CS 536 (Park) **Midterm** **Oct. 15 (Tue.), 1996**

PROBLEM 1

(a) What is the difference between *bandwidth* and (effective) *throughput*? What are the main factors that can cause them to be different?

(b) Explain the difference between the units *bps* (bit per second) and *baud*. In modems, which one is usually bigger than the other? Give an example where the opposite is true.

(c) What property of *signals* that occur in practice makes it possible to do *signal processing* including the building of hardware substrates for communication systems? What does Nyquist's theorem say and why is it relevant to *digital* communication?

(d) A T1 link is a baseband medium employing TDM. Noting that a telephone line is assumed to have a maximum bandwidth of 4kHz, a T1 frame is expected to carry 24 voice channels (or slots), 1 bit is expended per frame for delimiting purposes, and 8 bits are used for quantization, derive the bandwidth of a T1 link.

(e) What are the main pros/cons of TDM (telephony) vis-a-vis packet switching (data communication)? What is the role of ATM (automatic teller machine) in this context?

PROBLEM 2

(a) As we traverse upward from the physical layer to the transport layer in a TCP/IP-based protocol stack, list all the demux (demultiplexing) keys and their functionality.

(b) Assuming the data link layer implements reliable service, how is it possible for IP to be unreliable? Give three reasons why an IP packet may not be able to make it to its final destination in an internetwork. Which one of the three is the most likely?

(c) Assuming a TCP/IP-based protocol stack, enumerate all the inefficiencies in terms of duplicate functionality that you can think of. Noting that optical fiber has an extremely small error rate, which of the redundant functionalities could be done away with and why is it beneficial performance-wise?

(d) In practice, why is it possible to have modems achieving, on average, faster transmission rate than the theoretical maximum ($\approx$ 30kbps) predicted by Shannon's (2nd) theorem? If you are in the business of transmitting the outcome of (unbiased) coin tosses to an attentive couch potato audience, will it do you any good to buy a modem touted by some manufacturer to run at 100kbps over phone lines? Why, or why not?

(e) What are the pros/cons of Manchester encoding vis-a-vis NRZ? Where does the 4B/5B code fit in this context?

PROBLEM 3

(a) What is the motivation behind using output-buffered switches over input-buffered ones? Give two scenarios where the relative advantage is maximized vs. minimized.

(b) Assuming a 51.2μs propagation delay on an 100Mbps Ethernet segment, what should the jam time (in bits) be? In the worst case, after how much time will a station realize that there has been a collision? Is CSMA/CD an algorithm that scales well w.r.t. bandwidth?

(c) What is a *switched Ethernet hub*? Under what conditions is it superior w.r.t. total throughput compared to the case when all stations are hooked up to a single Ethernet segment? Describe the function that the hub must perform. Is it a data link layer entity or network layer entity?

(d) What are the pros/cons of packet switching vis-a-vis circuit switching? If switch complexity is to be minimized, which design is better to use? Sketch the function that needs to be carried out at the beginning of a call or connection set up (*admission control*) under circuit switching.

(e) In the context of the socket-programming framework, sketch the structure of a concurrent server using the names of the actual system calls. What are the semantics of `accept` and why is it imperative in this context?

PROBLEM 4

(a) Sketch the access control algorithm employed by DQDB; what problem is it trying to solve? It is claimed that DQDB's access control algorithm makes the shared medium behave like a FIFO queue. In what sense is this true? Give a careful justification.

(b) Sketch a sliding window-based reliable communication mechanism that uses negative ACKs instead of positive ACKs. You don't need to specify minor details but the overall structure of your scheme should be precise. Can you think of any advantages to using negative ACKs over positive ones?

(c) Assume three hosts A, B, and C are connected via an internet where A, B reside on a common LAN, so do B, C, but A and C do not. Assuming C is a gateway and IP is run at the network layer and both LANs are Ethernets, give in excruciating detail the life of an IP packet sent from A and destined for C as it makes its way down A's protocol stack its journey toward B. Concentrate on the "address resolution" aspect of the journey as it is manifested at the various layers in the protocol stack.

(d) Describe Perlman's algorithm for building a spanning tree in a bridge-connected LAN environment. Carefully argue why it works correctly; in particular, show why it eventually terminates.