15-441 Computer Networks
Homework #1
Out: 9/08/05 Due: **NOON** 9/22/05 in Wean Hall 7112

Instructions: Please type or neatly handwrite a solution to each of the following questions. For full credit, please explain how you derived an answer; don't just give the final result. Papers are due at noon on Thursday, September 22, 2005, at Wean Hall 7112.

Note: bps = bits/s
Kbps = 10^3 bits/s
Gbps = 10^9 bits/s

1. Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony. The distance from the moon to Earth is approximately 385,000 km, and data travels over the link at the speed of light – 3 x 10^8 m/s. [Problem 1.15 from Peterson and Davie]

    a. Calculate the minimum RTT for the link.

    b. Using the RTT as the delay, calculate the delay x bandwidth product for the link.

    c. What is the significance of the delay x bandwidth product computed in (b)?

    d. A camera on the lunar base takes pictures of Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image, which is 25 MB. What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished?

2. Suppose you are designing a sliding window protocol for a 1-Mbps point to point link to the moom, which has a one-way latency of 1.25 seconds. Assuming that each frame carries 1 Kbyte of data, what is the minimum number of bits you need for the sequence number? [Problem 2.24 from Peterson and Davie]

3. Suppose nodes A and B are on the same 10 Mbps Ethernet segment and the propagation delay between the two nodes is 225 bit times. Suppose node A begins transmitting a frame, and before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? [Problem 5.14 from Kurose and Ross]

4. Assume that a SONET receiver resynchronizes its clock whenever a 1 bit appears; otherwise, the receiver samples the signal in the middle of what it believes is the bit's time slot. [Problem 2.10 from Peterson and Davie]

    a. What relative accuracy of the sender's and receiver's clocks is required in order to receive correctly 48 0 bytes (one ATM AAL5 cell's worth) in a row?

    b. Consider a forwarding station A on a SONET STS-1 line, receiving frames from the downstream end B and retransmitting them upstream. What relative accuracy of A's and B's clocks is required to keep A from accumulating more than one extra frame per minute?

5. An ex-441 student is designing a network link using the Ethernet MAC protocol. He/She decides that the minimum packet size should be 1000 bits, that at most 200 machines can be connected at a time and that the transmission rate will be 100Mbps. Assuming that electrical signals travel at 2x10^8 m/s, what should be the maximum wire length of the link? Please explain your answer. [Question 20 from 2004 midterm]

6. Six weeks ago, John Hackworth inherited a farm from his uncle, and moved out to a farm deep in the countryside. John soon discovered that there was no Internet access available on his remote farm. Being a commensurate hacker (and suffering from serious Slashdot withdrawal), John decides to implement RFC 1149, "A Standard for the Transmission of IP Datagrams on Avian Carriers." That's right, John is going to send his packets via carrier pigeon. First, John hired Alice, who lives in the nearest town where Internet access is available. Alice has a computer with Internet access. Whenever a packet arrives over the Internet, Alice checks to see that it is addressed to John's IP address. If it is, she decrements the TTL of the packet, and writes it onto a slip of paper, and dispatches it on a pigeon. Whenever a pigeon arrives, she checks to make sure that the packet is not addressed to John. If not, she decrements the TTL of the packet, and sends the resulting packet out over the Internet. [Question G from 2004 final]

    a. At which level of the OSI network model is Alice operating?

    b. What sort of network device would you classify Alice as?

    John soon discovers that his pigeons can only fly 60 miles before they need to stop for food and rest. Therefore, John hires Bob to man a station halfway between John's farm and Alice's town. John and Alice change their protocol slightly: any messages destined for Alice and the outside Internet are written on pink paper, while any messages destined for John are written on blue paper. Whenever a pigeon arrives at Bob's station, he checks the color of the paper the bird is carrying. If it is blue, he moves it to a new bird and sends it to John, and if it is pink he moves it to new bird and sends it to Alice.

    c. What level of the OSI network model is Bob operating?

    d. What sort of network device would you classify Bob as?

    This new system works much better. However, sometimes a hawk catches and eats one of the pigeons, so a message never arrives at its destination.

    e. Will IP still operate over this system, even with an occasionally lost bird? Why or why not?