In this assignment, we will take a closer look at quality of service and its metrics in a computer network. You can e-mail your solutions to the instructor, submit them during the class next week, or slide the solution under my office door (BA5238) before 5pm on October 9th.

The Story: A new Internet service provider company called Dogers has introduced a new type of network connection. Dogers claims to have the highest bandwidth among its competitors. To transfer data packets, Dogers installs a box called collector at each user’s home. This box collects all the packets that the user’s computer wants to send to the Internet, and stores them on a hard disk of 1 terabyte capacity (approximately $10^{12}$ bytes). A highly trained dog (thus, the name Dogers!) takes the hard disk to the Internet service provider’s building. Then, all the stored packets are sent to their destinations using the regular Internet connection. The same story is true for the packets that are headed towards the user’s computer. A collector located in Internet provider’s building stores all packets destined to user’s computer on a hard disk, and the Dogers dog carries that hard disk to the user’s home on its way back. It takes 10 minutes for the Dogers dog to take the hard disk from the user’s home to the Dogers building and 10 minutes to bring the data from Dogers to the user’s home. You can ignore delays associated with installing the hard disk on a new machine, and transferring data from/to the Internet. The process is continually repeated every 20 minutes.

[Hint: If you are familiar with computer networks, you know that this wouldn’t work unless we tweak a lot of things including TCP, various timeouts and buffer sizes. For now, let us assume all of these have been taken care of and ignore them.]

1) **Bandwidth [2 points]**. Calculate the maximum bandwidth of the Dogers’ connection, i.e. the maximum number of bytes that can be sent in a second over Dogers network. Convert your answer into Mbps (mega bits per second or $10^6$ bits per second). Remember each byte is equal to 8 bits. Is this higher than typical Internet connection bandwidth (i.e. 1 Mbps to 50 Mbps)?

2) **Delay [1 point]**. If you want to download a web page using Dogers network what is the minimum delay from the time you click on a link, until you receive that link? What is the maximum delay?

3) **Large File [2 point]**. Let us assume that you want to use your Internet connection to download a large file (for example a movie). Is Dogers’ connection appropriate for you? What if you want to use your Internet connection to chat? Explain your answer.
4) **Applications [2 points].** Which one of the following applications can use Dogers’ network? Which ones cannot?

   a. Text chat  
   b. Email  
   c. Video conferencing  
   d. YouTube (video streaming)  
   e. Downloading a large movie  
   f. Downloading your SLI 199 assignments  
   g. Uploading large photos  
   h. Web search  
   i. Facebook

5) **Sensitivity [1 points].** In general, explain what applications can work with Dogers’ network and what applications cannot. Explain your answer in terms of bandwidth and delay requirements for the applications.

6) **Jitter [1 point].** In class we talked about bandwidth, and delay. Jitter is how much the delay of different packets varies over time. If packets are sent or received over fixed time intervals, we say there is no jitter. If packets arrive in bursts, followed by a long period of time with no packet arrivals, we have a high jitter. Does Dogers’ network have a small jitter or high jitter? Explain your answer.

7) **Role [1 point].** As we saw in class, the Internet is a collection of routers and links. What is the role of the Dogers dog here? Is it similar to a router? Or, is it similar to a link? Explain briefly.