Computer Networking
HW1 solution

1.5

(a)

Time of passing 1st tollbooth = 10 * 12 = 120(sec)

Time of passing 2nd tollbooth = 10 * 12 = 120(sec)

Time of passing 3rd tollbooth = 10 * 12 = 120(sec)

Time of traveling 200km = 150 / 100 = 1.5(hr)

So, end-to-end delay = 1.5 hr +(3 x 120 sec) = 96 min

(b)

Time of passing 1st tollbooth = 8 * 12 = 96(sec)

Time of passing 2nd tollbooth = 8 * 12 = 96(sec)

Time of passing 3rd tollbooth = 8 * 12 = 96(sec)

Time of traveling 200km = 150 / 100 = 1.5(hr)

So, end-to-end delay = 1.5 hr +(3 x 96 sec) = 94 min 48 sec

1.6

(a) d_{prop} = m / s (sec)

(b) d_{trans} = L / R (sec)

(c) end-to-end delay = m / s + L / R (sec)

(d) the last bit just leaves host A

(e) the first bit is still in the link

(f) the first bit is already in the host B

(g) $\frac{\boldsymbol{m}}{\boldsymbol{s}} = \frac{\boldsymbol{L}}{\boldsymbol{R}} \Rightarrow m = \frac{\boldsymbol{L}}{\boldsymbol{R}} \times s = \frac{120}{56 \times 10^3} \times 2.5 \times 10^8 \simeq 535.71$ (km)

1.13

(a)

the average delay for the N packets is:

(L/R + 2L/R + ... + (N-1)L/R)/N

= L/(RN) * (1 + 2 + ... + (N-1))

= L/(RN) * N(N-1)/2

= LN(N-1)/(2RN)

= (N-1)L/(2R)

(b)

there will be no extra delay, and the answer is the same as (a)

=(N-1)L/(2R)

1.14

(a)

total delay is $\frac{IL}{R(1-I)} + \frac{L}{R} = \frac{L/R}{1-I}$

(b)

Let x = $\frac{L}{R}$.

Total delay is $\frac{x}{1-ax}$

For x= 0, total delay = 0; if we increase x, total delay increases, approaching infinity as x approaches 1/a.

1.20

Throughput = min(R_s, R_c, R/M)

1.25

(a)

R × d_{prop} = $2 \times 10^6 \times \frac{20000 \times 10^3}{2.5 \times 10^8}$ = 160000 bits

(b)

The maximum number of bits is 160000 bits.

(c)

The bandwidth delay is the maximum number of bits that can be transmitted in a link.

(d)

$\frac{2.5 \times 10^8}{2 \times 10^6}$ = 125(m)

It is longer than a football field, since the length of the football field is about 100m.

(e)

$$\frac{s}{R}$$

1.31

(a)

Time to send message from source host to first packet switch =

$\frac{8 \times 10^6}{2 \times 10^6}$ sec = 4sec.

With store-and-forward switching, the total time to move message from source host to destination host = 4sec * 3hops = 12 sec

(b)

Time to send 1st packet from source host to first packet switch =

$\frac{1 \times 10^4}{2 \times 10^6}$ sec = 5 msec.

Time at which 2nd packet is received at the first switch = time at which 1st packet is received at the second switch = 2 × 5 msec = 10 msec.

(c) Time at which first packet is received at the destination host = 5 msec × 3 hops = 15 msec . After 15 msec, every 5msec one packet will be received; thus time at which last (800th) packet is received = 15 msec 799×5msec = 4.01sec . It can be seen that delay in using message segmentation is by much less (almost 1/3rd)

(d)

i. Message segmentation can easily deal with bit error situations. When facing a single bit error, it just needs to retransmit the small packet instead of the whole message.

ii. Message segmentation can accerlate Routers handling packets. When facing queuing situations, smaller packets cause less delay.

(e)
i. Packets must be put in series at the destination.

ii. Message segmentation ends in many smaller packets. Since header size is usually the same for all packets regardless of their size, with message segmentation the total amount of header bytes is more.

(Additional problems)
Suppose that users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time.

(a)

$$\frac{\mathbf{3\times10^6}}{\mathbf{150}} = 20$$

(b)

transmitting rate = 10% ⇒ P = 0.1

(c)

$$P = C_n^{120}\,(0.1)^{n}\,(0.9)^{120-n}$$

(d)

$$P = 1 - \left(\sum_{n=0}^{20} C_n^{120}\,(0.1)^{n}\,(0.9)^{120-n} \right)$$

p=0.1, q=(1-p)=0.9 , n=120 ;

binomial distribution μ = np = 12, δ^2= npq = 120× 0.1× 0.9 ;

$$P(X \le 21) = \sum_{n=0}^{20} C_n^{120}\,(0.1)^{n}\,(0.9)^{120-n} = P\left(\frac{X-\mu}{\delta} \le \frac{21-12}{\sqrt{120\times 0.1\times 0.9}} \right)$$

$$= P (Z < 2.74) = 0.9969$$

$$P(X \ge 21) = 1 - 0.9969 = 0.003$$