ELEC3500 TELECOMMUNICATIONS NETWORKS

Question Set – 2

This question set consists of conceptual and numerical questions.

2-0. 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 application starts, it will continue running for a relatively long period. Answer following questions with justifications.

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

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

Answer [b: no congestion control needed]

2-1. Let us begin to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of transmission rate of R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A to send a packet size of L bits to host B.

a. Suppose host A begins to transmit the packet at time t = 0. At time t = d_{trans}, where is the last bit of the packet?

b. Suppose the $d_{prop} > d_{trans}$. At time t = d_{trans}, where is the first bit of the packet?

c. Suppose the $d_{prop} < d_{trans}$, At time t = d_{trans}, where is the first bit of the packet?

d. Suppose s = 2.5×10^8 m/sec, L = 120 bits, and R = 56 kbps. Find the distance m so that d_{prop} is equal to d_{trans}.

Answer: [a: last bit will leave host**, b:** first bit in transit**, c:** first bit reached B, A still transmitting**, d:** 535 km**]**

2-2. Suppose that users share a 2 Mbps link. Also, suppose each user transmits continuously at 1 Mbps when transmitting. Each user transmits only 20% of time.

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

b. For the remainder of the problem use packet switching technique. Why there will be essentially no queuing delay if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?

c. Find the probability that a given user is transmitting.

d. Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously.

Answer [0.008]

2-3. Suppose network users share a 3 Mbps link. Also, suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of time.

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 that there are 50 users. Find the probability that any given time exactly 5 users are transmitting simultaneously. (Use the binomial distribution)

Answer: [a: 20, b: 0.1, c: 0.1849]

2-4. Consider a packet switching communication link operating at 1 Gbps. Users are generating data at a rate of 100 kbps when active. Users generate data only for 10% time ($p = 0.1$).

a. What is the N the maximum number of users that can be supported simultaneously using circuit switched links?

b. Now consider packet switching and a user population of M users. Generate a formula in terms of p, M and N for the probability that more than N users are sending data.

c. Consider a packet switching system with 10 users. Find the probability that more than 5 users are transmitting data.

Answer [a: 10,000, c: 1.47×10^{-4}]

2-5. Consider figure 2.1. Assume that the two hosts on the left of the figure start transmitting packets of 1500 bytes at the same time towards the server. Suppose the link rates between the hosts and router A is 4 Mbps. Host A to Router A link has 6 ms propagation delay and the host B to router A has 2 ms propagation delay. Will queuing occur at router A?

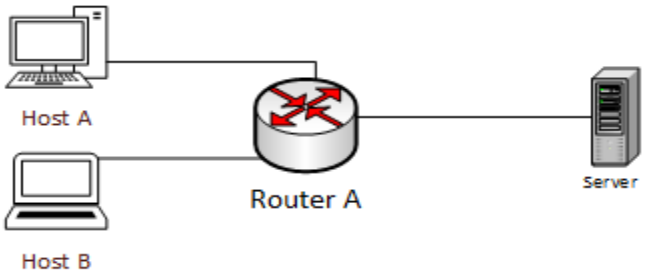

Figure 2.1

Answer: [No]

2-6. Consider a user who needs to transmit 1 GB data file to a server. The user live in a small town where only low data rate access network is available supporting transmission rate of 2 Mbps. A bus visit the town once a day from a nearby city located 150 km away, and stops in front of the user's house. The bus has a 100 Mbps WiFi connection. It can collect data from the user and transfer to the server via the internet though a 1 Gbps link from the city bus depot. Average speed of the bus is 60 km/h. The server is located in the city bus depot.

a. Calculate the file transmission delay to the server using user's own internet connection assuming data is transmitted continuously (no packet transmission).

b. Calculate the file transmission delay when bus used to transmit the file using the same assumption as (a).

Answer [1.193 hour, 2.527 hour]

2-7. Assume that a VoIP server connected in the internet serving large number of VoIP users. Users are using 32 kbps coder. Each VoIP terminal transmits voice data every 20 ms where 18 byte header is used for voice packets. Assume that VoIP users are using 10 Mbps internet connection. Link distance is 10 km. Use the default propagation speed of light. Calculate the voice packet transmission delay to the VoIP server.

Answer [0.1117 ms]

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