بنام خدا

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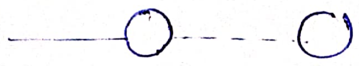
Problem 1



k-hop

a) . Circuit Switching

$$\text{Total Delay} = S + \frac{L}{R} + KD$$

. Packet Switching $\quad N = \frac{L}{P} = \#:\text{packet}$

queuing delay

arrival time last Packet

$$\text{total Delay}_{,PS} = \frac{L+NH}{R} + (k-1)\left(\frac{P+H}{R}\right) + (k-1)\delta + KD$$

conditions:

$$\frac{L+NH}{R} + (k-1)\frac{P+H}{R} + (k-1)\delta + KD < S + \frac{L}{R} + KD$$

$$= \frac{L}{R} + \frac{LH}{RP} + \frac{(k-1)P}{R} + \frac{(k-1)H}{R} + (k-1)\delta + KD < S + \frac{L}{R} + KD$$

$$\Rightarrow \frac{1}{R}\left[\frac{LH}{P} + (k-1)P + (k-1)H + (k-1)\delta R\right] < S$$

$$\Rightarrow \frac{1}{R}\left[\frac{LH}{P} + (k-1)(P+H+\delta R)\right] < S$$

b) $$\frac{\partial t_{PS}}{\partial P} = 0 \rightarrow \frac{k-1}{R} + \frac{LH}{R}\left(\frac{-1}{P^2}\right) = 0 \rightarrow +\sqrt{\frac{LH}{k-1}} = P$$

$P = \sqrt{\frac{100 \times 8}{2}} = 20$ bits , $N = \frac{100}{20} = 5$

$t_{delay\ min} = \frac{100 + 5 \times 8}{56 \times 10^3} + 2\left(\frac{20+8}{56 \times 10^3}\right) + 2 \times 0.4 \times 10^{-3} + 3 \times 1.5 \times 10^{-3}$

$= 2.5\ ms + 1\ ms + 0.8\ ms + 4.5\ ms = \underline{8.8\ ms}$

Problem 2

. Power input = 125 mW = $10 \log (10^{-3} \times 125)$ dB = $10[-3 + 3\log 5] \simeq -9.03$

. Noise power = $N_o \times BW = 4 \times 10^{-21} \times 400 \times 10^3 = 16 \times 10^{-16}$ W

$= 10 \log (16 \times 10^{-16}) = 10[-16 + 4\log 2] \simeq -147.95$

. total loss = $D \times 2\ \frac{dB}{Km} = 400$ dB

SNR $\geq$ 30dB $\rightarrow$ $10 \log \left(\frac{P_{out\ min}}{N}\right) \geq 30 \rightarrow \log_{10}\left(\frac{P_{out}}{N}\right) \geq 3$

$P_{out\ min} \geq N \times 10^3 \rightarrow P_{out\ min} \geq 16 \times 10^{-13}$, $P_{out\ min} \simeq -117.95$

a) no ampilifier $P_{out} = P_{in} - \text{total loss} = -9.03 - 400 \simeq -409$ dB

It's is not possible to have connection without ampilifier

b) $P_{in} - \text{total loss} + m \times 10 \geq P_{out\ min} \rightarrow -409\ dB - m \times 10 \geq -117.95$

$\rightarrow m \simeq 29.1 \rightarrow \boxed{m = 30}$

c) total loss = $200 \times 0.3 = 60$ DB

no ampilifier $P_{out} \rightarrow P_{in} - \text{total loss} = -9.03 - 60 = -69$ dB ✓

It's possible to have connection without ampilifiers

$m = 0$

Problem 3

$S_0 \cdot A = 1+1-1+1+3-3-1-1/8 = 0$

$0 \rightarrow$ not sent
$1 \rightarrow$ send 1
$-1 \rightarrow$ sent 0

$S_1 \cdot A = 0$

$S_2 \cdot A = -1$

$S_3 \cdot A = 1$; $S_4 \cdot A = 0$; $S_5 \cdot A = 0$; $S_6 \cdot A = 0$, $S_7 \cdot A = 0$

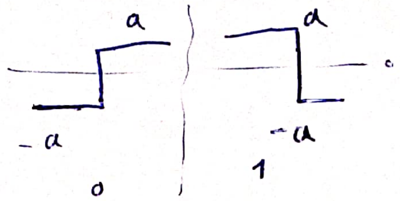
received number to A = $\overset{S_3}{1}\,\overset{S_2}{0} = 2$

b) Broadcasting and multicasting can be implemented using CDMA by assigning different chip sequence to different groups of receivers. If all receivers that need to receives a broadcast message can be assigned a common chip sequence, while receivers that need to receive a multicast message can be assigned a different chip sequence. The transmiter can then send the message using both chip sequences simultaneously and each receiver will decode only the part of the message that corresponds to its assigned chip sequence. this allows multiple receivers to receive the same message simultaneously without interfering with eachother.

