# HW#1

1 Questions: 40 pts/total

1. Why packet switching is called a store-and-forward approach? (2 pts)

2. Suppose users share a 10 Mbps link, and each user transmits continuously at 2 Mbps when transmitting. Each user transmits only 40 percent of the time. (1) How many users can be supported by this link when using circuit switching? (2) What is the utilization of the link? (2 pts/each)

3. Under the same setting as the problem above. Assuming that packet-switching is used with 8 users. (1) What is the probability that only a (selected) user is transmitting, and the rest are not transmitting? (2) What is the probability that more than 5 users are transmitting at the same time? You can show the equations without the numerical results. (4 pts/each)

4. Name at least one difference between DSL and cable networks? (2 pts)

5. What are the four delay components in this end-to-end transmission? (4 pts)

6. Given the network below, where L_1, L_2, L_3 are the length of the links in *meters*, R_1, R_2, R_3 are the transmission rate in *bits/second*, and the propagation speed is P *meters/second*. Sender S is sending packets of size K bits to the receiver R. (1) If we do not consider the propagation delay, what would be the end-to-end delay between S and R? (2) What is the throughput between S and R? (3) What can we do to reduce the end-to-end delay? (4) What can we do to increase the throughput between S and R? (2 pts/each)
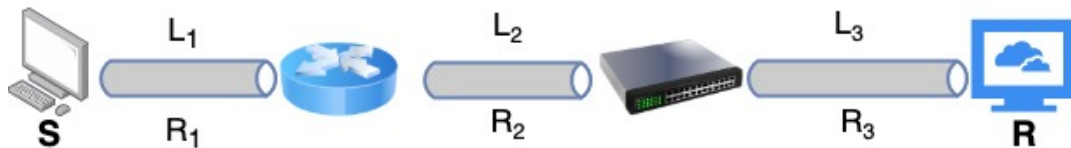
7. **(Transmission/propagation delay)** Consider a highway that has a tollbooth every 20 km, and cars travel on the highway at a rate of 100 km/hour. Assume that 8 cars travel together as a caravan and travel in a fixed order. Suppose each tollbooth services a car at a rate of 5 minutes per car, and no other cars except these 8 cars are on the highway. Finally, suppose that whenever the first car of the caravan arrives at a tollbooth, it will not be processed by the toll booth but wait at the entrance until all other cars arrive and line up behind it.

(i) What is the total time required for a whole caravan to travel from the entrance of the first tollbooth to the entrance of the next tollbooth (all cars should be lined up.) (2 pts)

(ii) Why in the example we emphasize that all the cars have to line up before the first car can be processed at the toll booth? (2 pts)

(iii) What is the meaning of the 5 minutes processing time at the toll booth? (Note: this is asking you which type of the delay it is). (2 pts)

(iv) According to the calculation in (i), will the first car arrive the next tollbooth before the fourth car's departure from the first tollbooth? Provide your evaluation here (only provide the Yes or No answer will not earn you the credit). (2 pts)

8. We use traceroute (Linux/Mac) or tracert (Windows) to find a path from your device/machine to a destination and also measure the end-to-end delays. Assume that there are two routers on the path between your machine and the destination, how many delay measurement (packets) will be sent out from your device? (2 pts)

9. What are the fundamental causes of packet loss? (2 pts)

2   How to submit the assignment

All the assignments should be submitted electronically to GitHub.

If you prefer to write your answers on papers, please take photos of your written assignments and submit them to GitHub.

Note: If you upload photos, please make sure that the resolution and quality of the photos should be acceptable (readable.) If the quality is too bad so the instructor cannot read/understand your work, it will be rejected and you'll be required to redo the assignment.