Adv ① No need for extensive infrastructure
② Less load on server

Disadv: ① No guarantee that all clients do receive the update
② update distribution can take some time to rise to full speed.

(e) Give an example to demonstrate that SSL is vulnerable to the man-in-the-middle attack.

SSL is not vulnerable to man-in-the-middle attack. SSH is vulnerable to man-in-the-middle attack

(f) Explain how the maximum distance between hosts in Ethernet related to minimum Ethernet frame size and link bandwidth.

To detect collision, the sender has to keep sending until it can see a jamming frame. In the worst case, Sender is on one End of Ethernet, starts sending a frame. A node at the other end starts sending just before it sees the first byte from the sender. It then sends a jamming sequence which needs to reach the original sender at the other end. Total time = 1 RTT.

# of bits sent in 1 RTT = minimum frame size

3. A client wants to download a file of size 32 MB using FTP (passive mode) from a remote server that requires client authentication. Communication link between the client and the server is 1 Mbps with 250 ms RTT. Assume that it takes two RTTs to establish a new TCP connection.

(a) **[10 Points]** How long will it take for the client to download this file?

Establish control connection : 2RTT
login, password : 2RTT
Client sends PASV : $\frac{1}{2}$ RTT
server sends IP addr/port# : $\frac{1}{2}$ RTT
establish data connection : 2RTT
Client send get request : $\frac{1}{2}$ RTT
server sends file : Transmit time + Propagat

$$\text{Total time} = 7.5\ \text{RTT} + \frac{32 \times 2^{20} \times 2^3}{1 \times 2^{20}} + \frac{1}{2}\ \text{RTT}$$

$$= 258 \text{ seconds}$$

(b) **[3 Points]** What is the effective throughput of the link?

$$\text{Effective throughput} = \frac{32 \times 8}{258}\ \text{Mbps}$$

$$= 0.992\ \text{Mbps}$$

(c) **[2 Points]** Will the effective throughput increase or decrease if the file to be downloaded is 100 MB?

Increase

4. A sliding window protocol is being set up for transmitting frames of size 10 Mb between the Earth and a newly established lunar colony over a 100 Mbps link. The distance from the moon to the Earth is approximately 390,000 km and the speed of light in space is 3×10^8 m/s.

(a) **[5 Points]** How long will it take to transmit a frame from the Earth to the lunar colony (from the first bit sent to the last bit received)?

Transmit time + propagation delay

$= \frac{10 \times 2^{20}}{100 \times 2^{20}} + \frac{390000000}{3 \times 10^8}$

$= 1.4$ seconds

(b) **[4 Points]** What is the optimal send window size?

Delay X BW with RTT as delay

$= 2.8 \times 100 = 280$ Mb

optimal send window size = $\frac{\text{Delay X BW}}{\text{frame size}}$

$= \frac{280}{10} = 28$

(c) **[2 Points]** What is a good value of timeout that a sender can use?

Timeout has to be greater than RTT. Accounting for scheduling delays, I would use timeout $= 1.5 \times RTT$

$= 42$ seconds

(d) **[10 Points]** Using your optimal send window size and timeout value, calculate the effective throughput of the link for transferring 1000 frames if

(i) no frames or acks are lost.

(ii) one frame is lost.

(iii) one ack is lost.

(i) Since no frames/acks are lost, the sender can send all frames continuously without any pause or retransmissio

So, effective throughput = BW of link

= 106 Mbps

(ii) It will take 42 seconds (timeout value) to detect frame loss and retransmit. So, overall an extra 42 seconds in total transmission time

