컴퓨터 네트워크 과제 1

과목명 컴퓨터네트워크

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P8.

Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of packet switching versus circuit switching in Section 1.3.)

a. When circuit switching is used, how many users can be supported?

20 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. $p = 0.1$

c. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)

$${}_{120}C_n \, p^n (1-p)^{120-n}$$

d. Find the probability that there are 21 or more users transmitting simultaneously.

$$1 - \sum_{n=0}^{20} {}_{120}C_n \, p^n (1-p)^{120-n}$$

X_j central limit theorem $\quad P(X_j = 1) = p$

$$P(\text{"21 or more users"}) = 1 - P\left(\sum_{j=1}^{120} X_j \le 21\right) \Rightarrow P\left(\sum_{j=1}^{120} X_j \le 21\right) = P\left(\frac{\sum_{j=1}^{120} X_j - 12}{\sqrt{120 \cdot 0.1 \cdot 0.9}} \le \frac{9}{\sqrt{120 \cdot 0.1 \cdot 0.9}}\right)$$

$$\approx P\left(Z \le \frac{9}{3.286}\right) = P(Z \le 2.74) = 0.997$$

P13.

a. 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? $\frac{L}{R}$ (sec)

첫번째 전송된 transmitted packet 의 queuing delay 는 0 이다.

$$\left(\frac{L}{R} + \frac{L}{R}2 + \dots + (N-1)\frac{L}{R}\right)N = \frac{(N-1)L}{2R}$$

b. Now suppose that N such packets arrive to the link every LN/R seconds. What is the average queuing delay of a packet?

$$\frac{(N-1)L}{2R}$$

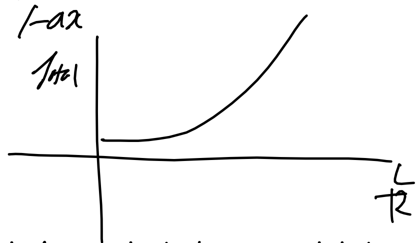
P14. Consider the queuing delay in a router buffer. Let I denote traffic intensity; that is I=La/R. Suppose that the queuing delay takes the from IL/R(1−I) for I<1.

a. Provide a formula for the total delay, that is, the queuing delay plus the transmission delay.

$$\frac{IL}{R(1-I)} + \frac{L}{R} = \frac{L/R}{1-I}$$

b. Plot the total delay as a function of L/R.

Let $x = L/R$ Total delay $= \frac{x}{1-ax}$



P15. Let a denote the rate of packets arriving at a link in packets/sec, and let μ denote the link's transmission rate in packets/sec. Based on the formula for the total delay (i.e., the queuing delay plus the transmission delay) derived in the previous problem, derive a formula for the total delay in terms of a and μ.

$$\text{Total delay} = \frac{L/R}{1-I} = \frac{L/R}{1-a(L/R)} = \frac{1/\mu}{1-a/\mu} = \frac{1}{\mu-a}$$

P16. Consider a router buffer preceding an outbound link. In this problem, you will use Little's formula, a famous formula from queuing theory.

Let N denote the average number of packets in the buffer plus the packet being transmitted.

Let a denote the rate of packets arriving at the link.

Let d denote the average total delay (i.e., the queuing delay plus the transmission delay) experienced by a packet.

Little's formula is $N = a \cdot d$. Suppose that on average, the buffer contains 10 packets, and the average packet queuing delay is 10 msec. The link's transmission rate is 100 packets/sec. Using Little's formula, what is the average packet arrival rate, assuming there is no packet loss?

$N = 10+1$

$N = a \cdot d$ $\quad 10+1 = a \cdot$ (queuing delay + transmission delay)

$11 = a^* (0.01 + 1/100) = a^* (0.01 + 0.01)$

$a = 550$ packets/sec.