CS 422 (Park) **Final** **May 5 (Thu.), 2005**

Remarks: Keep the answers compact, yet precise and to-the-point. Long-winded answers that do not address the key points are of limited value. Binary answers that give little indication of understanding are no good either. Time is not meant to be plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (40 pts)

(a) What is the end-to-end paradigm? How has it influenced the design of the Internet? What is the smart sender/dumb receiver design rule? Give an instance where it is employed in place of a more natural alternative (e.g., think of TCP). In what instance should it be violated?

(b) What is the TTL field in the IP header and how did it come into being? Is the original motivation for TTL still a valid problem today? What has changed? For what other practical purpose is the TTL field being used today?

(c) What are the two key functionalities of TCP? What are its two lesser ones? What is the main functionality of UDP? Why is UDP preferred over TCP when sending (pseudo) real-time multimedia streaming audio/video? Why not directly use raw IP?

(d) Describe how intra-domain and inter-domain routing decisions come into play when sending an IP packet from the REC108 lab at Purdue to one of Cisco's web servers in San Jose on the west coast. Note that the first tier-1 provider the packet hits on its journey is Level3 at a POP in Chicago.

PROBLEM 2 (30 pts)

(a) What are dynamically assigned IP addresses? What is the distinction between NAT and NAPT? Does NAT, strictly speaking, increase the usable global IP address space? How does NAT tie in with non-routable IP addresses in the context of home networks? Does Purdue use non-routable IP addresses? If so, for what purpose(s)?

(b) What is the technical distinction between stub and transit domain (i.e., autonomous system)? Why is it essential for global reachability that tier-1 providers peer with each other? Why is it not a purely technical matter when a tier-2 provider attempts to swim with the big fish and become tier-1? What are the driving motivations for content and access providers to peer with each other? Is this still advised in today's bandwidth market?

(c) In what way is congestion control `Method B` superior to `Method A`? Why does TCP use linear increase/exponential decrease (`Method B`) when there is a superior `Method D`? Which method is used for multimedia streaming? What might happen if TCP were used instead?

PROBLEM 3 (30 pts)

(a) What class does the IP address 128.10.9.25 belong to? Supposing 8 bits are used for the host ID in subnetting, what will a 3-column IP route table within Purdue that contains reachability information for 128.10.9.25 look like? What happens at such a router when an IP packet with destination address 128.10.9.11 arrives, supposing that the router is directly connected to a LAN to which 128.10.9.11 is connected to? List the route table look-up and forwarding steps. What is the key difference when the router in question is not connected to a LAN that directly connects 128.10.9.25 (i.e., at least another IP router needs to be traversed before a LAN connecting 128.10.9.25 can be reached)?

(b) What is the 2-person consensus problem and how does it affect TCP connection tear-down? Is TCP's solution correct? Describe a scenario where connection tear-down leads to a corrupted state at the sender/receiver. Why is this a practically relevant problem? Is there a fundamentally better solution to the connection tear-down problem? What about connection set-up?

BONUS PROBLEM 4 (15 pts)

What is the tragedy of commons and how does it impact congestion control on the Internet? Describe the design principles underlying a selfish congestion control protocol that would "steal" bandwidth away from TCP over a shared bottleneck link. How would you implement the selfish protocol as a variant of TCP? What, if anything, prevents users from deploying selfish file transfer protocols on the Internet? Is it easier or more difficult to deploy selfish versions of CSMA/CA in WLANs? Explain your reasoning.