Total Time = Time to transmit 1000 frames + 42

$$= \frac{1000 \times 10 \times 2^{20}}{100 \times 2^{20}} + 42$$

= 142 seconds

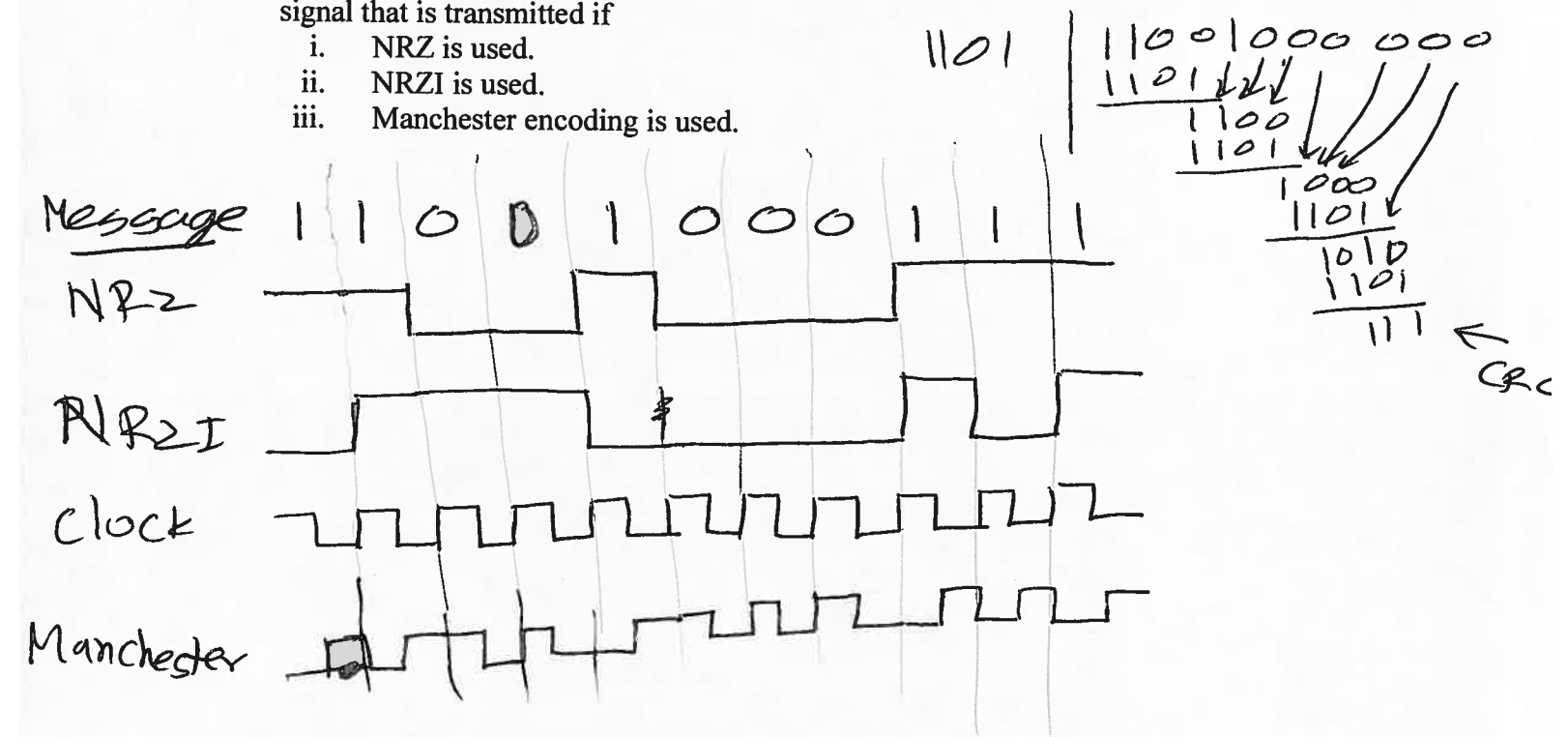
$$\text{Effective throughput} = \frac{1000 \times 10}{142} = 70.42 \text{ Mbps}$$

(iii) Since only one Ack is lost, the Ack for the next frame will be received before sender times out., So, no retransmissions

Effective throughput = 100 Mbps

5. (a) **[10 Points]** Consider a bit sequence 11001000 is to be transmitted. A three-bit CRC (Polynomial: $x^3 + x^2 + 1$) is used to protect it against errors. Show the encoded signal that is transmitted if

   i. NRZ is used.
   ii. NRZI is used.
   iii. Manchester encoding is used.



(b) **[3 Points]** Which of the following bit errors during transmission in (a) will be definitely be detected, and which ones may not be detected?
Note: Do not perform polynomial division on the receiver side to answer this question.

i. One bit in the message has been inverted: 11011000 Yes

ii. One bit in the CRC has been inverted Yes

iii. Five bits (all marked bold here) have been inverted: **0**1111**0**1**1** Yes

iv. Four bits (all marked bold here) have been inverted: 1**0**0**1**0**0**1**0** May not

v. Two bits (one in the message and the other in the CRC) have been inverted Yes

vi. All the bits of message and CRC have been inverted Yes

(c) **[3 Points]** Suppose two-dimensional odd parity is used for transmitting a 36-bit message. Which of the following bit errors during transmission will be definitely be detected, and which ones may not be detected?

i. Two bits have been inverted Yes

ii. Six bits have been inverted Yes

iii. Four bits have been inverted May not

iv. Four bits (all in the parity row or the parity column) have been inverted Yes

v. Eight bits have been inverted May not

vi. All the bits of the message and parity row and column have been inverted Yes

6. (a) **[8 Points]** Consider the internetwork of three Ethernet networks connected via two learning bridges and the following sequence of events:

I. H7 sends a frame f1 to H4
II. H5 sends a frame f2 to H8
III. H4 sends a frame f3 to H5
IV. H5 moves to the Eth 3
V. H1 sends a frame f4 to H5
VI. H8 sends a frame f5 to H5
VII. H5 sends a frame f6 to H2
VIII. H7 sends a frame f7 to H5
IX. A new bridge B3 is added connecting Eth 1 and Eth 3

i. Show the forwarding tables of B1 and B2 after step III

B1:

Host	Port
H7	1
H5	1
H4	1

B2:

Host	Port
H7	1
H5	0
H4	0

ii. Show the forwarding tables of B1 and B2 after step V

B1:

H7	1
H5	1
H4	1
H1	0

B2:

H7	1
H5	0
H4	0
H1	0

iii. Which networks will the frame f1 be transmitted on?

Eth 1, Eth 2, Eth 3

iv. Which networks will the frame f4 be transmitted on?

Eth 1, Eth 2

v. Which networks will the frame f5 be transmittes on?

Eth 2, Eth 3

vi. Which frames will not reach their destinations?

f4

vii. What problem step IX might cause?

This introduces a cycle in the internetwork.

(b) **[6 Points]** Consider a WiFi network using CSMA/CA. Node A wants to send a message to node B. So, A sends an RTS control frame and B replies with a CTS control frame.

i. Node C sees RTS and CTS. Can C transmit to node D at this time? No

ii. Node E sees RTS but not CTS. Can E tranmsit to node F at this time? Yes

iii. Node G sees CTS but not RTS. Can G transmit to node H at this time? No

iv. Node J does not see RTS or CTS. Can J transmit to node K at this time? Yes

v. In each of these cases (i, ii, iii and iv), explain whether it is an instance of hidden node problem, exposed node problem, or none?

(i) None
(ii) Exposed node
(iii) Hidden node
(iv) None