Com S 486 Assignment 1

Due: 11:59pm Saturday February 9

1. **(10points)** Consider two hosts A and B connected by a single link of rate R *bps*. Suppose that the hosts are separated by *m meters*, and suppose the propagation speed along the link is *s meters/second*. Host A is to send n *packets* each of size *L bits* to Host B. Answer the following questions:

   a. What is the propagation delay over the link?

   b. What is the transmission time for each packet?

   c. Ignoring processing and queuing delays, what is the total time needed for all the *n packets* to be received by Host B?

   d. Suppose $s=2*10^8$, *L=120 bits, R=112 kbps,* and *n=10*. Find out the total time needed for all the *10* packets to be sent and received.

2. **(10points)** We now consider the sending of real-time voice from Host A to Host B over a packet-switched network. Host A converts analog voice to a digital *64 kbps* bit-stream on the fly. Host A then groups the bits into *112*-byte packets. There is one link between Hosts A and B; the transmission rate is *10 Mbps* and the propagation delay is *2 msec*. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?

3. **(10points)** Consider a network where each packet has length *L bits*. A packet switch receives a packet (denoted as P) and determines the outbound link to which P should be forwarded. Just at this time, *x bits* of one other packet has been transmitted on this outbound link and *n* other packets are waiting to be transmitted to the link. Suppose packets are transmitted in order and the transmission rate of the link is R bits/second. Express the queuing delay that will be experienced by packet P in terms of *L, x, n* and *R*.

4. **(20points)** In modern packet-switched networks (including the Internet), the source host segments long, application-layer messages into smaller packets and sends the packets into the network. The receiver then reassembles the packages back into the original message. We refer to the process as *message segmentation*. Now consider the sending of a large message of $8*10^6$ bits from Hosts A to B that are connected by a sequence of three links (and two switches) between them. Suppose each link has rate *4*

Mbps. Ignore propagation, queuing and processing delays. Answer the following questions:

a. Consider sending the message from A to B **without** message segmentation. How long does it take to move the message from A to the first switch? Keep in mind that each switch uses store-and-forward packet switching. What is the total time to move the message from A to B?

b. Now suppose that the message is segmented into *400* packets each of *20,000* bits long. How long does it take to move the first packet from A to the first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from A to the first switch. At what time will the second packet be fully received at the first switch? How long does it take for the whole message to arrive at B?

5. **Programming**

In this programming assignment, you are required to implement a simple network application based on the client/server model using connection-oriented communication (i.e., socket programming with TCP – refer to the tutorial and code examples on the lecture notes for Chapter 2).

For the client program, named Client:

- It runs with two arguments (the server's hostname or IP address, and the server's port number). That is, in pyrite.cs.iastate.edu, it can be run as follows:

   >Client localhost 6789

- Once it starts, it waits for inputs from the user, and sends each line of input to the server as a String; the server returns the length of the String; the client then outputs

      "From server: the last input's length is x."

   The Client program ends after the user inputs "QUIT".

For the server program, named Server:

- It runs with one argument (the server's port number). In pyrite, it can be run as follows:

> >Server 6789
- Once it starts, it waits for connections from the clients. After a client connects, it waits for Strings sent from the client, and returns the length for each of the Strings.

Submission Guidelines:

- Make sure your source programs, i.e., Client.java and Server.java, compile successfully on the *pyrite.cs.iastate.edu* server (which runs Linux operating system and can be log on with your ISU Net-ID).

- Submit your source programs to canvas assignment website.

Grading Guidelines:

- Program Correctness (40points)
    - Your source programs are successfully compiled and created in pyrite.cs.iastate.edu.
    - Your programs successfully send/receive the messages as specified in the above.

- Program Robustness and Friendliness (5points)
    - Errors in socket operations are properly handled.
    - It is easy to run and understand the outputs of your programs.

- Program Comments (5points)
    - Your source code is properly commented.