CS 3251: Computer Networks I February 27, 2013

Problem Set 2: Routing and Transport Layer

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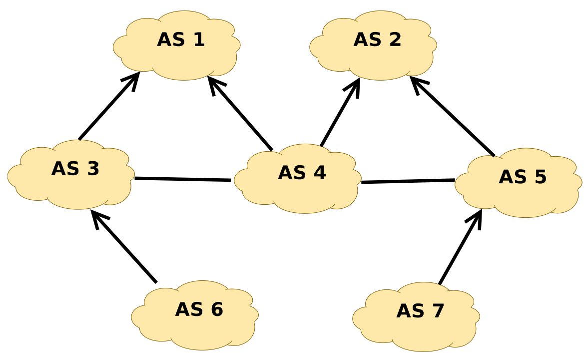
Turn in your writeup and talk on **March 15, 2013** by 11:59pm. *Please upload your solutions to T-Square. Other forms of submission will not be accepted!* We will be providing more information about how to turn in your assignment as the due date approaches.

1 BGP Routing Policies

Consider the figure below, which shows a set of ASes and different peering and customer-provider relationships, as we learned about in class. Each arrow shows the direction from customer to provider (i.e., the flow of money). Assume that all customer-provider relationships are the same price. Also, assume that all ASes follow the preference and export rules that we discussed in class.



1. Which path will AS 2 choose to reach AS 7? Why?
2. Will AS 1 be able to use AS 4 to reach AS 2? Why or why not?
3. This graph actually has a partition (i.e., two ASes that will not learn routes about each other's customers). Explain which two ASes are partitioned from one another and why the partition exists.

2 Socket Programming

This problem will give you practice with socket programming. There are two parts to the assignment:

1. Write a client and server using TCP to transfer an arbitrary size binary file across a network.
2. Write a client and server using UDP to transfer an arbitrary size binary file across a network.
3. You can chose to do one of the following:

- Write Python client code that performs a TCP transfer across the network. The server must be written in C (You can use your code from part 1).
- Write C client code to implement your own reliability scheme for UDP protocol transfer. The UDP file transfer should end up recovery the whole file at the server.

Deliverables: You shoud submit your code in the following heirarchy : Part 1, Part 2, Part 3 folders with each containing src/, bin/ ,doc/ , include/ folder.

- src must have your code
- bin must have your own binary file
- doc must have documentation of how to run and test your code
- include must have the header files
- Have a Makefile

Graphs expected:

1. You should run each of Part 1, Part 2, Part 3 of your code with client code on your laptop and Server code on any of the Gatech servers. Transfer files of the following sizes: 1 KB, 5 KB, 50 KB, 100 KB, 1 MB, 10 MB, 100 MB, 1 GB. *Perform each of these transfers five times and record the times taken for each transfer.*
2. Calculate the mean and standard deviation of the five observation.
3. Plot the graph of time taken for each file transfer across the network. The x axis of your graph should be file size, and the y axis should be the average time taken to transfer a file of that size.
4. Give any other interesting observations. You can submit one graph with three separate lines, one for each pf Parts 1, 2, and 3.

3 Domain Name System

In this question, you will perform some hands-on DNS queries using `dig` and play with DNS lookups from various applications to understand more about the DNS. In the second part of this question, you will implement a variation on a stub DNS resolver.

RFC 1035 may be helpful for answering some of these questions.

1. We'll first warm up by learning a few things about Georgia Tech's DNS setup. You may find `dig` helpful for completing this problem. Run "`traceroute ai`" from some machine on the Georgia Tech campus network. (Depending on where on the campus you run this experiment, you may see different results. If this isn't producing anything interesting for you, look at the "hostname" entry in your /etc/hosts file and explain what it does and what you're seeing when you run the above command.) Now run "`traceroute ai.`" from the same machine. Include the output from each run in your problem set writeup. Are the two traceroutes running traces to different machines? Why or why not?

2. What are the authoritative nameservers for `gatech.edu`? How long will your resolver cache the records pointing to these nameservers?

   What are the College of Computing's authoritative nameservers (*i.e.,* , for the domain `cc.gatech.edu`)? Give two benefits of topologically diverse authoritative nameservers.

   Why do NS records return names, rather than IP addresses?

