CS 3516 (A18) – Quiz 2 –
Friday, August 31, 2018

Student Name: _____

WPI Username: _____

Please answer the following questions using only the front side of this sheet of paper. **This quiz is closed book/notes. One page cheat-sheet is allowed**. *We will not grade the backside or any additional sheets of paper.* We will scan the quiz and return it electronically. To ensure it is properly scanned, please avoid wrinkling, folding, or otherwise distorting the paper. *You can use the back of the paper for any calculations you might have to perform.* Please mark exactly which question/sub-question you are answering. (**8 Points in total.**)

1. **Suppose two hosts A and B are separated by 20,000km and are connected by a direct link of R = 200Mbps. Suppose the propagation speed over the link is $2.5*10^8$ meters/sec, then:**
   a. **Calculate the metric "bandwidth-delay product"? (2 points) [Hint: delay = T_{prop} (i.e., propagation delay)]**
   b. **Provide an interpretation for a metric "bandwidth-delay product"? (1 point)**
   c. **Consider the traffic flow from A to B. If the package size is L=1kbits and average package arrival rate a=2k packages per second, what is the traffic intensity? Will there be significant queuing delay (3 points)**

   Note that in the questions, we consider 1k=10^3, 1M =10^6.

a. $R * T_{prop}$ = 200Mbps * 20,000km/$2.5*10^8$ meters/sec = (200 * 10^6 bits/sec) * (80 * 10^{-3} sec) = 16,000,000 bits=16Mbits **(2 points total; 1point for showing calculation, 1point for correct answer.)**

b. The bandwidth-delay product of a link is the **maximum number of bits that can be in the link at any given time (1 point.)**

c. La/R = 1kbits * 2k packets/s / 200Mbps = 2Mbps / 200Mbps = 0.01. Since La/R ~ 0, the queuing delay is small. **(3 points; 1 point for showing calculation, 1 point for correct answer, 1point for small queuing delay.)**

2. **Consider 1 client and 1 server with M paths between them. No two paths intersect anywhere. Each path k (k = 1, 2,…, M) consists of N links with transmission rates R_1^k, R_2^k,… R_N^k. If the server can use only one path to send data to the client, what is the maximum throughput the server can achieve? (2 points)**

If only use one path, the max throughput is given by:

$$\max\{\min\{R_1^1, R_2^1, \ldots, R_N^1\}, \min\{R_1^2, R_2^2, \ldots, R_N^2\}, \ldots, \min\{R_1^M, R_2^M, \ldots, R_N^M\}\}.$$

[2 points total. 1 point for all the 'min' expressions. 1 point for 'max' in the beginning]

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