Stanford University
Computer Science Department

Fall 2003 Comprehensive Exam in Networks

1. **Closed Book/ No Laptops & Notes Write only in the Blue Book.**
2. **The exam is timed for 60 minutes.**
3. **Write your Magic Number on the Blue Book.**

The following is a statement of the Stanford University Honor Code:

A. The Honor Code is an undertaking of the students, individually and collectively:

1. *that they will not give or receive aid in examinations; that they will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading;*
2. *that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.*

B. The faculty on its part manifests its confidence in the honor of its students by refraining from proctoring examinations and from taking unusual and unreasonable precautions to prevent the forms of dishonesty mentioned above. The faculty will also avoid, as far as practicable, academic procedures that create temptations to violate the Honor Code.

C. While the faculty alone has the right and obligation to set academic requirements, the students and faculty will work together to establish optimal conditions for honorable academic work.

By writing my Magic Number below, I certify that I acknowledge and accept the Honor Code.

Magic Number----------

Comprehensive Exam: Networks (60 points) **Autumn 2003**

1. (15 points total) *End to end*

   (a) (8 points) Define the so-called "end-to-end argument" in networking, and describe the key way this principle has affected the design of the Internet.

   (b) (7 points) Describe briefly how an Internet ebanking would be structured to be truly "end-to-end", focusing on the basic debit-credit transactions.

2. (15 points total) *TCP transport protocol* TCP was originally described and implemented as a go-back-N protocol with respect to its error control.

   (a) (8 points) Describe what this means, illustrating with a time-based diagram of packet exchanges including a single data packet loss. (You can assume the connection is already set up.)

   (b) (7 Points) Provide a formula for determining the TCP maximum throughput for a given packet drop rate D, introducing whatever additional parameters/variables you need, e.g. max link data rate R, MTU M, etc. and assuming that only data packets are dropped, there is at most one drop occurring per go-back-N event, and the transmission rate in the absence of drop is only limited by the link rate.

3. (15 points total) *Virtual Circuits vs. Datagrams* The UN has decided to jump in to mediate the never-ending dispute between the "virtual circuit" (VC) nerds and the "datagram" nerds of networking. You are called upon to provide quantifiable evaluation of the two approaches.

   (a) (5 points) Regarding bandwidth consumption, describe how you would quantify the bandwidth cost differential between VCs and datagrams, defining any parameters (e.g. difference in header size D) that you need, and assuming separate network layer packets are used to setup and teardown VCs and there is some reasonable limit on number of VCs per host.

   (b) (5 Points) Considering memory consumption in the routers and the endpoints, describe how you would quantify this cost between VCs and datagrams. (You can give formulae or just provide a convincing description that you know the key parameters and how they affect.)

   (c) (5 points) What cost factors would you consider most significant between VCs and datagrams as the Internet scales (you can consider others, such as processor cycles), why, which of VCs vs datagrams would you favor, and why?

4. (15 points total) *Ethernet*

   (a) (6 points) Describe the key extension that the Ethernet media access control (MAC) protocol, CSMA-CD, makes over Aloha network protocol and explain what effect this has on its performance characteristics.

   (b) (5 points) The ATM boys used to claim that Ethernet could not be scaled to higher speeds than 10 MBPS yet now we see 10 GBPS Ethernet emerging (after 100MBPS and 1 GBPS). What the basis of their argument (or any argument) that you could not scale Ethernet to higher speeds and how has industry gotten around this?

please turn over

(c) (4 points) Peterson and Davie say: "it might seem that a wireless protocol would follow the exactly the same CSMA-CD algorithm as Ethernet" as a lead-in to why not. Describe why not and what 802.11 does about it.

The End