Problems

P. 1

Consider 2 hosts A and B, that are connected through a link of bandwidth R = 1.2 Mbps. The distance between A and B is d=10km. The propagation speed is c = 2\*108 m/s.

1. Find the propagation delay
2. Find the transmission delay, for a packet of L = 1.2Kb.
3. Find the packet length, such that host B receives the first bit of the packet the same time that host A sends the last bit.
4. Consider that we double the length of the link. How will the delays be affected?

**Solution**

1. The propagation delay is
2. The transmission delay is
3. This is true when:
4. When the length of the link is doubled we have d’ = 2\*d
The propagation delay thus becomes

Thus the propagation delay is also doubled.

The transmission delay becomes

Thus the transmission delay does not change because it is independent from the length of the link

P. 2

Find the time required for the transmission of a file of M bits in a network that uses TDMA with N time-slots. The total bandwidth is B bits/sec. Also consider that the end-to-end circuit establishment needs time τ sec. Ignore the length of the packet header.

**Solution**

Consider that the length of a single time-slot is t seconds. So, in a single-time slot B\*t bits are transmitted. Given that the total length of the file is M bits, r = total TDMA rounds are needed for whole file to be transmitted. Every TDMA round lasts for N\*t seconds. So, for the transmission of the file

 seconds are needed.

In this time we must also add the time that the end-to-end circuit needs in order to be established, so the total time needed is

P. 3

Consider sending a large file of *F* bits from Host A to Host B. There are two links (and one switch) between A and B, and the links are uncongested (i.e., no queueing delays). Host A segments the file into segments of *S* bits each and adds 40 bits of header to each segment, forming packets of *L = 40 + S* bits. Each link has a transmission rate of *R* bps. Find the value of *S* that minimizes the delay of moving the packet from Host A to Host B. Neglect propagation delay.

**Answer**

The total number of packets are F/S.

Assume that F/S is integer.

Denote, h = 40, the header size.

The total delay will be

Taking the derivative of the delay for S

And setting it to zero we have

So the value of *S* that minimizes the delay of moving the packet from Host A to Host B is

P. 4

Suppose users share a 1 Mbps link. Also suppose each user requires 100 Kbps when transmitting, but each user only transmits 10% of the time. (See the discussion on "Packet Switching versus Circuit Switching" in Section 1.4.1.)

1. When circuit-switching is used, how many users can be supported?
2. For the remainder of this problem, suppose packet-switching is used. Find the probability that a given user is transmitting.
3. Suppose there are 40 users. Find the probability that at any given time, *n* users are transmitting simultaneously.
4. Find the probability that there are 10 or more users transmitting simultaneously.

**Answer**

1. Each user requires 1/10th of the bandwidth. So, when circuit-switching 10 users can be supported.
2. Each user transmits 10% of the time so

P(a given user is transmitting) = 10/100 = 0.1

1. Consider p the probability that a user transmits,

so (1-p) is the probability that a user does not transmit

There are possible combinations of n users, given that the total users are 40.

Remember that :

So the probability is:

1. The probability that 0 or 1 or 2 or … or 9 users transmit is

So the probability that 10 or more users transmit is