Assignment #3 (5% with 1% Bonus Point)

CS5263 Wireless Multimedia Networking Technologies and Applications
Department of Computer Science, National Tsing Hua University Hsin Chu, Taiwan

Please attach additional sheets and clearly mark the question numbers. Due at 10:00 a.m. on November 12th, 2012. Please turn in hardcopies before the lecture starts. See course website for grading policies, especially about late submissions.

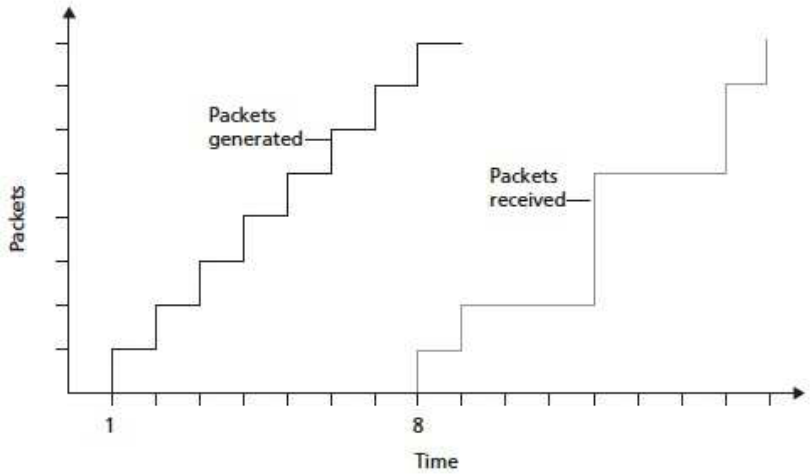

Fig. 1

1) (1%) Surf the Web and find a site that stream stored audio and/or video. Then use Wireshark to determine:
   a) Whether metafiles are used
   b) Whether the audio/video is sent over UDP or TCP
   c) Whether RTP is used
   d) Whether RTSP is used

   Give screenshots to back up your observations.
2) (1%) Consider the procedure described in Section 7.3 for estimating average delay d_i. Suppose that $u = 0.1$. Let r_1t_1 be the most recent sample delay, let r_2t_2 be the next most recent sample delay, and so on.
   a) For a given audio application suppose four packets have arrived at the receiver with sample delays $r_4t_4, r_3t_3, r_2t_2, and r_1t_1$. Express the estimate of delay d in terms of the four samples.
   b) Generalize your formula for n sample delays.
   c) For the formula in b), let n approach infinity and give the resulting formula. Comment on why this averaging procedure is called an exponential moving average.
3) (2%) See Figure 1. A sender begins sending packetized audio periodically at $t = 1$. The first packet arrives at the receiver at $t = 8$.
   a) What are the delays (from sender to receiver, ignoring any playout delays) of packets 2 through 8? Note that each vertical and horizontal line segment in the figure has a length of 1, 2, or 3 time units.

b) If audio playout begins as soon as the first packet arrives at the receiver at $t = 8$, which of the first eight packets sent will not arrive in time for playout?
c) If audio playout begins at $t = 9$, which of the first eight packets sent will not arrive in time for playout?
d) What is the minimum playout delay at the receiver that results in all of the first eight packets arriving in time for their playout?

4) (1%) Refer to Figure 1 again. Show packet audio transmission and reception times.
a) Compute the estimated delay for packets 2 through 8, using the formula for d_i from Section 7.3.2. Use a value of $u = 0.1$.
b) Compute the estimated deviation of the delay from the estimated average for packets 2 through 8, using the formula for v_i from Section 7.3.2. Use a value of $u = 0.1$.

5) (1%) Suppose that the WFQ scheduling policy is applied to a buffer that supports three classes, and suppose the weights are 0.5, 0.25, and 0.25 for the three classes.
a) Suppose that each class has a large number of packets in the buffer. In what sequence might the three classes be served in order to achieve the WFQ weights? (For round robin scheduling, a natural sequence is 123123123 . . .).
b) Suppose that classes 1 and 2 have a large number of packets in the buffer, and there are no class 3 packets in the buffer. In what sequence might the three classes be served in to achieve the WFQ weights?