Bee Cha
CSCI 156
Homework 1

(P7)
Users share a 1 Mbps link. Each user requires 100 Kbps. Each user transmits 10 percent of the time.

a. *When circuit switching is used, how many users can be supported.*
With circuit switching, each user has to be given the maximum transfre rate, which is 100 Kbps. So if each user shares a 1 Mpbs (1000 Kpbs) link, then the maximum users that can be supported on that link is **1000 Kpbs / 100 Kpbs = 10**. A total maximum of 10 users can only be supported.

b. *Suppose packet switching is used. Find the probablity that a given user is transmitting.*
Each user transmits p = 10 percent of the time. When actively transmitting, the user will transmit 0.1 Mbps at the probability of 1 – p or (1 – 0.1)

c. *Suppose there are n = 40 users. Find the probablity that exactly k users are transmitting simultaneously.*
Binomial Distribution
The max number of users that can be support simultaneously is 10. 11 or more users simultaneously can cause a queue. n = 40 users, k number of active users, and (n – k) number of users are inactive.

$$P(num\,of\,active\,users) = \binom{n}{k} p^k (1-p)^{(n-k)}$$

$$\text{where} \quad \binom{n}{k} = n! \big/ k!(n-k)!$$

And our users are 10 percent active at a time, thus:

$$P(num\,of\,active\,users) = \binom{40}{k} (0.1)^k (0.9)^{(40-k)}$$

d. *Probability of 11 users transmitting simultaneously*

$$P(num\,of\,active\,users) = \binom{40}{11} (0.1)^{11} (0.9)^{(40-11)}$$

$$= 0.001089$$

(P12)
N packets arrive simultaneously to a link with no current packets being transmitted or queued. Each packet is of length L and has transmission rate R. What is the average queuing delay for N packets?

Note: The queuing delay for a packet is **L/R**

Base case: Since there's no other current packets being transmitted or queued, the 1st packet has 0 delay.

2nd packet → 1st packet + delay of packet = 0 + L/R
3rd packet → 2nd packet + L/R = L/R + L/R = 2L/R
4th packet → 3rd packet + L/R = 2L/R + L/R = 3L/R
…

Nth packet → delay of (n-1) packet + L/R = (n-1)L/R

Then to get the average delay: → (Number of Delay) / (Number of Packets)
Which is: → [θ + L/R + 2L/R + 3L/R + … + (n-1)L/R] / (N)
→ [L (n-1) ~~N~~] / (2R~~N~~)
→ [L (n-1)] / (2R)

(P18)
Suppose host A and B are separated by 10,000 kilometers and are connected by a link of R = 1Mbps. Suppose the propagation speed is 2.5 * 10^8 meters/sec.

a. *Calculate the bandwidth-delay product R * d_prop*
R = 1Mbps
and there are 1 kilometer per 1000 meter and the host is spearated by 10,000 km so,
d_prop = [(10000km * 1000m) / (2.5 * 10^8 m/s)]
thus
R * d_prop = 1Mbps * [(10000km * 1000m) / (2.5 * 10^8 m/s)] = 0.04s
or 10^6 * 0.04 = 40,000 bits

b. *Consider sending a file of 400,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?*
Wouldn't it just be 40,000 bits?

c. *Provide an interpretation of the bandwith-delay product.*
It's when transmitting data, the link can only encompass a maximum number of data simultaneously.

d. *What is the width of a bit in the link? Is it longer than a football field?*
Well, to make a link of 10,000km full, it should contain 40,000 bits. When the bits gets sent out, then it becomes 10,000km / 40,000bits for the length. 10,000km/40,000bits = 1 kilometer per 4 bits which becomes 0.25 kilometer per 1 bit

Is it longer than a football field?
A football field is 100 yards. 100 yards = 91.44 meters. 91.44 meters = 0.09144 kilometers
0.09144 kilometers < 0.25 kilometers
therefore a football field is smaller

e. *Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.*
The bandwith-delay product is defined to be the maximum number of bits a link can contain at a time. Earlier, we calculated the delay as R* d_prop. So then to get total bits that a link can carry, we take its total length and divide it by its propagation speed and multiply it by the transmission speed:

(m/s) * R

Then to find the length of each bit, we take the length of the link, and divide it by the total number of bits the link can carry:

(m) / [(m/s) * R] => (s) / [(m/m) * R] => (s) / R

which happens to be the propagation speed over the transmission rate