CS 536 (Park) **Midterm** **Oct. 24 (Wed.), 2001**

PROBLEM 1 (40 pts)

(a) There are two fundamental approaches to reliable communication: ARQ and FEC. What are their pros/cons? Are either guaranteed to work correctly?

(b) When discussing signal propagation in wireless communication, it was stated that the signal strength of the receiver, in free space, varied proportionally to $1/f^2$ when viewed from the frequency perspective. It was thus concluded that when frequency doubled, i.e., $f \rightarrow 2f$, the cell size would have to decrease 4-fold (hence 16-fold in 2-D) to maintain the same power level. Noting that the received signal power depends on distance $\propto 1/d^2$, is the aforementioned conclusion accurate? What is the increase in cell density that reflects both frequency and distance dependence?

(c) Discuss the pros/cons of CSMA/CD vs. token ring as different approaches to medium access control, especially as it relates to the traffic load (i.e., number of users) impinging on the system. Does it make sense to use a token ring protocol for wireless LAN communication? If so, how would it work?

(d) FDM underlies the growth in data rate achieved in broadband communication. Is FDM necessarily analog or digital? What would digital FDM mean? What are its merits vis-à-vis analog FDM?

PROBLEM 2 (30 pts)

(a) What is the fundamental difference between wired LANs and wireless LANs from the multiple access control perspective and their achievable data rate, when the shared medium is accessed by many users?

(b) Assume you are using Stop-and-Wait for reliable communication. Given frame size X (bits), RTT D (msec), and bandwidth B (bps), express the throughput achievable by Stop-and-Wait as a function of X, D, and B. Is your expression still valid if every frame/packet is lost—e.g., due to transmission errors—with probability p? Assuming the losses across different frames occur independently, ascertain the impact of p on reliable throughput where retransmissions are counted only once toward throughput.

(c) What is the hidden station problem, and how is it addressed in CSMA/CA?

PROBLEM 3 (30 pts)

(a) What are the trade-offs between positive ACK and negative when using ARQ for reliable communication? Sketch how ARQ, with negative ACK, would work. Are there additional challenges? Which one would you prefer, and why?

(b) What are three key simplifying assumptions—in decreasing order of relevance—in the analysis of the CSMA/CD protocol discussed in class? What are the qualitative consequences of each assumption on the utilization of the system? Was our analysis optimistic or pessimistic?

BONUS PROBLEM (15 pts)

Given that data link layer addresses are globally unique and internetworking can be achieved, in principle, by protocols at the data link layer, is there a case to be made for creating a protocol layer above the MAC layer? Discuss your reasoning.