EE 450Homework 1
Spring 2013Nazarian

Score:___/100

Student ID: _____ Name: _____

Assigned : Friday 01/25/2013

Due: 01/31/2013, Thursday morning at 11am (EE450 HW locker, on the 3rd floor of EE Building) Late submission is accepted for two days with a max penalty of 15% per day. For each day, submission between 11am- 12pm: 2%, 12-1pm: 4%, 1-2pm: 8%. After 2pm:15%.

Notes:

- **The goal of this homework is to help you review the basics of network performance measures.**
- **This assignment is based on individual work. No collaboration is allowed. Please watch the first lecture of this course regarding the academic integrity policies and also refer to the syllabus for a summary of AI policies (including the penalties for any violation.) If you have any doubts about what is allowed or prohibited in this course, please contact the instructor.**

1) Suppose cars travel at a rate of 100km/hr on a highway it can accelerate to 100km/hr right after it leaves a tollbooth). Also, assume that the processing time for each car at each tollbooth located at uniform intervals on the highway is 12 seconds. 10 cars are travelling in a caravan together and consider each car to be analogous to 1 bit.

a) Suppose the caravan travels 150km, beginning in front of one tollbooth, passing through a second tollbooth and then finishing just in front of the third tollbooth. What is the end-to-end delay? (10 pts)

b) Repeat part assuming there are 8 cars in the caravan instead of 10. (5 pts)

2) Consider sending a real-time voice signal (VoIP) from Host A to Host B over a packet switched network. Host A converts analog voice to a digital 128kbps bit stream on the fly. Host A then groups the bits into 56 byte packets. There is one link between Hosts A and B; its transmission rate is 1Mbps and its propagation delay is 10ms. As soon as Host A gathers a packet, it sends it to host B. When Host B receives an entire packet, it converts the packet's bits into an analog signal. How much time elapses from the time a bit is created (from the original signal at Host A) until the bit is decoded (as part of the analog signal at Host B). (20 pts)

3) A, B and C are connected by 15 Mbps links. The distance between A and B is 200km, while the B and C are 500km apart. The processing time and queuing delay cumulatively at each node is 20% of the transmission time. Find the time taken to send a 1 Megabyte packet from Node A to Node C (assuming store and forward at each node). (20 pts)

4) Consider a packet of length L which begins at system A and travels over three links to a destination end system. These three links are connected by two packet switches. The packet switch delays each packet by $d_{proc.}$ Suppose the packet is 1500 bytes. The propagation speed on all

three links is 2.5 *10^8 m/s, the transmission rates on all three links are 2Mbps, the packet switch processing delay is 3ms, the length of the first link is 1000km, the second link is 3000km and the third link is 2000km. What is the end-to-end delay? (20 points)

5) Assume that we know that the bottleneck link along the path from the server to the client is the first link with rate R_s bits/sec. Suppose we send a pair of packets back to back from the server to the client, and there is no other traffic on this path. Assume each packet of size L bits and both links have the same propagation delay d_{prop}.

a) What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives? (10 pts)

b) Now assume that the second link is the bottleneck, that is, $R_c<R_s$. Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose the server sends the second packet T seconds after sending the first packet. How large must T be to ensure no queuing after the second link? Explain. (15 pts)