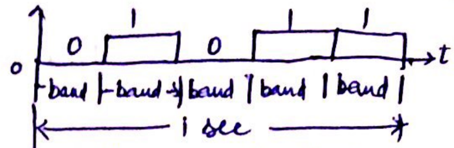
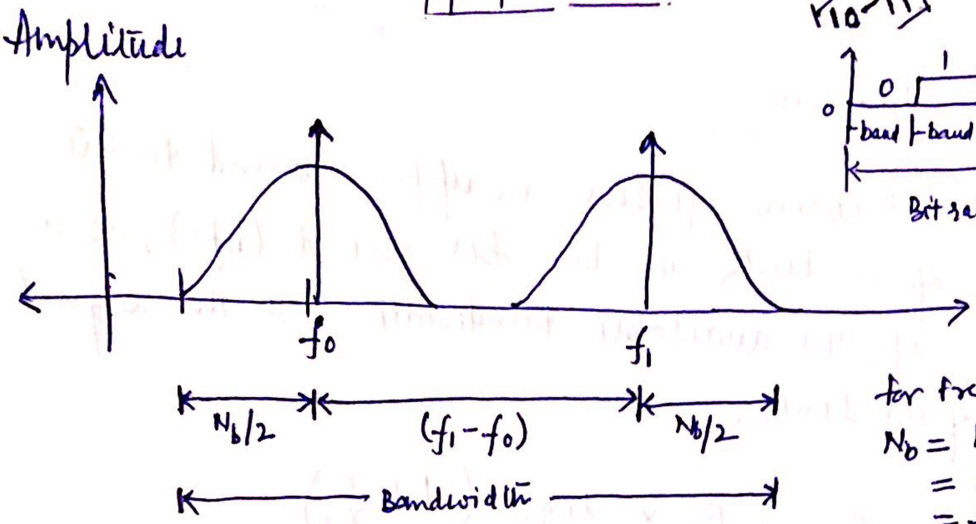


Bit rate = 5, Baud rate = 5.



for freq. shift keying
N_b = baud rate
= bit rate
= f_b

$$\text{Bandwidth} = \frac{N_b}{2} + (f_1 - f_0) + \frac{N_b}{2}$$

$$= (f_1 - f_0) + N_b$$

$$BW(\text{min}) = N_b + N_b = 2N_b \quad , \text{where } (f_1 - f_0 = N_b)$$

Q1) Calculate the bandwidth of an FSK system in which, the transmission takes place at 4000 bps rate and the frequency difference b/w the two carriers is 3000 Hz.

Ans:- $(f_1 - f_0) = 3000$ Hz , Bit rate = 4000 bps. = N_b.

Now, Bandwidth = $(f_1 - f_0) + N_b$

= 3000 + 4000

$\boxed{BW = 7000 \text{ Hz}}$

Q2). For half duplex FSK transmission, the bandwidth of medium is 8000 Hz. If the freq. diff. b/w two carriers is 4000 Hz, calculate max. bit rate.

Ans) BW = 8000 Hz, $(f_1 - f_0) = 4000$ Hz.

Maximum bit rate for FSK

BW = $(f_1 - f_0) + N_b$.

8000 = 4000 + N_b

N_b = 4000 bauds/sec.

in FSK baud rate = bit rate

$\boxed{\text{Bit rate} = 4000 \text{ bps.}}$

Shannon's Theorem.

Shannon's Theorem givens an upper bound to the capacity of a link in bits per second (bps), as a function of the available bandwidth and the signal-to-noise ration of the link.

$$C = B \times \log_2\left(1 + \frac{S}{N}\right).$$

where, C = achievable channel capacity;
B = bandwidth of the line
S = average signal power
N = average Noise power.

The signal-to-noise ration (S/N) is expressed in deci bels (dB)
by $10 \times \log_{10}\left(\frac{S}{N}\right)$

i.e. $\frac{S}{N} = 1000$ will be $= 10 \times \log_{10}(1000)$
$= \underline{30\text{ dB}}$.

Q1). It is required to transmit a data at a rate of 64 Kbps over 3KHz telephone channel. What is the min. SNR required to accomplish this?

$C = 64$ Kbps., $B = 3$ KHz, SNR = ?
$C = 64 \times 10^3$ bps | $B = 3 \times 10^3$ Hz |

$$C = B \times \log_2\left(1 + \frac{S}{N}\right)$$

$$64 \times 10^3 = 3 \times 10^3 \times \log_2\left(1 + \frac{S}{N}\right).$$

$$21.33 = \log_2\left(1 + \frac{S}{N}\right)$$

$$2642245.95 = 1 + \frac{S}{N}$$

$$\frac{S}{N} = \underline{2642244.95 \text{ or } (64.22 \text{ dB})}$$

10–11

Piggybacking :- Book.

(For Y)

Protocol Performance:-

Throughput $U = \frac{1}{1+2a}$, $a = \frac{t_p}{t_f}$

where, t_p = Propagation time required to reach destination for a transmitted bit.

t_f = Transmission time required to transmit a frame

Now, $t_p = \frac{d}{V}$ (distance of the link) (velocity of propagation)

& $t_f = \frac{L}{R}$ (length of the frame (bits)) (rate).

