Homework 3

Date due: Tuesday, Sept 23, 2014 by 2PM -- note, this is 2 weeks before it is due

Submit your final typed document to ramCT. Each question or sub-question is worth 2 points: 0 for wrong or no answer, 1 for partial credit, and 2 for correct answer. Total points for this homework is 54 points.

- Problem 1: (28 points total; 14 sub-questions)
  Calculate the total time required to transfer a 2000 KB file in the following cases, assuming an RTT of 110 ms, a packet size of 1KB data, and an initial 2 x RTT of "handshaking” before data is sent.
  1. The bandwidth is 2 Mbps, and data packets can be sent continuously.
     a. What is the transmit time per packet?
     b. How many packets do we need to send?
     c. What is the transmit time for all of the packets?
     d. What is the total time?

  2. The bandwidth is 2 Mbps, but after we finish sending each data packet we must wait one RTT before sent the next.
     a. How many packets do we need to send?
     b. How many RTTs must we wait?
     c. What is the total time?

  3. The bandwidth is "infinite", meaning that we take transmit time to be zero, and up to 20 packets can be sent per RTT.
     a. How many packets do we need send?
     b. How many RTTs must we wait for? (Hint: what is special about the last 20 packets?)
     c. What is the total time?

  4. The bandwidth is infinite, and during the first RTT we can send one packet \((2^{1-1})\), during the second RTT we can send two packets \((2^{2-1})\), during third we can send four \((2^{3-1})\), and so on.
     a. How many packets do we need send?
     b. How many iterations must we go through to send all the packets?
     c. How many RTTs must we wait for? (Hint: what is special about the last 20 packets?)
     d. What is the total time?
Problem 2 (10 points; 5 sub-questions):
Suppose that a certain communications protocol involves a per-packet overhead of 100 bytes for headers and framing. We send 1 million bytes of data using this protocol; however, one data byte is corrupted and the entire packet containing it is thus lost. Give the total number of overhead + loss bytes for packet data sizes of 1,000, 5,000, 10,000, and 20,000. Which size is optimal?

Problem 3 (8pts, 4 sub-questions):
Consider a simple protocol for transferring files over a link. After some initial negotiation, 'A' sends data packets of size 1 KB to 'B'; B then replies with an acknowledgement A always waits for each ACK before sending the next data packet; this is known as stop-and-wait. Packets that are overdue are presumed lost and are retransmitted.

1. In the absence if any packet losses or duplication, explain why it is not necessary to include any "sequence number" data in the packet headers.
2. Suppose that the link can lose occasional packets, but that packets do not always arrive in the order sent.
   a. Is a 2-bit sequence number (that is, N mod 4) enough for A and B to detect and resend any lost packets?
   b. Is a 1-bit sequence number enough?
3. Now suppose that the link can deliver out of order, and that sometimes a packet can be delivered as much as 1 minute after subsequent packets. How does this change the sequence number requirements?

Problem 4: (8 points, 4 sub-questions)
Suppose a 1Gbps point-to-point link is being set up between the earth and a new lunar colony. The distance from the moon to the earth is approximately 385,000 kilometers. (Even though it is closer at apogee now, making a beautiful super-moon viewing tonight as I write this). Data travels at the speed of light over the link: \(3 \times 10^8\) meters/second.

1. Calculate the minimum RTT for the link.
2. Using the RTT as the delay, calculate the delay x bandwidth product for the link.
3. What is the significance of this delay x bandwidth product you just computed?
4. A camera on the lunar base takes pictures of the Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image, which is 25MB. What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished? Assume bandwidth delay only.

Note: All homework assignments are individual assignments. Please do your own work.