ECE 2305: Introduction to Communications and Networks

Quiz #1

3:00-3:30 PM, 27 March 2014

Name: SOLUTION

Box #: _____

Instructions:

- Do not open this quiz until you are instructed to do so.
- This quiz is closed book, but you are permitted to bring one doubled-sided 8.5" by 11" sheet of *handwritten* notes.
- Calculators are permitted.
- Laptops or other electronic devices with wireless capability are *not* permitted.
- No collaboration is permitted; the WPI academic honesty policy is in effect.
- There is no penalty for guessing.
- You must show all your work to get full credit.
- You have 30 minutes to complete the quiz.

Problem	Points	Score
1	10	
2	10	
3	15	

Good luck!

1. **Ping (10 pts total)**

(a) (4 pts) Describe one use of the ping utility.

Ping can be used to determine if the network is working correctly and if a given host is responding.

Ping can also be used to get a rough measure of round-trip response times to a given host.

Ping can't be used to measure data rate or throughput. It can only measure latency (round trip delay)

(b) (6 pts) When the ping application generates an ICMP echo request, the transport layer encapsulates the data with a header. List three things that are contained within this header.

- source port
- destination port
- source address
- destination address
- check sum
- time to live

2. **Layering (10 pts total)**

(a) (4 pts) Describe two advantages of layering in protocol architecture.

1. Can change layers without impacting other layers, e.g. change from ethernet to wifi physical layer
2. Peer communication: applications can form logical connections without needing to know any details of other layers.
3. Simplify design & analysis of protocols
4. Easier standardization due to separation of functions

(b) (2 pts) Describe one disadvantage of layering in protocol architecture.

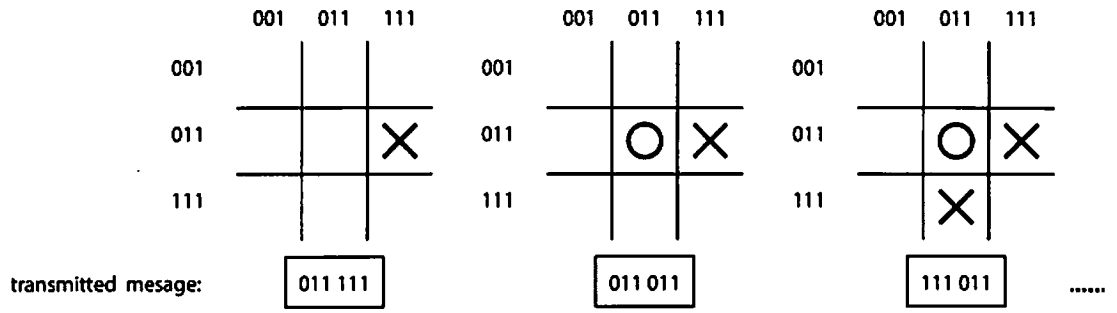
Potential for increased latency since messages have to propagate through multiple layers.

In general, layering adds overhead that wouldn't be present if all functions were realized in a single layer

(c) (4 pts) Provide an example of one physical layer protocol commonly used in the TCP/IP protocol suite. What is the maximum bit rate of this protocol?

10BaseT ethernet	10 Mb/s
100 BaseT ethernet	100 Mb/s
Gigabit ethernet	1000 Mb/s
802.11g	54Mb/s
802.11n	600Mb/s

3. **Signaling (15 pts total)** Suppose there is a communication system designed to convey the individual moves of two players playing a game of tic-tac-toe as shown below. It is known that player X always goes first. The rows and columns are encoded such that 001 corresponds to the first row/colum, 011 corresponds to the second row/column, and 111 corresponds to the third row/column. To identify the move of each player, six bits are transmited corresponding to the (row,column) index of each player's move.



(a) (3 pts) How many different (distinct) messages can be transmitted?

9 messages, one for each (row, col) combination

(b) (4 pts) Suppose the players are very fast and *each* make 2 moves per second (4 total moves per second). What is the data rate (in bits per second) of the communication system?

6 bits per message

× 4 messages per second

24 bits per second

(c) (8 pts) Suppose, instead of transmitting a message as each move occurs, you only transmit one message indicating the state of the tic-tac-toe board after the game is complete. Note that each square on the board can be in one of three states at the end of the game: {blank, x, o}. Devise a messaging scheme that can convey the final state of the tic-tac-toe board with less than 20 bits. You do not need to enumerate every possible message, but your messaging scheme should be explicit. Comment on the efficiency of your messaging scheme with regards to the minimum and maximum number of bits required by the original messaging scheme.

Hint: A tic-tac-toe game requires a minimum of 5 moves and can have a maximum of 9 moves.

- Could allocate two bits to each (row, col)

  00 = blank
  01 = X
  10 = O

  Then just send 18 bits to convey the state of all 9 cells.

- Note that each row has 27 possibilities. Could allocate 5 bits to cover these possibilities, e.g.

  (blank, blank, blank) = 00000
  ⋮
  (O, O, O) = 11010

  } 27 possible states of a row.

  Then we can just send 5×3 = 15 bits to convey the state of all 3 rows (all 9 cells).

- Original messaging scheme:

  minimum bits = 5 moves × 6 $\frac{\text{bits}}{\text{move}}$ = 30 bits

  maximum bits = 9 moves × 6 $\frac{\text{bits}}{\text{move}}$ = 54 bits

⇒ This new messaging scheme is 2-3 times more efficient than the original messaging scheme, but we lose the ordering of the moves.