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CS118 Homework 1

1. What are network protocols? Please write down the definition of network protocols.
   →**Network protocols are sets of procedural rules that determine message order and format of communicating entities, the actions taken on transmission, and receipts of messages and events.**

2. Tell the following statements true or false.

   (**True**) End systems are just hosts. There are no differences between the two terms.
   →**In the context of networking (and in our book), there really is no difference.**

   (**False**) In packet switching transmissions, bandwidth is divided into pieces and each packet uses one or several pieces of bandwidth.
   →**Packet switching uses the full link bandwidth.**

   (**True**) Full buffer is the only reason that causes packet loss.
   →**Essentially, a full buffer is the sole reason behind packet loss. But it more precisely occurs in conjunction with network congestion and a buffer overflow.**

3. Consider an application that transmits data at a steady rate (e.g., 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 answers:

   (a) Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
   →**A circuit-switched network is more ideal in this situation. Circuit-switched networks are used in applications like telephones and are suited for streaming; since our application sends data in extremely short intervals, but for a long duration, the streaming that circuit-switched networks have will work well. Packet-switching, on the other hand, is more suited for sending data in bursts.**

   (b) Suppose that a packet-switched network is used and the only traffic in this network comes from such applications 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?
   →**No congestion control is necessary. In the worst case, all the applications send their data at the same time. But since the sum of those rates is still less than the capacities of all links, no overflow will ever happen and even queuing will be rare.**

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4. 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?
**→The first packet has no queuing delay, but the Nth (and last) packet has to wait (N-1)L/R in the queue – that is, the time for all the previous N-1 packets to be processed. Therefore, we take the average of these two values to be (N-1)L/(2R).**

5. Suppose users share a 1 Mbps link. Also suppose each user requires 100kbps 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?
**→In total, we have 1 Mbps split between users that use 100 kbps. Therefore, we can have (1 Mbps)/(1 kbps) = 1000000/100000 = 10 users supported at the same time.**

(b) For the remainder of the problem, suppose packets switching is used. Find the probability that a given user is transmitting.
**→The probability that a certain user is transmitting is, as the problem states, 0.1. Therefore, p=0.1.**

(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.)
**→We would use the formula:**

$$\boldsymbol{\binom{40}{n} p^n (1-p)^{40-n}}$$

$$\boldsymbol{\binom{40}{n} (0.1)^n (0.9)^{40-n}}$$

(d) Find the probability that there are 11 or more users transmitting simultaneously.
**→The probability that at most 10 users transmit simultaneously is:**

$$\sum_{n=0}^{10} \binom{40}{n} (0.1)^n (0.9)^{40-n}$$

**Therefore, subtracting that value from 1 gives us the probability that at least 11 users are transmitting at the same time.**

$$1 - \sum_{n=0}^{10} \binom{40}{n} (0.1)^n (0.9)^{40-n} = 0.00146972$$