

Computer Network – Assignment 1

Due: 2009-04-10 (Fri.) 18:00

1. (I-7) Suppose users share a 1 Mbps link. Also suppose each user requires 100 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of statistical multiplexing in Section 1.3.)
 - a. When circuit switching is used, how many users can be supported?
 - b. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.
 - c. Suppose there are 40 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (*Hint*: Use the binomial distribution.)
 - d. Find the probability that there are 11 or more users transmitting simultaneously.

2. (I-12) Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R . What is the average queuing delay for the N packets?

3. (I-18) Suppose two hosts, A and B, are separated by 10,000 kilometers and are connected by a direct link of $R = 1$ Mbps. Suppose the propagation speed over the link is $2.5 \cdot 10^8$ meters/sec.
 - a. Calculate the bandwidth-delay product, $R \cdot d_{prop}$.
 - b. Consider sending a file of 400,000 bits from Host A to Host B. Suppose the file is sent continuously as on large message. What is the maximum number of bits that will be in the link at any given time?
 - c. Provide an interpretation of the bandwidth-delay product.
 - d. What is the width (in meters) of a bit in the link?
 - e. Derive a general expression for the width of a bit in terms of the propagation speed s , the transmission rate R , and the length of the link m .

4. (II-10) Consider a short, 10-meter link, over which a sender can transmit at a rate of 150 bits/sec in both directions. Suppose that packets containing data are 100,000 bits long, and packets containing only control (e.g., ACK or hand-shaking) are 200 bits long. Assume that N parallel connections each get $1/N$ of the link

bandwidth. Now consider the HTTP protocol, and suppose that each downloaded object is 100 Kbits long, and that the initial downloaded object contains 10 referenced objects from the same sender. Would parallel downloads via parallel instances of non-persistent HTTP make sense in this sense? Justify and explain your answer.

5. (II-18) Consider distributing a file of F bits to N peers using a P2P architecture. Assume a fluid model. For simplicity assume that d_{min} is very large, so that peer download bandwidth is never a bottleneck.
- Suppose that $\mu_s \leq (\mu_s + \mu_1 + \dots + \mu_N)/N$. Specify a distribution scheme that has a distribution time of F/μ_s .
 - Suppose that $\mu_s \geq (\mu_s + \mu_1 + \dots + \mu_N)/N$. Specify a distribution scheme that has a distribution time of $NF/(\mu_s + \mu_1 + \dots + \mu_N)$.
 - Conclude that the minimum distribution time is in general given by $\max\{ F/\mu_s, NF/(\mu_s + \mu_1 + \dots + \mu_N) \}$