CS 422 (Park) **Midterm** **Oct. 19 (Tue.), 1999**

Remarks: There are four problems of which Problem 4 is a bonus problem carrying 20 pts. Problems 1, 2, and 3 constitute 100 pts (there are ten subproblems). Keep the answers compact, yet precise and to-the-point. Long-winded answers that do not address the key points are of limited value. Time is not meant to be overly plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (40 pts)

(a) Why is "high-speed" networks a misnomer? What is the technically more correct or precise term to use? In what sense can one defend "high-speed," if challenged, as a passable (if not the most desirable) terminology?

(b) Your modem takes digital data (i.e., bits) from your computer and transmits them as analog signals over the local loop's copper wire. Peeking into the modem, what are the two main tasks—the second is of an optional, but practically important, nature—that are performed? Can the *content*, i.e., bit pattern of the digital data, influence the actual data rate achieved by the modem? Explain.

(c) As a continuation of Problem 2, as soon as the analog signal reaches the local exchange (i.e., telephone office) it is converted back into digital form and then transported as digital signals over the telephone company's digital backbone network. Explain the main tasks involved in the digital data over digital medium transmission process. What problem can a long sequence of 0's (or 1's) cause, and how is this handled?

(d) Consider direct sequence CDMA with code rate r. Describe, precisely, under what error conditions (i.e., bit error patterns) error correction is achievable. What about error detection? Is there a separate criterion different from error correction? Explain. What are two additional desirable properties of direct sequence CDMA that are not true, in general, of other data link encoding schemes?

PROBLEM 2 (40 pts)

(a) Explain the three control components of Ethernet's CSMA/CD. Suppose we were able to conduct a CS 422 lecture, albeit with everyone blindfolded, such that communication relied solely on sound transmission. In order to convey and discuss networking material (including Ethernet) in an orderly/intelligible manner, how would one employ CSMA/CD for the "wireless communication" example at hand? Describe the behavior or protocol that each person would have to obey. What would be the meaning of MA/CD in this context?

(b) Why does the stop-and-wait protocol, in general, need a 0/1 bit marker in the header to function correctly? To make stop-and-wait perform at its best—i.e., high (reliable) throughput—what component must be carefully calibrated and how? Why is this more easily accomplished at the data link layer than when the protocol is run at the internetworking layer? Why is a window-based extension of stop-and-wait a necessity in modern networks?

(c) Give a sketch of how the token ring (e.g., FDDI) medium access control works. How does the conflict between utilization and fairness manifest itself in this context? How does FDDI resolve this problem? What is "leader election" and how is it used in the FDDI context?

(d) Protocols in the data link layer, typically, only handle error detection but not error correction. How is this justified? In real networks, is error detection foolproof (i.e., guaranteed to prevent from erroneous frames from passing through)? Explain. Under what conditions is forward error correction (FEC)—a form of error correction—carried out at the network layer a necessary feature to achieving reliable data transport? What are the two main drawbacks of this approach?

PROBLEM 3 (20 pts)

(a) LAN or MAC addresses (e.g., Ethernet) are given out by a central agency such that they are unique: no two LAN interfaces possess the same 48 bit address pattern. Given this property, why are network addresses (e.g., IP) created and employed for internetworking? What is subnetting and how is it related to the aforementioned question? Give a sketch of a router in terms of its operation or function when internetworking—i.e., communication between two or more LANs—is done with MAC addresses only. What difference (if any) exists between this router and a bridge?

(b) What are the pros and cons of packet switching versus circuit switching? What are the two principal functions of IP? Is IP necessarily a packet switched internetworking mechanism? If not, what part of IP makes it packet switched and how can it be made to follow a circuit switched scheme?

BONUS PROBLEM 4 (20 pts)

The Internet has been dominated by the *end-to-end paradigm* which puts heavy preference on performing a networking function—if possible—end-to-end as opposed to per hop (i.e., between every pair of directly connected network devices). A case in point is reliability where ARQ is carried out in the transport layer by TCP rather than per hop at the network layer. Assuming new routers are designed to run ARQ per hop, what are the pros/cons of the new design vis-à-vis the current design?