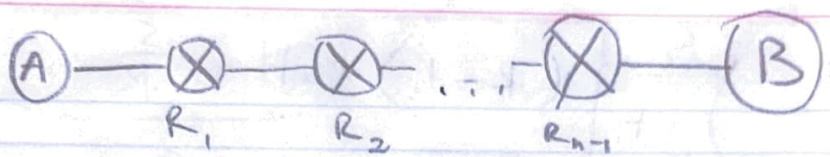
CECS 474 - HW 1

P~~r~~ 2, 3, 5

2. a)




packet 

H: header, S: size of 1 packet

K = num of packets

entire packet size = $H + \frac{S}{K}$

$T_{Delay} = \frac{H + \frac{S}{K}}{C}$

entire link = $n \times \frac{H + \frac{S}{K}}{C}$ } 1 packet thru the entire link

all packets is $(K-1) \times \frac{H + \frac{S}{K}}{C}$

all packets : $\left( n \times \frac{H + \frac{S}{K}}{C} \right) + \left[ (k-1) \times \frac{H + \frac{S}{K}}{C} \right]$

or $\left[ (n+k-1) \frac{H + \frac{S}{K}}{C} \text{ seconds} \right]$

b) $f(k) = \underbrace{(n+k-1)}_{M(k)} \cdot \underbrace{\frac{H + \frac{S}{K}}{C}}_{N(k)}$ set $\frac{df(k)}{dk} = 0$

$$\frac{df(k)}{dk} = (n+k-1) \cdot \frac{d}{dk}\left( \frac{H + \frac{S}{K}}{C} \right) + \left[ \frac{d}{dk}(n+k-1) \right] \cdot \frac{H + \frac{S}{K}}{C}$$

$$= \frac{1}{C}(n+k-1) \cdot \left( -\frac{S}{K^2} \right) + \left( \frac{H + \frac{S}{K}}{C} \cdot 1 \right)$$

$$\left[ 0 = -\frac{Sn + Sk - S}{Ck^2} + \frac{H}{C} + \frac{S}{Ck} \right] Ck^2$$

$$0 = -Sn \cancel{-SK} + S + Hk^2 \cancel{+SK}$$

$$0 = Hk^2 - Sn + S$$

$$Sn - S = Hk^2$$

$$\pm\sqrt{\frac{S(n-1)}{H}} = k \quad \text{packets}$$

There may + or − packets; however, we take the positive as it represents a positive amount of smaller packets. However, b/c packets are sent in a finite amount, this value must represent a whole number of packets when evaluated.

3. 30 Mbit MP3 file

links speed of 10 Mbps

propagation speed is $2 \cdot 10^8$ m/s

Distance : $1 \cdot 10^4$ km

1) (S) ——— (D)

$T_D = \frac{L}{R} = \frac{30 \text{ Mbit}}{10 \text{ Mbps}} = 3 \text{ s}$ **B**

2) End-to-end delay = $T_D + P_D = 3s + \frac{d}{s} = \frac{1 \cdot 10^7 \text{ m}}{2 \cdot 10^8 \text{ m/s}} = \frac{10000 \cdot 1000 \text{ m}}{2 \cdot 10^8 \text{ m/s}} = 3.05 \text{ s}$ **b**

3) $10 \text{ Mbps} \cdot 3.05 = 30.05 \text{ Mbps}$ = **C**

4) (S) —5km— (X) —5km— (D)

End-to-end delay $= T_D + P_D = L_1 + L_2 = (T_{D1} + P_{D1}) + (T_{D2} + P_{D2})$

$= \left(\frac{L}{R_1} + \frac{D_1}{S}\right) + \left(\frac{L}{R_2} + \frac{D_2}{S}\right)$

$= \left(\frac{30\,\text{Mbit}}{10\,\text{Mbps}} + \frac{5000\,\text{km} \cdot 10^3\,\text{m}}{2 \cdot 10^8\,\text{m/s}}\right) + \left(\frac{30\,\text{Mbit}}{10\,\text{Mbps}} + \frac{5000\,\text{km} \cdot 10^3\,\text{m}}{2 \cdot 10^8\,\text{m/s}}\right)$

$= (3\,\text{s} + 0.025\,\text{s}) + (3\,\text{s} + 0.025\,\text{s})$

$= \boxed{6.05\,\text{s (A)}}$

5) Given the above info, $E - E_D$ for one link is $3\left(\frac{10\,\text{Mbit}}{10\,\text{Mbps}} + \frac{5000\,\text{km}}{2 \cdot 10^8\,\text{m/s}}\right) =$ 1s + 0.025

@ 2 links = 2.00 s @ 3 packets = $\boxed{6.05\,\text{s C}}$

6) 30 Mbps → 10 FDM = 30 s + $P_D$ = $\boxed{30.05\,\text{sec A}}$

5. 2 Mbps link, use 300 Kbps when transmitting 12% of the

a) 2 Mbps / 300 Kbps = **6 users**

b) $P = 1/12 = 0.083$

c) $P(n) = {}^{N}C_{n}(P)^{n}(1-P)^{N-n}\big|_{N-n}$

$= \boxed{{}^{n}C_{n}\left(\frac{1}{12}\right)^{n}\left(\frac{11}{12}\right)^{n-n}}$

d) $P(7) = 1 - P\left(\sum_{j=1}^{7} X_j \leq 12\right)$

$= 1 - P\left(\frac{\sum_{j=1}^{7} X_j - 3}{\sqrt{7 \cdot 0.083 \cdot .916}} \leq \frac{4}{\sqrt{7 \cdot .083 \cdot .916}}\right)$

$= 1 - P\left(z \leq \frac{4}{\sqrt{5.3249}}\right)$

$= 1 - P(z \leq 5.483) = 1 - 0.08 = \boxed{0.02}$

e) $M = 10$

$$10C_7 \left(\frac{1}{12}\right)^7 \left(\frac{11}{12}\right)^{10-7}$$

$$= \boxed{2.5 \cdot 10^{-6}}$$

f) **6 users**