Homework Assignment 3

Due: Nov 14th

Directions: Some of the problems appear long but they are not too hard when you understand them. Each problem is meant to teach you something. We will pick 2 out of the 4 problems.

1. **Ethernet, Min Packet Sizes, and Semi-Reliability**: At Interop 2017, a leading trade show, two members of the 2017 cs118 class have unveiled their new version of the Ethernet. Their product, Nethernet, is identical to standard Ethernet except that it no longer requires a minimum packet size. Recall Figure 1 below that we used to justify the minimum packet size. The problem is that if *A* and *B* sent small frames, they might collide in the middle of the wire and yet neither *A* or *B* would detect the collision. To fix the problem, Nethernet adds the following rule: if a station like *A* sends a short packet of size less than 64 bytes, *A* must wait for at least 51.2 usec after its first bit is sent; if *A* detects any transmission during this period, *A* detects a collision, and does the usual retransmission.

   a) If Nethernet requires no min packet size, what additional features of the normal Ethernet protocol can be removed as well?

   - b) Receivers normally discard runt packets of size less than 64 bytes in normal Ethernet. Is this rule still valid for Nethernet? Explain.

- c) Nethernet also requires the normal means of detecting collisions (i.e., more than one signal at the same point is detected by an increase in voltage) as well as the new mechanism? Explain with an example why this is needed so that all stations can detect a collision.
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- d) Suppose we use the mechanism in c) as well as the new Nethernet mechanism to detect collisions. Show using an example that it is still possible for some station to not detect collisions.
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- e) Use the results of b) and d) to show that Nethernet collisions can result in duplicate packets being received by a receiver.

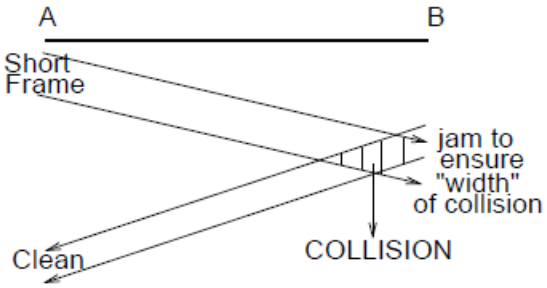


Figure 1:

Do not forget that when A is sending the receiver need not be B. It could be any station C that is anywhere on the Ethernet to cause problems.

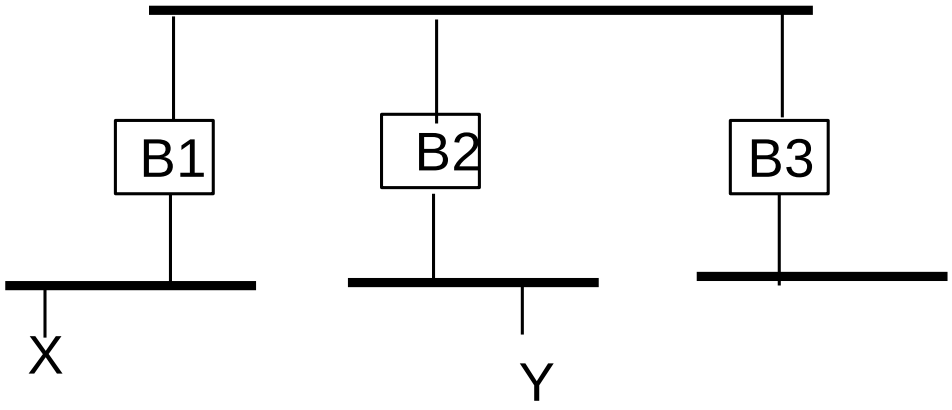
- 2. Bridging: It often happens that a node knows the higher layer address of another node and needs to know its Data Link address. Suppose someone builds an "introduction" service to do this as follows. An intro server has a well known multicast address, say INTRO. A node *X* that wishes to know the Data Link address corresponding to higher level address *H*, sends a LAN frame with destination address *INTRO* and with its own source address *X*, but with *H* in the data portion of the frame. When the server gets the frame, it looks up the Data Link address corresponding to *H* (say *Y*). It then forwards the original frame to *Y* by changing the destination address from *INTRO* to *Y*. When *Y* gets the frame, *Y* knows *X*'s address from the source address and so can send a reply directly to *X*. When *X* gets such a reply, *X* also knows the Data Link address of *Y*.