Problem 4:

a) $P_0 = 4P_1$, $P_0 + P_1 = 1 \rightarrow 5P_1 = 1 \rightarrow P_1 = 1/5$, $P_0 = 4/5$

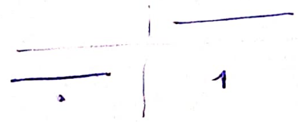
(i) manchester encoding



$$\underset{T=1}{Power(0) = Power(1)} = a^2/2$$

$$Power = P_0 \times Power(0) + P_1 \times Power(1) = \frac{4}{5} \times a^2/2 + \frac{1}{5} \times a^2/2 = a^2/2$$

(ii) NRZ (with 0 amplitude for 0)



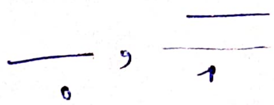
$\underset{T=1}{Power(1) = a^2}$

$$Power = P_0 \times Power(0) + P_1 \times Power(1) = \frac{a^2}{5}$$

(iii) NRZI (with 0 amplitude for 0)

$$Power = \left(\frac{Power(1)}{2} + \frac{Power(0)}{2}\right) P_0 + P_1 \left[\frac{Power(0)}{2} + \frac{Power(1)}{2}\right] = a^2/2$$

(iv) AMI



$$Power = P_0 \times Power(0) + P_1 \times Power(1) = \frac{a^2}{5}$$

b) (i) Manchester: No problems

(ii) NRZ: در هر دو حالت مشکل داریم ، چون سیگنال زمانی تغییر میکند که بیت عوض شود

(iii): NRZI:

صفرهای پشت هم ← مشکل داریم

یک های پشت هم ← مشکل نداریم

iv AMI

صفرهای پشت هم ← مشکل داریم

یک های پشت هم ← مشکل نداریم

Problem 5

دور اول

زمان خارج شدن بسته از Router A $= \frac{10^3 \times 8}{100 \times 10^9} + 0.1\,ms + 0.01\,ms + \frac{10^3 \times 8}{40 \times 10^9} = 0.11\,ms + 28 \times 10^{-5}\,ms$

زمان خارج شدن بسته از Router B $= 0.11\,ms + 28 \times 10^{-5}\,ms + 0.01\,ms + \frac{10^3 \times 8}{50 \times 10^9} = 44 \times 10^{-5}\,ms + 0.12\,ms$

زمان خارج شدن بسته از Router C $= 44 \times 10^{-5}\,ms + 0.12\,ms + 0.01\,ms + 40 \times 10^{-5}\,ms = 84 \times 10^{-5}\,ms + 0.13\,ms$

اتمام دور اول

زمان خارج شدن A $= 84 \times 10^{-5}\,ms + 0.13\,ms + 0.01\,ms + 20\,ms \times 10^{-5} = 104 \times 10^{-5}\,ms + 0.14\,ms$

زمان خارج شدن B $= 104 + 10^{-5}\,ms + 0.14\,ms + 0.01\,ms + 16 \times 10^{-5} = 120 \times 10^{-5}\,ms + 0.15\,ms$

زمان خارج شدن C $= 120 \times 10^{-5}\,ms + 0.15\,ms + 0.01\,ms + 40 \times 10^{-5} = 160 \times 10^{-5}\,ms + 0.16\,ms$

آغاز دور دوم

زمان خارج شدن A $= 160 \times 10^{-5}\,ms + 0.16 + 0.01\,ms + 20\,ms \times 10^{-5} = 180 \times 10^{-5}\,ms + 0.17\,ms$

زمان خارج شدن B $= 180 \times 10^{-5}\,ms + 0.17\,ms + 0.01\,ms + 16 \times 10^{-5} = 196 \times 10^{-5} + 0.18\,ms$

نوبت بسته B در دور سوم می‌رسید

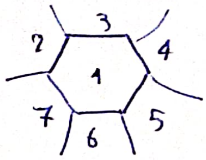
زمان رسیدن بسته B در دور سوم $= 8 \times \frac{10^3 \times 8}{100 \times 10^9} + 0.1\,ms = 64 \times 10^{-5}\,ms + 0.1\,ms$

مدت زمان در صف $= 180 \times 10^{-5}\,ms + 0.17\,ms - 64 \times 10^{-5}\,ms - 0.1\,ms$

$= 116 \times 10^{-5}\,ms + 0.07\,ms$

Problem 6

a)

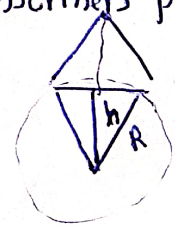


1050 sparate frequency bands

- The maximum umber of frequency bands per cell $N = \frac{1050}{7} = 150$

- Subscribers per cell $= N \times$ subscribers per T1 $= 150 \times 24 = 3600$

b)



$\frac{h}{R} = \sqrt{3}/2 = \sin 60°$

- اگر D را فاصله بین دو مرکز cell مجاور بگیریم

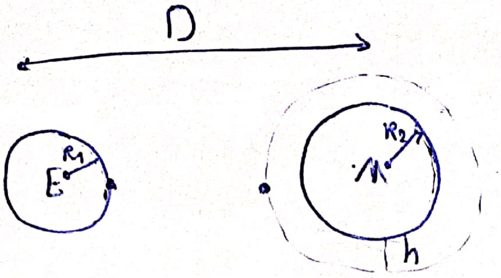
$D = 2h = 100\,m$, $R = \frac{2/h}{\sqrt{3}}$

