15-441 Computer Networks
Homework #2
Out: 2/10/05 Due: 1:30 PM 2/17/05

Instructions: Please type or *neatly* handwrite a solution to each of the following questions. For full credit, please explain how you derived an answer; don't just give the final result. papers are due at the beginning of class on Thursday, February 17, 2005.

Follow the instructions below to set up your account on the netclass machines. You won't be able to log in if you don't follow everything completely. We will be using these machines more extensively in later homework assignments, at which point you will learn more about the setup of the netclass cluster, so you should ensure that your account works properly now.

1. Create a directory in your Andrew home directory called 15-441.
2. Now you need to give access to *campusnet* by typing the following:
   (a) fs sa /afs/andrew.cmu.edu/usr/[your_username] system:campusnet l
   (b) fs sa /afs/andrew.cmu.edu/usr/[your_username]/15-441 system:campusnet rl
3. Create a file called *.klogin* inside the 15-441 folder which contains: **your_username@ANDREW.CMU.EDU**
4. Use *ssh* to connect to netclass machines. The username will be your_username@ANDREW.CMU.EDU, not just your Andrew id. If you use *ssh* don't forget to use the "-l" flag with the correct username, otherwise ssh will try to use just your Andrew id and you will not be able to login. **You must also specify "-1" to indicate that *ssh* should use protocol version 1.** (e.g. *ssh -1 -l your_username@ANDREW.CMU.EDU netclass-1.intro.cs.cmu.edu*)
5. If you have problems logging in, send email to Ed Bardsley (ebardsle@andrew.cmu.edu)

Homework Exercises:

1. Suppose a router has built up the following routing table. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3 or R4. Assume the router does a longest

prefix match. Describe what the router does with a packet addressed to each of the following destinations: [Peterson and Davie 4.21]

Subnet Number	Subnet Mask	Next Hop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
(default)		R4

(a) 128.96.39.10

(b) 128.96.40.12

(c) 128.96.40.151

(d) 192.4.153.17

(e) 192.4.153.90

2. Give an example of an arrangement of no more than ten (10) routers grouped into no more than five (5) autonomous systems so that the path with the fewest hops from a point A to another point B crosses the same AS twice. Explain what RIP would do in this situation. Explain what BGP would do in this situation.

3. The program *traceroute* allows you to find out the path (i.e. sequence of routers) that a packet will follow to a specific destination. The routers along the path are often identified by name, which means that you can learn the identity of the various ISPs that your packets travel through.

   For this problem use *traceroute* (in /usr/sbin/) to record the path taken by packets from a CMU host to:

   - www.lcs.mit.edu
   - www.freebsd.org
   - www.qf.edu.qa

   (a) Can you identify the Autonomous System number for each router? Attach a printout of the traceroute output and mark which routers belong to which AS, if an AS can be identified. (Hint: you can use the command *whois -h radb.ra.net [IP address]* or *whois -h whois.arin.net [AS #]* to get more information.)

(b) Can you identify the ISPs used in the above queries? On the printout from the previous question mark which ISPs use which routers. (Hint: look at the router names, and try to visit the corresponding web site.)

(c) Try to classify the ISPs as local, regional, or backbone.

(d) What is the name of CMU's local ISP?

(e) Notice that CMU uses different backbone ISPs depending on the destination. Experiment with the route taken by packets to different destinations (academic, commercial, national, international, etc.). What observations can you make about which backbones traffic to different kinds of destinations is routed over?

4. ssh to one of the *netclass[1-10].intro.cs.cmu.edu* machines. Use the *ping* command to contact *netclass-11*. Ping will cause your local host to create an entry in the arp cache for this host. Find the IP and hardware address of *netclass-11*. (Hint: lookup the *arp* command.)

   Now we want to get the Ethernet hardware address and the IP address for the Ethernet interfaces on *netclass-3*. For each of eth0 and eth1, what is the IP address and hardware address? (Hint: lookup the *ifconfig* command.)

   Which ethernet card is used for the default route? (Hint: lookup the *netstat* command.)

5. You are part of the first manned exploration mission to Mars. After a long trip you arrive on Mars, and your team discovered the remains of an ancient civilization. More interestingly, they have discovered that the former Mars inhabitants use 10Mbps shared media Ethernet for computer communications. Since you took 15-441, you are given the task of analyzing their Ethernet infrastructure. [Spring 2003 Midterm]

   The first thing you discover is that, since copper was apparently not known on Mars, the Ethernet cables are made out of a material completely unknown to mankind. Otherwise, the Ethernet protocol and parameters used (packet format, MAC, physical characteristics, ...) are identical to the ones used on Earth, except for two parameters: the minimum and maximum frame size.

   (a) The minimum frame size on the Mars Ethernet is 128 bytes, compared to the Earth version (64 bytes). Can you explain why the Martians decided to change the minimum frame size?

(b) The maximum frame size is 4000 bytes, compared to 1500 on Earth. Can you explain why the Martians may have increased the maximum frame size?

(c) What are the potential drawbacks of a larger minimum frame size and a larger maximum frame size?

When you try to report your findings to mission control on Earth, you discover that transmission is extremely slow. You can only send one picture (of 1000x1000 pixels, 8 bits per pixel) every 3 hours (every 10,000 seconds, to be exact)! The radio link transmits at 800 KBits/second, but the average bit rate you are achieving to mission control is only a fraction of this speed.

Again, you are asked to apply your 15-441 expertise to diagnose this problem. After some digging, you discover that the communication link uses a very simple point-to-point datalink protocol: it uses flow control and assumes that the transmission channel is reliable. The packet size of 1000 bytes. You also discover that the radio transmission system was originally built for the Apollo 11 mission to the moon. You immediately suspect that the engineers who built this Mars shuttle did not take 15-441!

	Moon	Mars
Diameter (km)	3500	6800
Distance to Earth (km)	390,000	390,000,000
Distance to Sun (km)	150,000,000	230,000,000

(d) Do you think you can explain the problem? Please be precise and give numbers. We have provided some information (which may or may not be relevant) above about distances at the time of the mission. Also, the speed of radio waves in a vacuum is 300,000 km/second.

(e) How would you fix the problem? Again, be precise. How practical do you think this is?