Assignment 1

1. When the time is N\*(L/R), the 1st packet will be at the destination, the 2nd packet will be at the first router and a 3rd packet will be at the second router. Therefore, at time N\*(L/R) + L/R, the 2nd packet will have reached the destination and the 3rd packet will now be in the third router. This continues until you get the generalized formula **(N + P-1)\*L/R**, where P are the packets.
2. If the total distance is 150km and the speed is 100km/h then the total transmission delay will be 150km/100(km/h) = 1.5 h. It takes 12 seconds for each toll booth to reach a single car, so it will take 2 minutes for a toll booth to reach 10 cars. Since there are 3 toll booths it will take 6 minutes (2 minutes \* 3 toll booths). Therefore, the end-to-end delay will be 1.5 h + 6 minutes = **1 h and 36 minutes**.
3. First we need to use this information to find the time the bit is created, which is 56\*8/(68\*10^6) = 0.007 seconds. Next, we need to calculated the time required to transmit the packet which is 56\*8/(2\*10^6) = 0.00022 seconds. Adding in the propagation delay, it will take **.007 seconds + .00022 seconds + .01 seconds = .01722 seconds.** This is a total time of **17.22 milliseconds**.
4. The 1st end system needs L/R1 to transmit the packet onto the 1st link, needs L/R2 to transmit the packet onto the 2nd link and needs L/R3 to transmit the packet onto the 3rd link. The packet propagates d1/s1 over the 1st link, d2/s2 over the 2nd link and d3/s3 over the 3rd link.

Therefore the **end-to-end delay = L/R1 + L/R2 + L/R3 + d1/s1 + d2/s2 + d3/s3 + dproc + dproc**

Plugging this into the 2nd part, we see that the **end-to-end delay = 6 + 6 + 2 + 16 + 4 + 3 + 3 = 64 msec.**

1. The queueing delay would be 0 for the 1st packet, L/R for the 2nd packet, 2L/R for the third packet and therefore (N – 1)L/R for the Nth packet. Therefore the average delay for the N packets is **(L/R + 2L/R + …. + (N – 1)L/R)/N** (sum of all packets / number of packets).