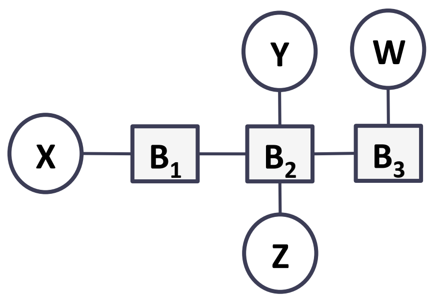
15-744 Computer Networks — Spring 2015
Homework 1
Due by 2/20/2015, 10:30am

(to be submitted in the beginning of class in hard copy)

Name:

A Ethernet

1. Suppose learning bridges B_1, B_2, and B_3 start with empty forwarding tables. Consider the following sequence of transmissions in the shown network:



- At time t_1, host X sends packet P_1 to host Y;
- At time t_2, host W sends packet P_2 to host Z;
- At time t_3, host Y sends packet P_3 to host W;
- At time t_4, host Z sends packet P_4 to host Y.

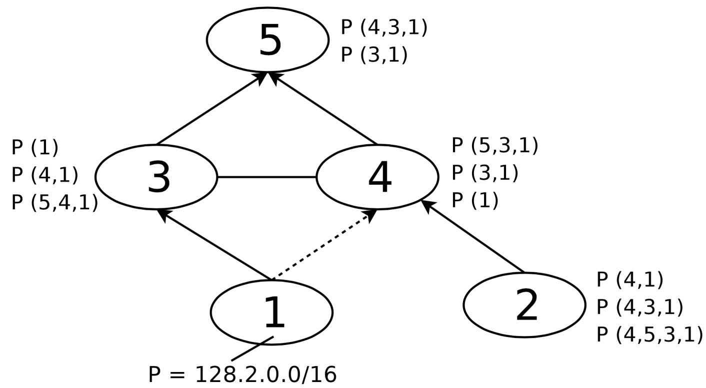
Given the above information:

(a) Show the forwarding table of each bridge after each of the above transmissions are done.

(b) For each packet, specify which host's network interface will see it.

B BGP

2. Consider the AS graph below in parts (a) and (d):



The vertices are individual ASes and edges are links between them.

(a) Now suppose the arrows represent customer-provider relationships where the customer points to its provider. An edge without arrows represents a link between peers. The dashed edge is a backup link. Suppose all ASes follow the export rules proposed by Gao and Rexford. List the routes in each AS's local-pref list shown above that can never be received by that AS.

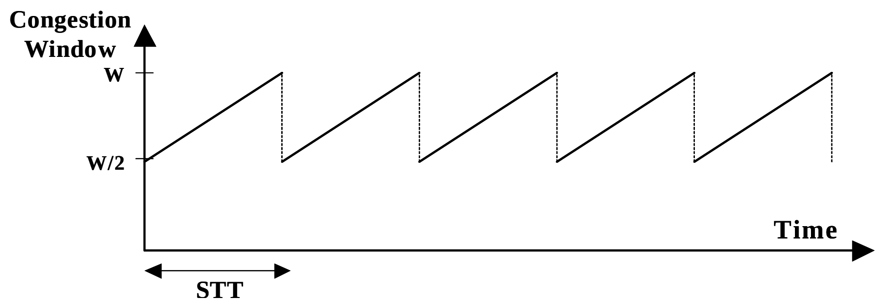
(b) Suppose AS X thinks that AS Y drops too many packets. Using only BGP, is it possible for AS X to implement a policy stating that "traffic outbound from my AS should not cross Y?" Why or why not?

(c) Now suppose AS X thinks that AS Y generates a lot of illegal file sharing traffic. Using only BGP, is it possible for AS X to implement a policy stating that,"I don't want to carry traffic from Y to my customers?" Why or why not? Assume that AS X does not want to deny transit to traffic from any other AS.

(d) Bonus question: Shown next to each AS is its local-pref ranking of possible routes to P , a prefix in AS 1. Ignore the arrows for now and consider all edges equally valid. Is this AS graph guaranteed to converge? Why or why not? (If you read Gao and Rexford early, this question is for you!)

C TCP

3. The picture below shows the famous TCP saw tooth behavior. We are assuming that fast retransmit and fast recovery always work, i.e. there are no timeouts and there is exactly one packet lost at the end of each"toot". We are assuming that the flow control window is large and that the sender always has data to send, i.e. throughput will be determined by TCP congestion control.



In the picture, W represents the congestion window size at which a congestion packet loss occurs (expressed in maximum transfer units). You can assume that W is large, so feel free to approximate (W-1) or (W+1) by W. STT represents the "saw tooth time" expressed in seconds. The aim of this exercise is to derive the average throughput of a TCP connection as a function of the roundtrip time (RTT), the maximum transfer unit (MTU), and the packet loss rate (PLR) for the connection. Please use the notation suggested by the figure, i.e. W and STT, as intermediate values if you need them.

(a) Calculate the STT as a function of W, and the RTT. (Hint: the congestion window goes from W/2 to W in one STT, and remember the congestion window is increased by 1 MTU every RTT).

(b) How much data is sent in one STT? (Hint: how much data is sent each RTT?)

(c) What is the average throughput of the connection?

(d) What is the average packet loss rate? (Hint: How many losses occur per STT?)

(e) What is the relationship between the throughput and the packet loss rate?

D Basic Tools

4. Take a look at the man pages for `netstat` and `traceroute` to answer the following questions.

   (a) Start an FTP connection using the command ftp (e.g., FTP to ftp://gnu.mirror.iweb.com). After you login as anonymous, try to find information regarding the corresponding TCP connection using `netstat` in a different window. Explain the fields in the line corresponding to your ftp connection. What are the local and remote port numbers and IP addresses for that TCP connection? What is the dedicated port used by FTP?

   (b) Perform a `traceroute` on www.berkeley.edu at three different hours of the day (submit the times as part of the homework).

      1. Find the average and standard deviation of the round-trip delays at each of the three hours.
      2. Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours?
      3. Try to identify the number of ISP networks the `traceroute` packets pass through from source to destination. Routers with similar names and/or similar IP addresses should be considered as part of the same ISP. In your experiments, do the largest delays occur at peering interfaces between adjacent ISPs?
      4. Repeat the above for a destination on a continent different then the source. Compare the intra- and inter-continent results.
      5. What kind of problem do you expect to be able to solve using `traceroute`?