

Network Overview, Utilities and Basic Probability

Assigned reading: Peterson and Davie: Chapter 1

All problems carry equal weight. To receive full credit, show all of your work.

1. Your company has a large data store to back up every week and you want to find the quickest possible way to get your backup off site. You have two choices: (1) use your high-speed internet connection and transfer all of the data over the internet or (2) copy your data to a flash drive and drive it over in your car. Your internet connection is over an OC3 line (155.52Mbps), and you copy to your flash drive via high-speed USB (480Mbps), each flash drive holds 32 GB and you live two hours away from your storage location. If you have 4TB of data to back up every week. Answer these two questions (a) How many flash drives would you need with option #1? (b) Which transmission method has the higher data rate?

2. Consider two machines, A and B, connected by a 1 Gbps Ethernet with four store-and-forward relay switches on the path between them. Suppose that no other machines are using the Ethernet, that each of the three links introduces a propagation delay of $3\mu\text{s}$, and that a switch begins transmitting a packet immediately after receiving the last bit of the packet.
 - a. What is the total transfer time for a 1500B packet, as measured from transmission of the first bit at A to receipt of the last bit at B?

 - b. What is the effective bandwidth for transmission of a large file from A to B, assuming that packets of size 1500B are used and that packet headers are 120B long? Assume that the nodes can send constantly, and in particular that the switches can simultaneously receive a packet from one side while transmitting a previous packet out the other side, and that A is not slowed down waiting for acknowledgements.

 - c. What is the effective bandwidth if, after each transmission of a 1500B packet, node A must wait for a 40-byte acknowledgement from B? For simplicity, you can assume there are no packet headers.

3. Suppose users share a 1 Gbps link. Also suppose each user requires 180 MBps when transmitting, but each user only transmits 8 percent of the time.
 - a. When circuit switching is used, how many users can be supported?

 - b. For the remainder of this problem, suppose packet switching is used. Suppose there are 30 users, and each user is equally likely to transmit at any point in time (e.g., there are no correlations in sending times across users). Find an equation for the probability that at any given time, n users are transmitting simultaneously.

 - c. What is the probability that the link will get overloaded?

4. For each of the following links, compute how many bits can be “in flight” at any point in time (i.e., how many bits are within the link itself, as opposed to being stored in queues at the link endpoints). Use one-way delay, measured from first bit sent to first bit received.

- a. 1 Gbps Ethernet with a delay of 4 μ s.
- b. 1.5-Mbps T1 link, with a one-way delay of 30 ms.
- c. 10 Mbps link through a satellite in geosynchronous orbit, 35,000 km high. The only delay is speed-of-light propagation delay.

5. 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 facebook.com`. The response should tell you that `facebook.com` is registered on the server `whois.tucows.com` owned by TUCOWS INC. Try `whois myspace.com`. Now try `whois -h <whois server for myspace.com> myspace.com`. You will find out a lot more information. Here is what you need to turn in: (i) Give the phone # of the technical contact, (ii) Give both the English language names, and the internet addresses of all nameservers, and (iii) Give 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. Here is what you turn in: Report the average (average over five pings) round trip times for pings to the nameservers for `facebook.com`, for `myspace.com` and for `linkedin.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 64.233.189.99`. How many routers are encountered along the way? You can try identifying the intermediate routers further using `ping`. Here is what you need to turn in: (i) Give the internet address of the ninth router encountered for the `traceroute` to `www.google.com`. (ii) Also, `ping` that router and report whether `ping` and `traceroute` report the same round trip times to that router. (iii) Which states of the USA does your packet traverse through?