P8)

a. Each user requires 200 kbps when transmitting, but they only transmit 10 percent of the time.

**Average bandwidth requirement is:**

Average bandwidth requirement per user = 200 kbps \* 0.1 = 20 kbps

**Total bandwidth required for all users:**

Total bandwidth required = Average bandwidth per user \* Number of users

= 20 kbps \* Number of users

**Find the maximum number of users that can be supported:**

10 Mbps = 10,000 kbps

So, the equation becomes:

10,000 kbps = 20 kbps \* Number of users

Number of users = 10,000 kbps / 20 kbps = 500 users

Therefore, when using circuit switching, the maximum number of users that can be supported is 500.

b. Probability of transmitting = Percentage of time transmitting / Total time

**The probability of transmitting for a given user is:**

Probability of transmitting = 10% = 0.10

Therefore, the probability that a given user is transmitting at any given moment is 0.10 or 10%

c. Using binomial distribution formula = *P*(*X*=*k*)=(*kn*​)×*pk*×(1−*p*)*n*−*k*

P(X=k) = (120 k) x (0.10)^k x (1-0.1)^120-k

P25)

a. First, we need to calculate the propagation delay (d\_prop). This is the time it takes for a signal to travel from one end of the link to the other.

Propagation delay (d\_prop) = distance / propagation speed

= 20,000,000 meters / (2.5 x 10^8 meters/sec)

≈ 0.08 seconds

Now, we can calculate the bandwidth-delay product (R \* d\_prop):

Bandwidth-delay product = R \* d\_prop

= 5 Mbps \* 0.08 seconds

= 0.4 Megabits

So, the bandwidth-delay product for this link is 0.4 Megabits.

b. The maximum number of bits that will be in the link at any given time is equal to the bandwidth-delay product (R \* d\_prop).

We have already calculated the bandwidth-delay product in part (a), which is 0.4 Megabits.

So, the maximum number of bits that will be in the link at any given time is 0.4 Megabits.

Since 1 Megabit = 1,000,000 bits, we convert 0.4 Megabits to bits:

0.4 Megabits \* 1,000,000 bits/Megabit = 400,000 bits

Therefore, the maximum number of bits that will be in the link at any given time is 400,000 bits.

c. The bandwidth-delay product represents the maximum data volume in transit over a link. It's the product of the link's bandwidth and propagation delay. This figure guides network design, optimizing performance, buffer sizing, and TCP window adjustments. It's vital for efficient resource utilization and latency reduction.

d. To find the width of a bit in the link, we need to consider the propagation delay and the speed of the signal.

Propagation speed = 2.5 × 10^8 meters/sec

Propagation delay (d\_prop) = 0.08 seconds (as calculated earlier)

The width of a bit can be calculated as the distance the signal travels during the propagation delay. This can be calculated as:

Width of a bit = Propagation speed × Propagation delay

Substituting the values:

Width of a bit = 2.5 × 10^8 meters/sec × 0.08 seconds

= 2 × 10^7 meters

So, the width of a bit in the link is 20,000,000 meters.

e. The width of a bit in terms of the propagation speed (s), the transmission rate (R), and the length of the link (m) is simply the length of the link (m). In other words, the width of a bit is equal to the distance the signal travels along the link during the propagation delay, which is the length of the link itself.