**컴퓨터네트워킹 과제**

**HW#1**

**강좌 명: 컴퓨터네트워킹**

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**Q3. Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions. Briefly justifying your answer:**

**a. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?**

**b. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?**

a) circuit-switched network가 더 적합하다.

이유는 이 어플리케이션이 예측가능한 대역폭이 있는 긴 세션이 필요하기 때문이다. 또한 전송률이 이미 알려져 있어 bursty하지 않아서 대역폭은 큰 낭비 없이 예약 가능하기 때문에 circuit-switched network가 더 적합하다.

b) congestion control이 필요하지 않다.

이유는 최악의 상황에서 모든 어플리케이션이 동시에 한 네트워크의 링크에 전송된 경우이다. 하지만 여기 각각의 링크들의 용량이 이 어플리케이션의 데이터 총량보다 크다고 나와있기 때문에 congestion이 발생하지 않는다. 따라서 이러한 용량을 고려한다면 congestion 제어 메커니즘은 필요하지 않다.

**Q6. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by single link of rate R bps. Suppose that the two hosts are separated by m meter, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.**

**a. Express the propagation delay, dprop, in terms of m and s.**

**b. Determine the transmission time of the packet, dtrans, in terms of L and R.**

**c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.**

**d. Suppose Host A begins to transmit the packet at time t = 0. At time t = dtrans, where is the last bit of the packet?**

**e. Suppose dprop is greater than dtrans. At time t = dtrans, where is the first bit of the packet?**

**f. Suppose dprop is less than dtrans. At time t = dtrans, where is the first bit of the packet?**

**g. Suppose s = 2.5 \* 10^8, L = 120 bits, and R = 56 kbps. Find the distance m so that dprop equals dtrans.**

a) dprop: propagation delay로 physical link의 길이 / propagation speed이다.

따라서 dprop = m/s

b) dtrans: transmission delay로 packet의 길이 / link transmission rate이다.

따라서, dtrans = L/R

c) dproc + dqueue + dtrans + dprop인데 processing과 queuing을 무시하므로 dtrans + dprop만 해주면 된다.

따라서 dend-to-end = m/s + L/R

d) bit는 이제 막 Host A를 떠나는 지점에 있다. Transmission delay란 전송하려는 패킷을 output link로 밀어내는데 걸리는 시간이기 때문에 t = dtrans일 경우 이제 막 output link로 밀어내지는 지점에 있다.

e) dprop은 실제 link를 타고 데이터가 전송될 때 발생하는 delay이므로 dprop이 dtrans보다 크면 t = dtrans일 때 first bit은 아직 link에 있다. 즉, Host B에 도착하지 못한 상태이다.

f) first bit은 Host B에 도달해 있다.

g) m/s = L/R인 m은 m/(2.5 \* 10^8) = 120 / (56\*10^3)

m = 120 \* 2.5 \* 10^5 / 56 = 535714 meter다.

**Q13. (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?**

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

a) 처음 패킷의 queuing delay = 0 두번째는 L/R. 세번째는 2\*L/R. N번째는 (N-1)\*L/R

따라서 모든 queuing delay를 더해서 N으로 나눠주면 된다.

(1 + 2 + 3 + … + N-1) =

b) N 패킷의 송신에는 LN/R초가 걸리기 때문에 N패킷의 각 batch가 도착했을 때는 버퍼가 비어 있다. 따라서 모든 batch의 평균 지연은 1개의 평균이 된다.

**Q16. 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*· *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?**

전체 delay는 Transmission delay + Queuing delay

Transmission delay = L/R

1개의 패킷을 전송한다고 가정하면 L = 1packet, R = 100packets/sec

따라서 Transmission delay = 1/100 sec = 10msec

Queuing delay = 10msec

따라서 Total delay는 20msec = 0.02 sec

N = 10 -> N = a \* 0.02

10 = a \* 0.02

a = 500 packets/sec

따라서 평균 패킷 arrival rate는 500 packets/sec이다.

**Q18. Perform a Traceroute between source and destination on the same continent at three different hours of the day.  
a. Find the average and standard deviation of the round-trip delays at each of the three hours.  
b. Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours?  
c. Try to identify the number of ISP networks that the Traceroute packets pass through from source to destination. Routers with similar names and/or similar IP addresses should be considered as part of the same ISP. In your experiments, do the largest delays occur at the peering interfaces between adjacent ISPs?  
d. Repeat the above for a source and destination on different continents. Compare the intra-continent and inter-continent results.**

a) 

D1 = 1.03 msec

D2 = 0.48 msec

D3 = 0.45 msec

평균 = 0.65msec

표준편차 = √((1.03-0.65)^2 + (0.48-0.65)^2 + (0.45-0.65)^2)/3

√0.0711 = 0.267 msec

b) 라우터의 수는 송신원과 행선지 사이의 9. 시간이 지나면서 경로가 변경되었을 수 있다.

c) ISP 네트워크의 수는 7이다.

가장 큰 지연은 인접한 ISP간에 발생할 가능성이 높다.

d) intra-continent 결과는 DNS에 빠르게 도달하기 위해 사용된다.

inter-continent 결과는 사용자에게 필수적인 서버에 사용된다.

**Q33. Consider sending a large file of *F*bits from Host A to Host B. There are three links (and two switches) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of *S*bits each and adds 80 bits of header to each segment, forming packets of *L*= 80 + *S*bits. Each link has a transmission rate of *R*bps. Find the value of *S*that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.**

link의 수: 3

switch의 수: 2

파일의 크기: F

Segment의 크기: S

Segment의 수: F/S

Header의 크기: 80

패킷의 크기: 80+S

전송률: R bps

Transmission delay: L/R = (80+S)/R sec

첫 패킷이 목적지까지 전송되는데 필요한 시간 T = 지연율 \* 3 = (80+S)/R \* 3

전체 지연율은 (80+S)/R \*3 + (F/S – 1) \* (80+S)/R = ((80+S)/R) \* (F/S + 2)

여기서 S의 최솟값을 찾는 것이므로 S에 대해서 미분한 식이 0이 되는 S 값이 답이다.