3. What is another "canonical name" for the College of Computing's Web server?

4. What is are the mail exchanges for `cc.gatech.edu`?

4 Back-of-the-Envelope Calculations for Networking

Perform some quick back-of-the-envelope calculations for the following values. *These questions are intentionally vague. Show your work.*

1. What is the expected round-trip time for a packet between San Francisco and New York, assuming no queueing delay. (Assume speed of light propagation.)

2. How much memory would a typical Internet routing table require? Hint: Find out how many IP prefixes are in a routing table. Then, estimate how large each routing table entry must be.

3. How long does a DNS lookup typically take on a cache hit, assuming initial lookups to a local resolver on the LAN? How long would it likely take if the A record were not in the local cache? How long would it take if the NS record for the second-level domain were not in the local cache?

4. Suppose that the MTU for an IP packet on a Gigabit Ethernet network is increased from 1500 bytes to 9000 bytes. How does this affect the likelihood of collision? How does it affect efficiency? Try to be as specific as you can.

5 BGP Routing Table Dumps

For this question, you will need to download the Routeviews routing table from `http://www.gtnoise.net/classes/cs3251/spring_2013/psets/ps2//tmp/rib.20130227.2000.txt.gz` This file contains a Cisco BGP4 routing table snapshot, taken at Oregon Route Views (`http://www.routeviews.org/`) on February 27, 2013. (*Beware:* This is a text file that is 50+ MB, compressed. You should be able to analyze it without uncompressing it using, for example `zcat`. Do NOT try to open it in a text editor, or you will be sorely disappointed.)

If you are curious about what other snapshots look like, you can find daily snapshots at `http://archive.routeviews.org/`

1. Find the routing table entry for the Georgia Tech campus network.

   (a) What is the IP address of the best next hop from this router to Georgia Tech? How does this router know how to reach that next hop IP address?

   (b) What is the AS number for Georgia Tech?

(c) What are all of the IP prefixes that Georgia Tech advertises to this router? Why does Georgia Tech advertise more than one prefix?

(d) Give an example of two IP prefixes that Georgia Tech advertises that "overlap" in IP address space. What is the reason that Georgia Tech would advertise two routes for overlapping IP address space?

(e) Give the sequence of ASes that Sprint (AS 1239) would likely take to `130.207.0.0/16`? To `128.61.64.0/18`? Given that these prefixes both belong to Georgia Tech, why would the AS paths differ?

(f) How many routes are there to get from this router to Georgia Tech?

(g) How many ASes must a packet traverse between the time it leaves the router and the time that it arrives at Georgia Tech, for each of the routes? What would determine which route is the "best" route, in each case?

(h) What are the AS numbers of all of Georgia Tech's upstream providers? What ISP does the above AS correspond to? (*Hint:* You can discover this information using a whois query.)

(i) In paths where Georgia Tech uses Cogent (AS 174) as an upstream, the AS path ends with five instances of the same AS number. Why? What is the likely relationship between this AS number and Cogent?

(j) Look at all of the routes for which the AS path contains the sequence `11537 10490`. What do the ASes that appear first in those AS paths all have in common? Why wouldn't the ASes that select paths that don't have `11537 10490` in them not be selecting those paths?

(k) Use `traceroute` to measure route from some machine at Georgia Tech to `archive.routeviews.org`. Please include the output of your traceroute with your problem set.

Find the sequence of ASes that correspond to this traceroute. *Hint:* You can do this either with a special version of traceroute, or you can manually look up the IP addresses with whois. Some versions of traceroute such as "nanog traceroute" will do the AS lookups for you automatically.

Is the sequence of ASes from Georgia Tech to the router the same as the reverse route in the trace data? Why might the reverse path differ? (Please list reasons other than the fact that your traceroute was performed at a different time as the table snapshot!)

2. Find an example routing table entry where the AS number on the AS path is repeated more than once. Explain what this behavior is. Which AS likely caused the AS number to appear multiple times, and why? (We discussed this in class.)

3. Write a script to count the number of entries in the routing table that have prefixes of different lengths. What is the most common prefix lengths? Explain the tradeoffs between longer and shorter prefix lengnths.

6 Book Problems

Please complete the following problems from Kurose and Ross, 6th Edition:

Chapter 4.

1. *Head of Line Blocking.* P9
2. *Link-State Routing.* P26
3. *Count to Infinity.* P34