$\rightarrow R = \frac{100}{\sqrt{3}} \simeq 57.7\ m$

c)

مانند قسمت a و b است
فرقی نمی‌کند

Problem 7



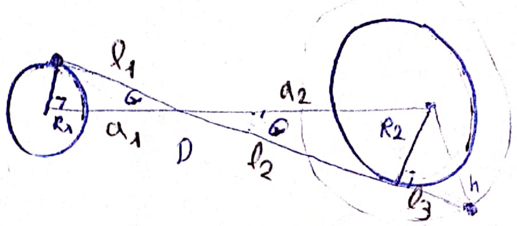
RTT = transmission time + propagation time x2

$$\downarrow \quad \frac{L}{R}$$

min. propagation time $= \dfrac{D - R_1 - R_2 - h}{c}$

max. propagation time

حالت اول



$$l_3 = \sqrt{(R_2+h)^2 - R_2^2}$$

$$l_{\text{کل}} = l_1 + l_2 + l_3 \qquad D = a_1 + a_2 = \sqrt{l_1^2 - R_1^2} + \sqrt{l_2^2 + R_2^2}$$

$$\sin\theta = \frac{R_2}{a_2} = \frac{R_1}{l_1} \rightarrow l_1 = \frac{R_1}{R_2}\sqrt{l_2^2 + R_2^2}$$

$$\sqrt{l_2^2 + R_2^2} + \sqrt{\frac{R_1^2}{R_2^2}(l_2^2 + R_2^2) - R_1^2} = D$$

$$l_2^2 + R_2^2 = x \qquad \sqrt{x} + \sqrt{\frac{R_1^2}{R_2^2}x - R_1^2} = D \rightarrow \frac{R_1^2}{R_2^2}x - R_1^2 = D^2 + x - 2D\sqrt{x}$$

$$\rightarrow x\left(\frac{R_1^2}{R_2^2} + 1\right) + \sqrt{x}(+2D) + (+R_1^2 + D^2) = 0$$

$$x = y^2 \rightarrow y^2\left(1 - \frac{R_1^2}{R_2^2}\right) + y(2D) + (R_1^2 + D^2) = 0$$

$$\rightarrow x = y^2 = \left(\frac{-2D + \sqrt{4D^2 - 4\left(1 - R_1^2/R_2^2\right)(R_1^2 + D^2)}}{2\left(1 - R_1^2/R_2^2\right)}\right)^2$$

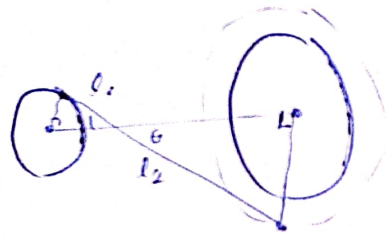
$$\Rightarrow l_2^2 = x - R_2^2$$

$$l_{\text{کل}} = l_1 + l_2 + l_3 = \frac{R_1}{R_2}\sqrt{x} + \sqrt{x - R_2^2} + \sqrt{h^2 + 2R_2 h}$$

$$x = \left(\frac{-2D + \sqrt{4D^2 - 4\left(1 - \frac{R_1^2}{R_2^2}\right)\left(R_1^2 + D^2\right)}}{2\left(+1 - \frac{R_1^2}{R_2^2}\right)} \right)$$

max propagation time $= \frac{l_{\text{کل}}}{c}$

حالت دوم اگر دورترین فاصله را به فرم زیر فرض کرد داریم



در این حالت داریم

$$l_{\text{کل}} = \sqrt{(R_1 + R_2 + h)^2 + D^2}$$ مانند قسمت قبل است

max propagation time $= l_{\text{کل}}/c$

b) minimum time $\rightarrow \frac{L}{R} + \; : \; \frac{D - R_1 - R_2 - h}{c}$

maximum time $\rightarrow \frac{L}{R} + \; : \; \frac{l_{\text{کل}}}{c}$ $\rightarrow$ در قسمت قبل $\sim$ max propagation time

Problem 8

1. False   maximum Rate is 56 kbps   In V.92 56 kbps DS, 48 kbps US

2. True ; when B calls A, the BSC acts as an intermediary. However, when B calls C, if C's number is in database, there might not be a need for the BSC or MSC

3. True;

with ack → throughput = $\dfrac{6\times10^6\times8}{200ms + \dfrac{6\times10^6\times8}{10^9}} \simeq 193.55$ Mbps

without ack → throughput = $\dfrac{6\times10^6\times8}{\frac{200}{2}ms + \dfrac{6\times8\times10^6}{10^9}} \simeq 324.32$ Mbps

4. True ; changes in layer k are generally independent of the protocols use in layer below (k-1)

5. False   This statement is a repetition of the first statement.