CS 536 (Park) **Final** **Dec. 11 (Tue.), 2001**

PROBLEM 1 (40 pts)

(a) Give a technical definition of congestion. Is packet loss synonymous with congestion? Can a router, with respect to its raw throughput, experience congestion? Explain your reasoning.

(b) Consider two hosts communicating over an internetwork where the protocol stack is comprised of TCP-over-IP-over-Ethernet. Describe all the possibilities by which packets can be discarded or corrupted. Also, describe all the recovery mechanisms at play in the 3 layers of the protocol stack to handle corrupted and dropped packets.

(c) Cellular (telephone) networks operating at macrocell radius use TDMA and CDMA to affect multiple access rather than use CSMA/CA. What's wrong—if anything—with using CSMA/CA as the MAC protocol?

(d) How are the underlying principles for routing different for intra-domain routing vis-à-vis inter-domain routing? Describe how routing table look-up is done at the intra-domain level using the following example: host A sends an IP packet to host B; host A is connected to router R_1 through Ethernet LAN L_1, router R_1 is connected to host B through another Ethernet LAN L_2.

PROBLEM 2 (30 pts)

(a) What is the technical meaning of congestion collapse? Describe the process by which it can arise. What is a practically sufficient condition for preventing congestion collapse from occurring? How is this related to TCP?

(b) Define what Poisson traffic is in discrete time. Let p_k be the probability of observing k consecutive packet arrivals. How does p_k vary as a function of k? Are packet arrivals "strongly" or "weakly" correlated? When we aggregate Poisson traffic over larger and larger time scales, why does the resultant traffic profile become rapidly flat? For traffic engineering purposes, is this good or bad? Explain.

(c) IPv6 allocates 128 bits for IP addresses to deal with the address depletion problem. Given that IPv6 is only partially deployed, how is the address depletion problem for inter-domain routing handled given that Class A, B and C addresses make inefficient use of their assigned address space? What does 128.10.27.22/25 mean? (*Hint: Recall CIDR and prefix matching.*)

PROBLEM 3 (30 pts)

(a) Describe the essential differences with respect to performing network control—in particular, MAC protocol and TCP performance—across three wireless networking contexts: wireless LAN, cellular networks and satellite networks. In your view, which one is the "hardest" and why?

(b) Internet traffic has been shown to be highly correlated across large time scales. Discuss the pros/cons of correlated traffic for traffic engineering purposes. What is considered the fundamental cause of correlatedness in Internet traffic? (Note: Discovery of this phenomenon was made in the late 1980s and early 1990s, well before the advent of the World Wide Web and MPEG video.)

(c) Why is congestion control different—i.e., more difficult—than temperature control of a room governed by a thermometer? Describe the key differences and their impact on control. In which category does Problem 5 of Assignment IV fall? Would linear increase/exponential decrease be a fitting control for the pseudo real-time audio player? If so, why, if not, why not?

QUAL I PROBLEM (For students taking Qualifier I only)

Assume WWW stands for "Wild Wild West" instead of World Wide Web, and you are given the task of creating a variant of TCP—call it TCP-Greedy—which is expected to achieve significantly higher throughput than other TCP protocols. This is to be accomplished by exploiting the "gentlemanly" or cooperative nature of TCP, which backs off when it thinks it has detected congestion via potential packet loss. How would your TCP-Greedy work? Describe its workings in a 2-connection scenario where one of the connections runs regular TCP and the other runs TCP-Greedy. What are the technical challenges associated with designing a super-effective TCP-Greedy protocol? Is there a danger of "shooting oneself in the foot?" What happens if all connections use TCP-Greedy?