Stanford University
Computer Science Department

Fall 2005 Comprehensive Exam in Networks

1. **Closed Book, - NO laptop. Write only in the Blue Book provided.**
2. **The exam is timed for one hour.**
3. **Write your Magic Number on this sheet and the Blue Book; DO NOT WRITE YOUR NAME.**

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 un-permitted 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)
Closed Book: Autumn 2005

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

   (a) (5 points) Define the so-called "end-to-end principle" as applied to the Internet.

   (b) (5 points) In the deep slumber of the night, the ghost of Albert Einstein comes to you, exhorting you to not take the end-to-end principle on faith, but to realize that it can be justified based on probabilistic analysis. That is, a given probability of undetected failure can be achieved at a lower cost using an end-to-end design rather than the alternative(s?). Give an example of a simple end-to-end design and probalistic analysis that supports Albert's position, or else argue that this is nonsense (perhaps induced by Albert's discomfort with entanglement).

   (c) (5 points) There is a known major risk to high winds coming up when fighting forest fires in steep terrain. In the summer of 1994 in Glenwood Springs, Colo., 13 firefighters died tragically when the wind came up in a steep canyon in which they were fighting a forest fire (mirroring a similar trajedy in 1949). In the book "Fire on the Mountain," John N. Maclean makes the case that bureaucratic bungling led to a revised weather report at the weather bureau not making it to these firefighters to warn them to leave the area. How would an "end-to-end" firefighter operate, and how might that affect Maclean's analysis?

2. (15 points total) *Transport Protocol Design*

   (a) (8 points) TCP maintains two key dynamic values per connection: 1) a round-trip estimation and 2) congestion window size. For each, describe in brief: i) how it is computed, ii) how is it used, iii) how it can be confused, and iv) what is done to minimize this confusion. (Your answers to iii) and iv) can be included in i) as long as you make clear what the challenges are in computing each accurately and the techniques used to address them, and you can focus on any particular published algorithms for i), if you are aware of several.)

(b) (7 points) Imagine that Osama Bin Laden (OBL) has gained control of the backbone Internet routers, but the Mullahs have ordered (for some curious reason) that he is limited to just being able to drop up to K percent of the packets, but can decide which ones to drop, at least based on L3/L4 properties. (The fatwa says he is not allowed to drop more or inject or modify traffic, thank you, Mullahs!) Describe your analysis of what OBL's best strategies are for interfering with Internet usage and the minimum values of K required to do so.

3. (15 points total) *Network Routing*

   (a) (7 points) Describe an example network that includes alternative routes between several different nodes with different costs, and show how distance-vector routing works on this network. Illustrate how distance-vector routing can behave badly on this network, giving a specific failure scenario.

   (b) (8 Points) Describe how BGP avoids loops as well as the tradeoff it makes between stability, scalability, lowest cost routes and policy, illustrating with an example.

4. (15 points total) *Ethernet*

   (a) (6 points) The phrase "Ethernet spanning tree loop" strikes terror into the hearts of LAN network operators everywhere. Describe what this is, why it arises, and whether or not such "loops" occur at the IP level, justifying your answer.

   (b) (5 points) Draw a graph of the throughput of a local area network as a function of (increasing) offered load, indicating its behavior depending on whether it is using pure Aloha, slotted Aloha or CSMA-CD as its access protocol. Justify the difference in performance characteristics for each.

   (c) (4 points) Peterson and Davie say: "It might seem that a wireless protocol would follow 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