  This protocol works fine on a LAN. But it can fail in an Extended LAN with transparent bridges.

  1. Describe a topology and a scenario in which this protocol fails.
  2. (How can you fix the introduction protocol to work in an Extended LAN?

  Some clarifications: An extended LAN is two or more Ethernets connected with a bridge. So draw 2 Ethernets connected by a bridge. Next place stations X, Y, and INTRO wherever you like to cause a problem. For instance, you can put them all on one side of the bridge, or any pair of them on one side and the remaining station on the other side. They key fact you must exploit is that "Bridges forward based on *destination* addresses and learn based on *source addresses*". Carefully go through the INTRO protocol to see what may cause bridging to fail,

3. Bridging and Pruned Multicast: In class, we learnt that bridges forward multicast messages everywhere. But can frames sent to multicast addresses be sent only to those LANs that have stations listening to that multicast address. Can bridges be modified to learn about multicast address. They can if we modify bridges to be non-transparent by modifying bridges and endnodes slightly. The figure shows two stations *X* and *Y*. Assume that initially only *X* is in group *G* (*G* is a multicast data link address). Then when *X* sends a multicast packet to *G* bridge *B*1 should (ideally) not forward the packet. Later, assume that *Y* also joins group *G*. All bridges should learn this fact. Now when *X* sends a packet to *G*, bridge *B*1 should forward the packet on the upper LAN, bridge *B*2 should pick up the packet and forward it to *Y*'s LAN, and bridge *B*3 should not forward the packet.



Thus bridges need to learn all the directions through which a multicast address like *G* is reach- able. To allow bridges to learn, we modify the endnodes that participate in a group *G* to periodically send a multicast packet to some "All Bridges Address". However, the endnodes put *G* as the *source address* in such a packet. Note that this violates transparency of bridges but we will do it anyway.

1. How would you modify the bridge learning algorithm to learn about multicast addresses like *G* based

on the periodic updates sent by the endnodes participating in the group? Describe the new learning algorithm in a few lines.

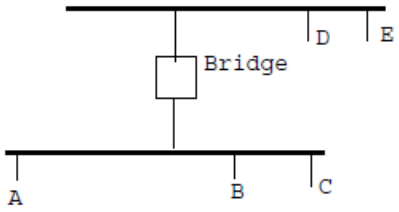
2. Explain what each bridge learns in the above example. Assume that initially only *X* sends updates and show what each bridge learns using a picture. Then show what happens when *Y* joins the group and begins sending updates using a second picture.

3. Suppose that *Y* crashes and stops sending updates. *X* continues to send updates. Explain precisely how bridges should timeout information asssociated with multicast addresses.

4. Not all stations participate in this protocol. What should a bridge do when it gets a multicast address that it has no learnt information about?

- **4. IP Broadcast Storms, Bridges versus Routers:** (Adapted from Perlman's book) A broadcast storm is an event that causes a flurry of messages. One implementation that caused broadcast storms was the Berkeley UNIX endnode IP implementation. In this implementation, an endnode attempts to forward a packet that it mysteriously receives with a network layer (IP) address that is different from itself. This is what you would do if you found a neighbor's letter wrongly placed in your mailbox. However, this seemingly helpful policy can cause problems.

  Consider the figure below which shows 2 LANs connected by a bridge, with several IP endnodes on each LAN. There are no IP routers. All IP endnodes are configured with the same mask and so can tell that they have the same net number. Suppose IP endnode A is incorrectly configured and incorrectly thinks its data link address is all 1's. The data link address of all 1's is the broadcast address: any packet sent to such an address is received by all stations on a LAN (it is the ultimate multicast address!).



What happens when another IP endnode B decides to send a packet to IP endnode A.? Assume that B initially does not have A's data link address in its cache, and so must do the ARP protocol. Give the sequence of events.

Suppose bridge B is replaced by an IP router. (Of course, the masks at the nodes have to be changed so that there are now two masks, one for each LAN.) The problem does not disappear but it does get a little better. Explain.