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15-441/Fall 2012
Homework #1
Assigned 9/18/2012 • Due 9/25/2012
Handin Electronically via AFS Dropbox

1. After finishing 441, you create a new networking startup that is housed in an abandoned Pittsburgh steel mill. You want a 5 gigabit (5000Mbps) CSMA/CD network. The size of your factory building necessitates that your cables be as long as 500 meters. The maximum backoff and retry attempts for your network is set to 8. To save money, you decide to twist your own ethernet cables using steel instead of copper. For purposes of this question, assume that electromagnetic waves propagate through your steel wires at a speed of 1.5×10^8 m/s.

   What is the minimum frame size for this network? Why? What happens if it is smaller? Please show your work.

2. Please explain the following about *amplifiers* and *repeaters:*
   a. What is the difference in the role and function of an *amplifier* and a *repeater*?
   b. Can an amplifier be used in a digital transmission system? If so, how? If not, why is it never needed?
   c. Can a repeater be used in an analog transmission system? If so, how? If not, why is it never needed?

3. In class, one detail of link layer protocols, including Ethernet, which we never mentioned is the *inter-frame gap*. Senders are required to pause between sending frames. This pause results in this gap between frames – they are not back-to-back. Please *reason about* and answer the following about this gap:
    a. In some sense, this wastes valuable network time. Think about it and take an educated guess -- what is the purpose of this gap?
    b. The Ethernet standard dates back to the early 1970s. The specification is for an inter-frame gap of 96 bit-time, which is the amount of time it takes to send 96 bits. Several things have evolved in computers and networks since then. If the standard were developed from a "blank slate" today, do you think this delay would be the same or larger or smaller? Why? In answering, we are most concerned with the factors that you are considering and how they fit into your model – not you ultimate assessment.

4. Consider CSMA/CD.
    a. It is rarely used over fiber optics. Why? What is differentiates this from wired LANs?
    b. It is rarely used in wireless communication. Why? What differentiates this from wired LANs?

5. Assume that a mobile phone provider wants to improve the service quality on their "all digital mobile-to-mobile network" by offering CD-quality, mono channel, sound with a bandwidth of up to 44.1KHz at 16 bits per sample. Given that the existing system supports a bandwidth of up to 3.6KHz at 1-byte per sample, how much will they need to expand their network capacity to handle the sample call volume?

6. What are the Hamming distances of the following code? How do you know? (compare the codewords within each code, not between the codes)

   Code 1:

   a. 1001 = Jump
   b. 1010 = Run
   c. 1111 = Stop
   d. 0000 = Walk

   Code 2:

   e. 100001 = Jump
   f. 101000 = Run
   g. 100111 = Stop
   h. 000000 = Walk

7. How many bits off error detection can each of the above codes support? Error correction? How do you know?

8. Most digital systems do not encode data using one state, such as a low voltage, for 0 and another state, such as a high voltage, for one. Instead, they use more complex encoding schemes. What is the most essential reason?

9. Given the fact that each system knows its own IP address, why can't routers just deliver packets within a LAN that way? Why do they need to use the MAC address?

10. Describe a situation in which the IP address associated with a MAC address would change. How might this affect a bridged/switched LAN?

11. Assume that network 128.32.x.x is divided into the following subnets, please determine the subnet mask for each:

    128.32.0.x (Hex: 80.20.00.x)
    128.32.128.x (Hex: 80.20.80.x)
    128.32.196.x (Hex: 80.20.C4.x)