Exam 1 (Midterm), Fall 2000
Computer Science 516
Computer Communication Networks
University at Albany

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1 Some Hints

Your professor suggests the following preparation strategies:

- This exam is open book and open notes (your own books and notes that is!). Calculators are permitted, networked devices are not.
- Write neat clean answers, since if the grader cannot understand you on the real exam, it will go badly for you.
- Show your work, if you are guessing the grader will not give much credit (even if you get lucky and guess right).
- Define your notation (you can use tables and/or diagrams).
- Set up the solution symbolically and simplify before plugging numbers in, it is easier to follow for the grader (and will get you most of the points).
- You can solve problems out of order, but keep the work for each problem in one place, and mark it clearly.

2 The Problems

1. Protocol Layering (15 %):
   (a) (5 %) What layer of TCP/IP is responsible for network wide addressing.
   (b) (5 %) When is segmentation and reassembly used in protocol implementation?
   (c) (5 %) On a Unix system (using the BSD TCP/IP sockets API) running many servers (say FTP, HTTP and mail) what mechanism is used to provide a unique service access point for each server?
2. Network Systems programming (20 %): Assume a BSD style sockets programming environment.
   (a) (5 %) What functionality does the accept system call provide?
   (b) (10 %) How does FTP's passive mode work? How is the port number selected in a Unix environment?
   (c) (5 %) How can a program with a single thread of control wait for (and respond to) asynchronous events on multiple sockets?
3. The Physical Layer and Information Theory (20 %):
   (a) (5 %) Downstream Cable Modems use QAM (quadrature amplitude modulation). Which parts of the wave are modulated by QAM?
   (b) (10 %) Consider the distribution of grades in all 10^6 freshmen CS students students as summarized in Table 1. Suppose that the professor conducting the sample wanted to compress and transmit the entire list of grades using Huffman Coding. The grades are originally stored as a list of ASCII characters. If the dictionary generated by the Huffman code is 256 bytes, how much space would a Huffman encoded version take, and how long is the transmission time on a 50 Kbps link? (10 %)?

Grade	Number of Students (in thousands)
A	100
B	150
C	230
D	175
E	220
W	125

Table 1: Grades List for Problem 3b

   (c) (5 %) Consider the CRC which has the generating polynomial: $G(x) = x^5 + x^4 + x + 1$.Give the CRC for the message 10010110_2.

4. Multiplexing and Telephony (25 %)

   (a) (10 Points) Consider a concentrator, as shown in Figure 1. Suppose

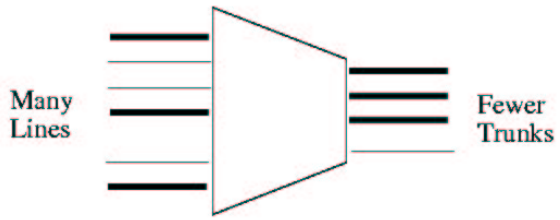

Figure 1: Multiplexing and ATM system from problem 4a

   that the offered load is 9 Erlangs. What is the minimum number of output trunks required to handle that load with a blocking probability of 1%? Show your work.

   (b) (15 Points) Consider an inverse multiplexer is used for a packet switched system. If we have two gigabit fiber link inputs with a sustained 70% utilization per link (on average).

      i. (5 %) How many 100 Mbps copper output links will we need if we are willing to have 85% utilization of the output links?

      ii. (10 %) What percentage of the input must be lost by the inverse multiplexer designed in problem 4(b)i if both input links saturate (go to 100 % utilization)?

5. Design principles and Queueing Theory (20 %): Suppose that a network interface card (NIC) implements the IP layer of the TCP/IP protocol in hardware (using a dedicated processor). Assume that when a packet is received it takes 3μsec (on average) to process the headers and trailers of received packets at the IP layer, and 6μsec (on average) for the software drivers to process the headers for the host to host layer.

   (a) (10 %) What is the maximum throughput of this system for received data if both the NIC hardware and host-to-host software can process packets in constant time? What would be the minimum response time of this system?

   (b) (10 %) Suppose that the mean interarrival time of packets into the system is 9μsec (on average), and that interarrival times and service times (both IP and host-to-host layers) are exponentially distributed. What is the expected response time and throughput of this system?