CS 9868 Internet Algorithmics
Assignment 1: Graduate and Undergraduate Students
Due October 5 during class

To answer some of the questions you will need to use network related UNIX or Windows commands. If you are not familiar with the commands, please read the UNIX man pages (type `man command-name`) or the Windows help.

1. (5 marks) Use the `host` (`/usr/sbin/host` or `/usr/bin/host`, depending on where you are logged on) command in any UNIX server where you have an account or the `nslookup` Windows command, to determine the IP address of at least one of the computers in the UWO's computer network. To use the commands you need to open a command window or a console and type either `host symbolic_name` or `nslookup symbolic_name`, where `symbolic_name` is the symbolic name of the computer. Report both, the symbolic name and IP address of the machine that you have selected. Assuming the classful IP addressing scheme, which class of IP addresses (A, B, C, D, or E) are assigned to the computers in the University's network? Which is the prefix (network number) shared by all IP addresses in this network? Up to how many different computers can belong to this network?

2. (15 marks) Use the `ping` command (`/usr/sbin/ping`) to estimate the number of actual computers in the UWO network assuming the classful IP addressing scheme. To do this, generate a list L of random IP addresses of the type and network number that you determined in the previous question. Issue a `ping` command for each one of these IP addresses (`ping IP_ADDRESS` and determine the fraction of L that corresponds to actual computers. Use this fraction to estimate the size of the University's network. Use a list L with as many IP addresses as you can.

   Show the list L that you used, the fraction of addresses that correspond to actual machines, and your estimate for the size of the network.

3. (5 marks) Use the `ipconfig /all` command in Windows or `ip addr show` command in UNIX to get the IP address of your computer in CIDR notation: `ip address / number of bits of network number`. Report the network number and computer number for your machine. Up to how many computers can belong to the subnetwork to which your computer is connected?

4. (10 marks) Use the `traceroute` (or `/usr/sbin/traceroute`) or `tracepath` UNIX command or the `tracert` Windows command (`traceroute symbolic_name` or `tracert symbolic_name`) to find the number of hops between your computer and remote destinations (e.g. to servers hosting Web sites). The maximum number of hops between two computers in the Internet is called the *diameter of the Internet*. Report on the maximum number of hops that you can find. Include the list of servers contacted by `traceroute` and their possible geographical locations (if you can find them). To try to find the geographical location of an IP address you can use one of several available Web services, like *IP2Location* (www.ip2location.com), or *IP Location* (www.iplocation.net).

5. (15 marks) Consider a network with a bus topology where 2 computers, A and B, wish to transmit messages at the same time. After a collision is detected each computer stops transmitting and waits for a random time selected from $\{1, 2, ..., d\}$. Upon waiting for the randomly selected time each computer checks the bus to to see if is free, and if so it starts transmitting again. If a new collision is detected the above process is repeated, until one of the processors is able to successfully transmit. Assume that $d = 3$ and that the value of d never changes.

   Assume that only computers A and B wish to transmit. After detecting the first collision,

- (5 marks) what is the probability that there will not be a second collision?
- (10 marks) What is the probability that exactly k rounds of the above procedure are needed before one of the computers can transmit?
 **Hint.** During $k-1$ rounds there will be collisions and in the k round the computers choose different random waiting times. Hence, the probability that k rounds are needed is
  probability of a collision in first round × probability of collision in second round × $\cdots$

6. (15 marks) Download the network analyzer called Wireshark from www.wireshark.org and install it on your computer. Run the program and select a network adapter where you see some activity (a wiggly line shows network activity). Click on the blue icon at the upper left corner to start capturing packets. Open in a browser the website of the Department of Computer Science and once the page has been loaded, click on the red square on the upper left corner of Wireshark's window to stop capturing packets. Find a network packet containing a datagram that was sent by your computer (to do this find a packet whose source address matches the IP address of your computer and whose protocol is HTTP).

   - Show the first 34 bytes of the package in hexadecimal notation.
   - Show the MAC source address and the MAC destination address contained in the header of the network packet in hexadecimal notation.
   - For the datagram contained in this network packet, show the following information in decimal notation or dotted decimal notation:
     - Protocol version number
     - Header length
     - Total length of datagram
     - Time to live
     - Source IP address and destination IP address

   If you are unable to run Wireshark, there are some network packets in the course's website that you can use to answer the above questions, but please try to run Wireshark and use it to learn to capture network packets. There are several online Wireshark tutorials, in case you are having trouble running the program.

7. (15 marks) Show the routing table for router R_1 in the following internet. The routing table should have two columns, one for the destination and the other for the next hop. Assume the classful IP addressing scheme. When R_1 is directly connected to the network containing the destination IP address, just write "deliver direct" in the corresponding entry of the routing table. For simplicity, assume that each router has only one IP address.
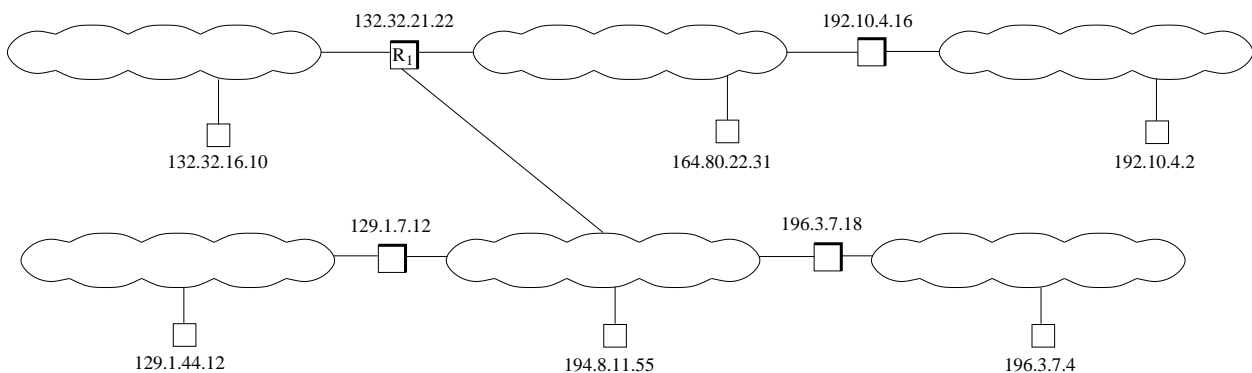
8. (20 marks) Consider the following internet. Assume that computer A needs to send a message m of length 500 bytes to computer B. Show the packets that are transmitted through each one of the networks so message m is delivered to B. The networks can transport packets of total length (including the header) at most (a) 1000 bytes for network 1, (b) 400 bytes for network 2, (c) 800 bytes for network 3. Use the following conventions:

- Each network packet has a header and the data. Specify a network packet for Network i as follows:

  [**packet header**: source MAC addr., dest. MAC addr., control bits for Network i; **packet data**: data]

- The lengths of the network packet headers for each network are as follows: network 1: 20 bytes, network 2: 30 bytes, network 3: 20 bytes.

- Specify datagrams as follows:

  {**datagram header**: source IP addr., dest. IP addr., rest of header; **datagram data**: data length}

- Assume that all IP datagrams have a header of length 20 bytes.

- To specify a MAC address just write "MAC address of x"; for example, "MAC address of A", "MAC address of R_1", and so on.

- To specify the IP address of a computer just write "IP address of x"; for example "IP address of A", "IP address of R_2, and so on.

- Show the packet(s) that are transported by each network:

  Network 1 packet(s): ...

  Network 2 packet(s): ...