Computer Networks and Network Security: Lab Assignment One

October 2021

P2

$$\lambda = \frac{60000}{24 \times 3600}$$
$$\mu = \frac{1}{180}$$
$$P_k \lambda = P_{(k+1)}(k+1)\mu$$
$$P_k = \frac{1}{k!}(\frac{\lambda}{\mu})^k P_0 = \frac{1}{k!}(\frac{\lambda}{\mu})^k \frac{1}{1 + \frac{1}{1!}\frac{\lambda}{\mu} + \frac{1}{2!}\frac{\lambda}{\mu}^2 + ... + \frac{1}{k!}\frac{\lambda}{\mu}^k} = 0.01$$
$$k = 100$$

P3

quad-core:

$$\lambda = 15$$
$$\mu_{per-core} = \frac{1}{200\ ms} = 5$$
$$\mu = 5 \times 4 = 20$$
$$\rho = \frac{\lambda}{\mu} = 0.75$$
$$t = \frac{1}{\mu}(\frac{\rho}{1-\rho}) + 200\ ms = 350\ ms$$

dual-core:

$$\lambda = 15$$
$$\mu = 5 \times 2 = 10$$
$$\rho = \frac{\lambda}{\mu} = 1.5 \geq 1$$

Infinite service time

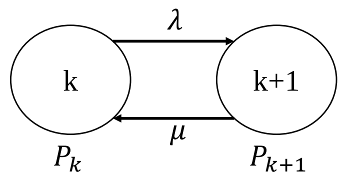

Figure 1: The state diagram.

P4

a.

$$d_{prop} = \frac{m}{s} seconds$$

b.

$$d_{trans} = \frac{L}{R} seconds$$

c.

$$d_{end-to-end} = d_{prop} + d_{trans} = (\frac{m}{s} + \frac{L}{R}) seconds$$

d.

The bit is just leaving Host A.

e.

The first bit is in the link.

f.

The first bit has reached Host B.

g.

$$m = \frac{L}{R} S = \frac{120}{56 \times 10^3}(2.5 \times 10^8) = 536Km$$

P5

a.

$$R \times d_{prop} = 2 \times 10^6 \times \frac{2 \times 10^7}{2.5 \times 10^8} = 160000\ bits$$

b.

$$d_{trans} = \frac{800000}{2 \times 10^6} = 0.4\ s$$

$$d_{prop} = \frac{2 \times 10^7}{2.5 \times 10^8} = 0.08\ s$$

$$maxbits = \frac{d_{prop}}{d_{trans}} \times 800000 = 160000\ bits$$

c.

The bandwidth-delay product is the maximum number of bits that can be in the link.

d.

$$the\ width\ of\ a\ bit = \frac{2\times10^7}{160000} = 125\ m,$$
$$which\ is\ longer\ than\ a\ football\ field.$$

e.

$$the\ width\ of\ a\ bit = \frac{m}{R\times d_{prop}} = \frac{m}{R\times\frac{m}{s}} = \frac{s}{R}$$

P6

$$Time\ of\ package\ generation = \frac{56\times8}{64\times10^3} = 7\ ms$$

$$d_{trans} = \frac{56\times8}{2\times10^6} = 0.224\ ms$$

$$d_{prop} = 10\ ms$$

$$total = 10+7+0.224 = 17.224\ ms$$

P7

$$40\ T = 40\times10^{12}\times8\ bits$$

$$t = \frac{40\times10^{12}\times8\ bits}{100\times10^6} = 3200000\ s = 37\ days$$

We prefer to transmit the data via FedEx.

P8

a. Circuit-switched network. Since the transmission rate is known and not bursty, bandwidth can be reserved for each application session without significant waste. In addition, the overhead costs of setting up and tearing down connections are amortized over the lengthy duration.

b. The network does not need congestion control mechanisms. Since each link has sufficient bandwidth to handle the sum of all of the applications' data rates.

P9

a.

$$\frac{3 \times 10^6}{150 \times 10^3} = 20\ users$$

b.

$$p = 0.1$$

c.

$$\binom{120}{n} p^n (1-p)^{120-n}$$

d.

$$1 - \sum_{n=0}^{20} \binom{120}{n} p^n (1-p)^{120-n}$$

$$Let\ X_i\ be\ independent\ random\ variables,\ P(X_i = 1) = p.$$

$$\begin{aligned} P(\text{"}21\ or\ more\ users\text{"}) &= 1 - P(\sum_{i=1}^{120} X_i \leq 21) \\ &= 1 - P(\frac{\sum_{i=1}^{120} X_i - 12}{\sqrt{120 \times 0.1 \times 0.9}} \leq \frac{9}{\sqrt{120 \times 0.1 \times 0.9}}) \\ &\approx 1 - P(Z \leq \frac{9}{3.286}) \\ &= 1 - P(Z \leq 2.74) = 1 - 0.997 = 0.003 \end{aligned}$$

$$Z\ is\ a\ standard\ normal\ random\ variable.$$

P10

a.

$$t_1 = \frac{8 \times 10^6}{2 \times 10^6} = 4\ s$$

$$t_2 = 4\ s \times 3 = 12\ s$$

b.

$$t_1 = \frac{1 \times 10^4}{2 \times 10^6} = 5\ ms$$

$$t_2 = 2 \times 5\ ms = 10\ ms$$

c.

$$t_1 = 5\ ms \times 3 = 15\ ms$$

$$t_2 = 15\ ms + 799 \times 5\ ms = 4.01\ s$$

It can be seen that delay in using message segmentation is significantly less

d.

If there is a single bit error, the whole message has to be retransmitted. Moreover, Without message segmentation, huge packets are sent into the network. Smaller packets have to queue behind enormous packets and suffer unfair delays.

e.

Packets have to be put in sequence at the destination. Moreover, Message segmentation results in many smaller packets and the total amount of header bytes is more.

P11

$$t_1 = \frac{S+80}{R} \times \frac{F}{S}\ s$$

$$delay = \frac{S+80}{R} \times (\frac{F}{S} + 2)\ s$$

$$\frac{d}{dS} delay = 0 \Rightarrow S = \sqrt{40F}$$

P12

When a Skype user (connected to the Internet) calls an ordinary telephone, a circuit is established between a gateway and the telephone user over the circuit switched network. The skype user's voice is sent in packets over the Internet to the gateway. At the gateway, the voice signal is reconstructed and then sent over the circuit. In the other direction, the voice signal is sent over the circuit switched network to the gateway. The gateway packetizes the voice signal and sends the voice packets to the Skype user.