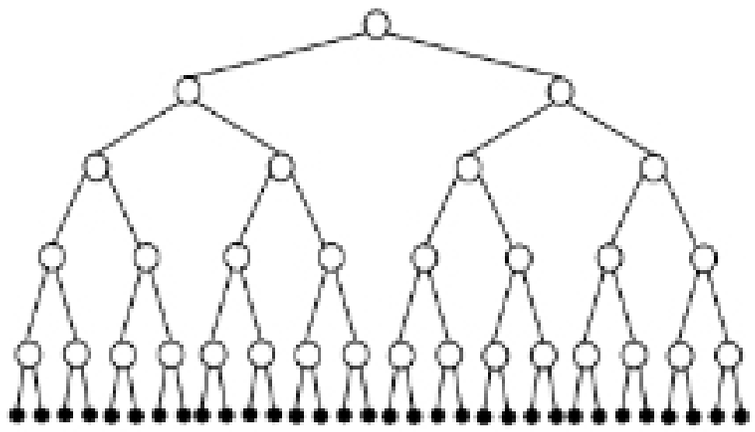

Figure 1: Binary tree

Problem 1

Consider two ways of doing network-wide broadcasting: source replication (unicasting each message to each destination), and in-network replication (true network-layer broadcast, i.e., routers help). Suppose a source-based spanning-tree is used to achieve network-layer broadcast. Further suppose that there is a single sender and 32 receivers, and the sender is connected to the receivers through a binary tree of routers as shown in Figure 1. Each time one packet (or a copy of a packet) is sent over a single link, it incurs one unit of cost.

a. What is the cost of sending a broadcast packet using source replication?

b. What is the cost of sending a broadcast packet using in-network replication?

c. Now assume you can choose any topology to connect the sender to the 32 receivers. What topology will have the greatest cost disparity between unicast emulation and true network-layer broadcast? You don't need to provide any numbers, just describe (or draw) the topology. You can use as many intermediate routers as you like.

Problem 2

This question is about the CRC algorithm, as described in your week-8 lecture slides.

a. If you have a 4-bit generator $G = 1001$, and a message $M(x) = 10111010$, what is the value of R?

b. What would the sender of the message send over the wire?

Problem 3

Suppose an IP implementation adheres literally to the following algorithm on receipt of a packet, P, destined for IP address D:

```
if (MAC address for D is in ARP cache)
    send P
else
    send out an ARP query for D
    put P into a packet queue until the response comes back
```

a. If the IP layer receives a burst of packets destined for D, how might this algorithm waste resources (*not* including its packet queue)?

Problem 3 continued on next page...

b. Describe briefly how you would modify the algorithm to be less wasteful.

c. Suppose we simply drop P, after sending out a query, when cache lookup fails. Identify one major problem that might occur. (Some early ARP implementations allegedly did this.)