CS 3251: Computer Networks I January 14, 2013

Problem Set 1: Link Layer and IP

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Turn in your writeup and talk on **January 28, 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 Learning (about) Bridges

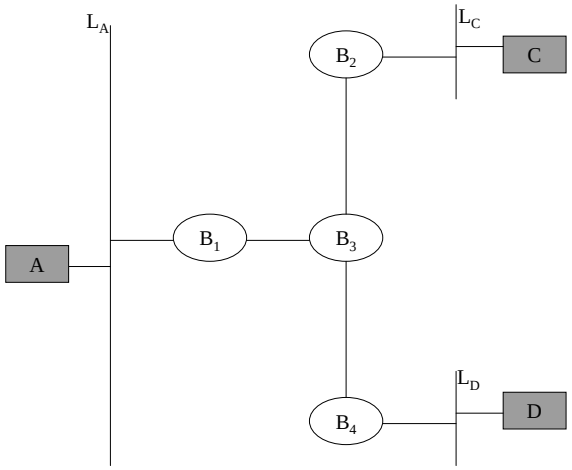

Figure 1: Bridge topology.

Consider the bridge topology shown in Figure 1. Assuming that all of the forwarding tables are initially empty, write out the forwarding tables at each of the four bridges $B1$ through $B4$ at the conclusion of the following transmissions:

1. D sends to A
2. A sends to D
3. C sends to A

In the forwarding table at each note, identify the port by the unique LAN segment (L_A, L_C, or L_D) reachable using that port, unless there isn't one, in which case use the identifier of the neighboring bridge to identify the port.

2 Circuit Switching vs. Packet Switching

Consider a typical dormitory network, where hundreds of users (and devices) might share a 10 Gbps link to the rest of the campus network. Each user alternates between periods of activity and inactivity. During periods of activity (where a user may be checking email, browsing the Web, watching videos, and swapping files), suppose each user creates a demand of 200 Mbps. During periods of inactivity, suppose (for simplicity) that the user generates no data.

Circuit Switching

1. With circuit switching, 200 Mbps must be reserved for each user at all times. Suppose that a one-second TDM frame is divided into 10 time slots of 100 ms each. How many simultaneous users can the circuit switched network support?

2. Suppose that a typical dorm room has 500 users. What is the probability that at least one user gets a "busy signal" with a circuit switched network (i.e., what is the probability that the number of active users exceeds the number of users that you calculated in part 1)?

3. Plot the probability of a "busy signal" as a function of the number of users in the dorm. In other words, show a plot with your answer from part 2, but varying the number 500 from zero to 2,000. What do you observe?

Packet Switching

1. Describe the advantages and disadvantages of packet switching with respect to circuit switching.

2. Suppose that users are sending traffic through a single router with an M/M/1 queue (look it up). Suppose that on average, there are 300 active users, each of which send about 10 Mbps *on average* (note that this accounts for peaks). Suppose that, as before, the average service rate of the link is 10 Gbps. What is the average delay seen by any given packet?

3. Suppose that a packet traverses five links with similar delay characteristics as it travels from Atlanta to San Francisco. What is the expected *total* delay experienced by each packet? *Clearly show your work, accounting for queueing delay, transmission delay, and propagation delay.* Assume that there is no processing delay.

4. Run a `ping` command from your computer at Georgia Tech (or somewhere in Atlanta) to `www.cs.stanford.edu`; this shows *round trip delay*. Show the output. Does this reconcile with your back-of-the-envelope calculations from the previous part? Why or why not?

3 Fun with ARP

This problem is a quick "hands on" assignment to get you familiar with ARP. For this problem, you will need access to a machine that has the `arp` command, as well as some kind of packet-capture capability (e.g., `tcpdump` or `ethereal`).

1. At your command prompt, type `arp -a` or equivalent. You should see a line that looks something like this:

   cc-cisco-143out4.cc.gt.atl.ga.us (143.215.131.1) at 0:16:9c:fd:98:0 on en0 ifscope [ethernet]

   - What is the IP address on this line?
   - What is the MAC address referring to?
   - What does 'en0' mean?

2. Now, issue your own ARP request with the `arp` command. Make an ARP request for whatever IP address you found in your ARP table from the first part of the problem. Turn in the command that you used to generate this request.

3. *Packet capture.* Use a packet capture program (e.g., `ethereal`, `wireshark`) to capture the ARP requests that you can see on your network. *In your writeup, show a screenshot (or text output) of your captured ARP packets.*

   - Why do you see "who-has" ARP requests from other machines that are not yours?
   - How often do you see an ARP request from your machine, or any other machine on the network? Why do you see these requests repeatedly? (Hint: Think about the discussion of "fate sharing" from lecture.)

4 IP Addresses

This problem is a "hands on" assignment to help you learn about Internet address registries. You will use the `whois` command-line tool. **Type "`whois -h whois.arin.net '?'`" for help using this tool.**

1. What is the current IP address for your computer from which you are doing this assignment? Explain how you got this information (there are several ways to do it).
2. What is the CIDR prefix range for the IP address you found from Part 1?
3. If you do this portion of the assignment from Georgia Tech, you will see something called "Direct Assignment" when you look up the IP address. What does that mean?
4. What is the AS number for the IP address that you looked up? Explain how autonomous system numbers are assigned, and how they are used.
5. Look up the following IP addresses. For each, give the IP prefix associated with the allocated IP adddress, and *entire allocations chain*, as well as the current owner of the prefix (i.e., the list of registries through which the prefix was allocated). *Include sub-allocations, including the size of each sub-allocation.*
   - 41.132.75.118
   - 204.77.224.9
   - 76.88.123.65
   - 99.151.0.68

5 IP Address Exhaustion and IPv6

Skim through Geoff Huston's article from the January 2013 *ISP Column*: `http://www.potaroo.net/ispcol/2013-01/2012.html`.

Huston says: "The past three years has been dominated by the mass marketing of mobile internet services, and the growth rates for 2012 perhaps might have been the highest so far recorded were it not for the exhaustion of the IPv4 address pools in the Asia Pacific region and Europe and the Middle East. In address terms this growth is being masked by the use of Carrier Grade NATs in the mobile service provider environment, so that the resultant demands for public addresses in IPv4 are quite low. In theory there is no such requirement for IPv6 to use NATS, and if the mobile world were deploying dual stack ubiquitously then this would be evident in the IPv6 address allocation data."

1. How is it possible for ISPs to keep adding customers if we are "out of IPv4 addresses"? (Explain this paradox.)
2. What is "Carrier Grade NAT"?
3. Describe the advantages and disadvantages of using NAT vs. IPv6 in terms of both functionality and potential to curb address space exhaustion.
4. Table 13 shows the largest IPv6 organizations by organization in 2012, in terms of /32 allocations. How many addresses is a /32 allocation, in IPv6?

6 Book Problems

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

1. *Access Networks.* R6, R9
2. *Delays and Throughput.* P24, P25