Carnegie Mellon

Computer Science Department.

15-744 Spring 2007 Problem Set 2

This problem set has 4 questions (each with several parts). Answer them as clearly and concisely as possible. You may discuss ideas with others in the class, but your solutions and writeup must be your own. If you do discuss at length with others, please mention in your solution for the problem who you collaborated with. Do not look at anyone else's solutions or copy them from anywhere.

This assignment is due by **5:00pm, Wed, Oct 14th** to the course secretary in Gates 9118.

A BGP Tables

1. Route servers (e.g. those available at `http://www.traceroute.org/#Route%20Servers`) are BGP speaking routers with a publicly accessible interface. In other words, you can telnet to these routers and access their full BGP tables.

   `route-views.oregon-ix.net` is one such route server hosted at the University of Oregon. One use of this route server is that you can potentially get the route(s) from any AS X to any AS Y at an AS path level. You can also get the routes that *almost* any AS X would take to reach a given address prefix P.

   For this exercise, download the following routing table entries from the RouteViews server at:

   `http://www.cs.cmu.edu/∼dga/15-744/S07/ps2/oix-full-snapshot-2007-02-14-1800.dat.bz2`

   Warning: this is 13 MB! You can use the `bzcat` command-line program to read it without decompressing it all. Although you only need a small part of this table to answer the following questions, you should to learn how to navigate large datasets like this efficiently. (Hint: write some code)

   RouteViews has archived their BGP tables since 1997. You can examine more of them at:

   `http://archive.routeviews.org`

   (a) CMU owns the address block `128.2.0.0/16`. Using this information, can you figure out the ISP CMU uses (the AS number of the ISP)? Using the `whois` service at `http://www.arin.net/whois/` or the `whois` command-line program, determine who this AS number actually corresponds to (the name of the ISP). Note: some address blocks allocated pre-CIDR appear without the netmask in the table; i.e., CMU's address block appears as `128.2.0.0`. Three, two, and one trailing 0 octets imply a class A (/8), class B (/16), or class C (/24) network, respectively.

   (b) Print the best AS route from the route server to CMU.

   (c) What is the AS number of MIT? List all providers of `mit.edu` that you can infer from the table. (Hint: MIT is one of the few class A networks. You can use `nslookup` to get the IP address for a host at MIT)

   (d) Some of the routes to MIT repeat its AS number multiple times. Why would they do that? What does this tell you about the upstream provider in those paths?

   (e) Find the first "Class C" CIDR address in the table (address prefix $\geq$ 192.0.0.0). How many class C networks does this address correspond to? What is the maximum number of routing table entries that this single CIDR address saves? Why is it that we can only infer the maximum, and not the actual, number of addresses that this CIDR address saves?

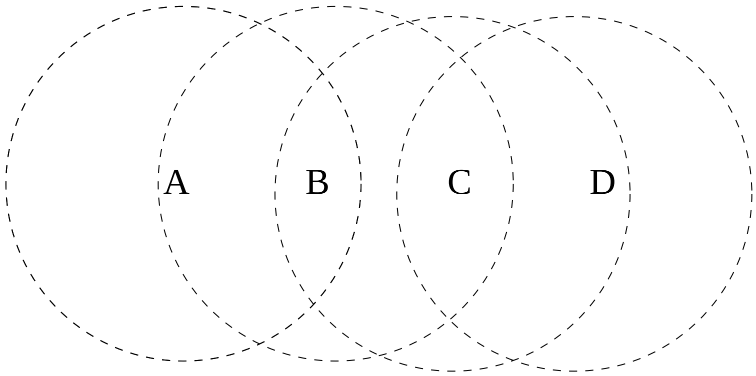
   You can get more information if you log into this route server by executing:

   `telnet route-views.oregon-ix.net`

   Run `sh ip bgp` at the prompt and you get the entire BGP table, shown one screen after another (much like when you execute `more`). In general you can type `sh ip BGP ?` for help on the possible extensions to the `sh ip bgp` command. For example, you can use the help to figure out that `sh ip bgp 12.0.0.0` will give you all the routes from `oregon-ix` to `12.0.0.0/8`.

B RTS/CTS

Consider the following topology of wireless laptops A, B, C and D. The dotted lines indicate the range of wireless transmissions from each node. For example, B is within range of A, A & C are within range of B, B & D are within range of C and only C is within range of D.



Assume that each node uses an RTS/CTS based MAC protocol (i.e. like MACAW)

2. If C is sending B an RTS, why does A know not to transmit?

3. If B is sending data to C, why does D know not to transmit?

4. Using the nodes above, give an example of the hidden terminal problem.

5. Irene Packet is considering implementing a walkie-talkie service for her wireless PDAs. Her program largely uses small packets to avoid delaying any voice. Should Irene use RTS/CTS for her deployment? Why?

C Collision Detection

6. The first random media access control (MAC) protocol developed in 1970 was the ALOHA protocol developed for wireless networks, which was a major building block for the Ethernet protocol. ALOHA's basic "collision" detection technique was that, after every transmission, the transmitter waited for an acknowledgement packet from the receiver to know that the transmission was successful. If an ACK was not received within a time period, the sender decided to retransmit the packet. Answer the following short questions.

   (a) ALOHA's "collision detection" technique in wireless networks is not truly collision detection. Why doesn't the ACK technique accurately detect collisions in wireless networks?

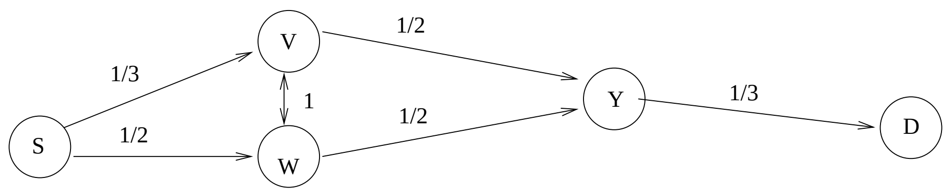
   (b) Ethernet, on the other hand, does not use ACK packets to detect collisions on the network. It has a true collision detection technique by which it ensures that a minimum packet size allows a sender to hear another transmission during its own transmission. What are the benefits of this over using an ACK to ensure successful transmission?

   (c) After collision detection was developed for Ethernet, its technique was not adopted by wireless networks. Why is it not possible to achieve true collision detection in wireless networks?

   (d) Finally, in wireless and wired protocols alike, a backoff occurs once a collision is detected. What is the purpose of the backoff, and why is the backoff value chosen randomly?

D ETX-OR

Consider the wireless network pictured below. Assume that links experience Bernoulli losses. The labeled edges indicate the *combined* delivery ratio (i.e., the probability that a packet is successfully received in the forward direction and that the acknowledgement is received in the reverse direction). V and W can hear each other perfectly. If there is no edge, assume that no packets make it through.



7. Assume that the link layer performs retransmissions. What is the expected number of transmissions to send one packet from S to D using the ETX metric along the path S-W-Y-D?

8. What is the expected number of transmissions needed to send a packet from S to D using ExOR? (Assume that there are enough packets in the batch so that the overhead of ExOR headers and its batch maps is insignificant, and that batch maps are received 100% reliably.)