CS 455 (Fall 2003) Mid-Term Exam.

Oct. 22nd, 2003

Print Your Name:

Read the following now.

- Write your name on *all* pages.
- You have 100 minutes to earn up to 180 points.
- For problems involving calculation, show intermediate steps to ensure partial credit (that is, in case your answers are incorrect).
- Brief and concise answers will be favored in grading.
- Write down your answers clearly. I reserve the right to take off points due to poor writing or English structures.
- One blank page is provided at the end for your convenience.

STOP! Do not turn to the next page until instructed to do so.

1. (20pt in total) Networking Architecture

   (a) (6pt) Name two layers of the OSI model that performs flow control.

   (b) (6pt) Name two functions of the Session layer according to the OSI model.

   (c) (8pt) Give two advantages and one disadvantage of network standards.

2. (40pt in total) Physical Layer

   (a) (6pt) Consider a periodic signal $x(t)$ whose period is 5 millisecond. It has been determined that harmonics up to $8f$ are required to represent the signal. Calculate the effective bandwidth of $x(t)$.

   (b) Consider a communication link with bandwidth H=4000 Hz and S/N=30dB.

      i. (10pt) Calculate its maximum data rate according Shannon's theorem.

      ii. (4pt) Nyquist's theorem cannot be applied here because a factor is unknown. Point out that factor.

(c) (8pt) Define *multiplexing* in one sentence. What is the multiplexing method of T1 line ?

(d) (8pt) Show the delay modulation encoding of the bit sequence $(1, 1, 1, 0, 0, 0, 1, 0)$, assuming that the the signal starts with the high voltage.

(e) (4pt) Give an 8-bit sequence that results in the *fastest* modulation rate with Manchester encoding.

3. (30pt in total) Medium Access Control

   (a) (10pt) Describe the purpose and the operations (how it works) of CSMA/CD in three sentences.

   (b) (6pt) Give two advantages of token-based MAC over CSMA/CD.

(c) (14pt) Consider a hypothetic Ethernet standard 5BaseX with the following specifications.

i. 3 segments of 500 meter cables can be cascaded by 2 repeaters to form networks diameters up to 1,500 meters.
ii. Signal propagation speed is 2×10^8 meters per second.
iii. Per repeater delay is 0.5 μsec.
iv. Minimum frame length is 20 bytes.
v. Data rate is 5 Mbps.

Determine whether collision detection would work with 5BaseX. Calculations are mandatory.

4. (20pt in total) Hamming Distance and Hamming Code

   (a) (5pt) We define a coding scheme as follows. For every 14 bits of data, two parity bits are added. The first parity bit is determined by even bit positions and the second by odd ones. The results are 16-bits codewords. Give the minimum Hamming Distance between any pair of valid codewords.

   (b) (15pt) Calculate the Hamming code of 1110101011.

5. (35pt in total) Cyclic Redundancy Codes
   Given the generator polynomial 1101111 and data frame 11011000011, answer the following questions.

   (a) (20pt) Compute the CRC checksum.

(b) (5pt) Show that the given generator can catch all errors involving odd numbers of bits.

(c) (10pt) Let $T(x) = 11000101110$ be the bit stream transmitted by a communication source. Due to transmission errors, it is received as $R(x) = 11010011111$. Give the error polynomial $E(x)$ of this transmission in the form of a bit stream and show that the error will not be caught by CRC using the generator 1101111.

6. (20pt in total) Sliding Window Protocols

   (a) A sliding window protocol needs a sufficiently large window to avoid "stop and wait." We have decided that a window size of 200 is needed for a given communication link. Determine the (minimum) number of bits in sequence numbers with

      i. (4pt) go-back-n protocol

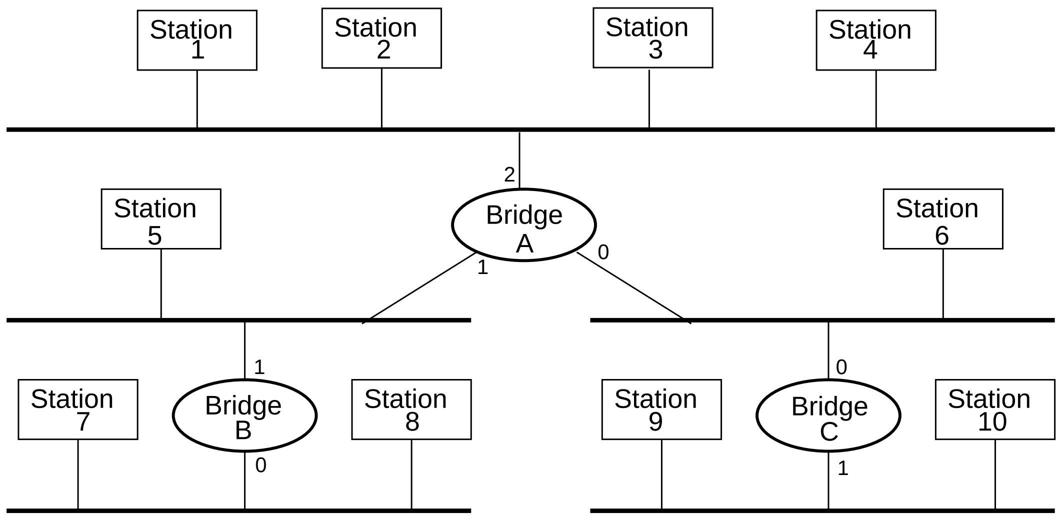
      ii. (4pt) selective repleat protocol

   (b) (12pt) In this question, you demonstrate the reason why the selective repeat protocol has the window size restriction of 2^{n-1}, where n is the length of sequence numbers. Specifically, we assume the use of the selective repeat protocol with 2-bit sequence numbers and a window of size 3. The receiver sees the following sequence of frames:

   `0 1 2          0`

   Give two plausible interpretations of the second frame 0.

7. (15pt in total) Bridges
   Consider a bridged network depicted below where all bridges are transparent bridges. Starting with empty routing caches at all bridges, show the contents of caches of Bridges A, B, and C, after Station 9 sends a frame to Station 6, Station 2 sends a frame to Station 6, and Station 10 sends a frame to Station 9.



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