CS 438 Communication Networks — Spring 2014

Homework 1 — Due Date: February 5

1. Please answer the following short-answer questions within a few sentences:
   a. One of the hardest things about running a computer network is being able to figure out what's going on when something goes wrong (e.g., protocol errors, link failures). Propose an architectural modification would you make to the Internet to simplify diagnostics. \Describe the pros and cons of your approach.
   b. Why don't we use DNS names in place of IP addresses in IP packets? What would be the benefits/downsides of doing that?
   c. Why not get rid of the IP layer, and directly implement transport atop IP?
   d. Does the Tor anonymity network (www.torproject.org) violate the end-to-end principle? Why or why not?

2. Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:
   a. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
   b. Suppose that a packet -switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

3. Hosts A and B are separated by 20,000 kilometers and are connected by a direct link of R = 2Mbps. Suppose the propagation speed over the link is $2.5 * 10^8$ meters/sec.
   a. Calculate the bandwidth-delay product, $\mathrm{R} * d_{proc}$.
   b. Suppose Host A needs to send a file of 800,000 bits continuously as one large file to Host B. What is the maximum number of bits that will be in the link at any given time?
   c. What is the width (in meters) of a bit in the link?
   d. Derive a general expression for the width of a bit in terms of the propagation speed s (meters/sec), the transmission rate R (bps), and the length of the link m (meters).

4. Consider a packet of length L which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate of link i, for $i = 1, 2, 3$. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, and L, what is the total end-to-end delay for the packet?

Suppose now the packet is 1,500 bytes, the propagation speed on all three links is $2.5 * 10^8$m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. Calculate the end-to-end delay.

5. A client is trying to connect to a web server which can only accept an average of one connection request in 10 connections.
   a. What is the probability the client builds a connection successfully on the first attempt?
   b. What is the probability the client builds a connection successfully on the second attempt?
   c. Derive the probability the client builds a connection successfully on the nth attempt?
   d. If the client is only willing to try 10 times, what is the probability of failure to get a connection?
   e. How many times would the client expect to try before getting a connection? Explain your answer.

6. Networking utilities whois, ping and traceroute
   a. The Unix utility whois can be used to find the domain name corresponding to an organization, or vice versa. The information is provided by a domain name registration service provider. Read the man page for whois and experiment with it. For example, try whois cnn.com. The response should tell you that cnn.com is registered on the server whois.corporatedomains.com owned by CORPORATE DOMAINS, INC. Try whois facebook.com.
      You need to turn in: (i) the phone # of the technical contact, (ii) both the English language names, and the internet addresses of all nameservers, and (iii) the date and time this record was last updated.

   b. The Unix utility ping can be used to find the round trip time (RTT) to various Internet hosts. See the man page for `ping` to see how to use `ping` and the `-s` option with other options to see how you can control the time between ping packet transmissions, and to display the resulting round trip times. Upon interrupting execution of `ping`, the min, average and maximum RTT will also be displayed.
      You need to turn in: the minimum, maximum, and average (average over five pings) round trip times for pings to the nameservers for `youtube.com`, for `apple.com` and for `google.com`. If there are multiple nameservers for a domain, use the first one listed.

   c. The Unix utility `traceroute` is like ping, but it sends packets that are limited to go one hop, then two hops, then three hops, and so on, towards a given destination, and the intermediate routers are reported. Read the man page for `traceroute` and experiment with it. Try `traceroute www.google.com`, or equivalently `traceroute`

`72.14.203.104`. How many routers are encountered along the way? You can try identifying the intermediate routers further using `ping`.

You need to turn in: (i) the internet address of the seventh router encountered for the `traceroute` to `www.google.com`. (ii) `ping` that router and report whether `ping` and `traceroute` report the same round trip times to that router.