Q1 Calculate throughput of Stop-and-Wait flow control mechanism where the frame size is 4800 bits and bit-rate is 9600 bps for a distance b/w devices is 2000km. If the speed of propagation over the transmission is 200,000 km/s. find throughput.

Sol^n:- Given, $t_f = \frac{L}{R} = \frac{4800}{9600} = 0.5$ sec.

$t_p = \frac{d}{V} = \frac{2000}{200000} = 0.01$ sec.

$a = \frac{t_p}{t_f} = \frac{0.01}{0.5} = 0.02.$

$U = \frac{1}{1+2a} = \frac{1}{1+2\times 0.02} = 0.96.$

$\boxed{\% U = 96\%}$ Ans.

Q2:- For a channel which has a propagation delay of 30 msec. and the bit rate is 10 Kbps. What range of frame sizes does Stop-and-wait protocol gives an efficiency of at least 60%.

Sol:- Given, Bit Rate $(R) = 10$ Kbps.

$t_p = 30$ msec.

Efficiency $\eta \geq 60\%$

i.e. $0.6 \leq \eta \leq 1$

We have to calculate range of frame size (L).

$$\eta = \frac{1}{1+2a} = \frac{1}{1+2\left(\frac{t_p}{t_f}\right)}$$

$$0.6 = \frac{1}{1+2\left(\frac{30\times10^{-3}}{t_f}\right)}$$

$$t_f = 0.6\,t_f + 60\times10^{-3}\times 0.6$$

$$t_f = 0.6\,t_f + 36\times10^{-3}.$$

$$t_f = \frac{36\times10^{-3}}{0.4} = 90\times10^{-3}\text{ sec.}$$ (transmission time for 1 frame)

Now, to calculate frame size.

$$t_f = \frac{L}{R}\ ; \quad L = t_f \times R = (90\times10^{-3})\times(10\times10^{3})$$

$L = 900$ bits.

$\boxed{\text{1 Frame size} = 900 \text{ bits}}$ Ans.

Scanned by CamScanner

Q3 A channel having bit rate as 3.8 Kbps with propagation delay of 20 msec. Find the range of frame size for Stop-and wait ~~with~~ to gain efficiency of 50%.

Ans:- $\boxed{96 \text{ bits}}$ / 152 bits*.

Q4. Given an error-free 64 Kbps satellite channel which is used to send 512 byte data frame in one direction with very short acknowledgements coming back the other way. What will be the maximum throughput for window size of 1, 7, 15 and 127.

Sol^n:- We know that,

$$U = \frac{W}{1+2a}$$

Given $R = 64 \text{ Kbps} = 64 \times 10^3 \text{ bps}$.

$(N)\ L = 512 \text{ bytes} = 512 \times 8 \text{ bits}$

$W = 1, 7, 15 \text{ and } 127.$

$$t_f = \frac{L}{R} = \frac{512 \times 8}{64 \times 10^3} = 64 \times 10^{-3} \text{ sec.}$$

$$a = \frac{t_p}{t_f}.$$

$t_p = 270 \text{ ms}$ for satellite channel.

$$\therefore\ a = \frac{270 \times 10^{-3}}{64 \times 10^{-3}} = 4.2187.$$

Now. (i) $W = 1$, $U = \dfrac{1}{1+2\times 4.2187} = 0.1059.$

(ii) $W = 7$, $U = \dfrac{7}{1+2\times 4.2187} = 0.7417.$

(iii) $W = 15$, $U = \dfrac{15}{1+2\times 4.2187} = 1.589$

(iv) $W = 127$ $U = \dfrac{127}{1+2\times 4.2187} = 13.459$

Q5:- A 100 km long cable runs at T1 data speed. The propogation speed in cable is 2/3 of the speed of light. How many bits fit in the cable.

Sol^n:- Given, $L = 100\ Km = 1 \times 10^5 m$

The data rate of T1 = 1.544 Mbps.

Also, speed $v = \frac{2}{3} \times 3 \times 10^8$ m/s.

$v = 2 \times 10^8$ m/s.

Now, No. of bits in 1 sec = 1.544×10^6 ~~sec~~ bits.

Distance covered in 1sec = 2×10^8 m.

$\therefore$ No. of bits for 10^5 m cable is ~~L~~ (x)

$$x = \frac{1.544 \times 10^6}{2 \times 10^8} \times 10^5 = 772 \text{ bits} \quad \text{Ans}$$

Q6:- Given the use of 1000 bit frames on a 1Mbps satellite channel. What will be the maximum Link utilization for.

(i) stop and wait ARQ.

(ii) continuous ARQ with window size = 7.

(iii) continuous ARQ with window size = 127.

Sol^n:- Given, that frame size = 1000 bits (L).

$R = 1Mbps. = 10^6$ bps.

$t_p = 270$ ms for a satellite channel.

$= 270 \times 10^{-3}$ sec.

$$t_f = \frac{L}{R} = \frac{1000}{10^6} = 1 \times 10^{-3} \text{ sec.}$$

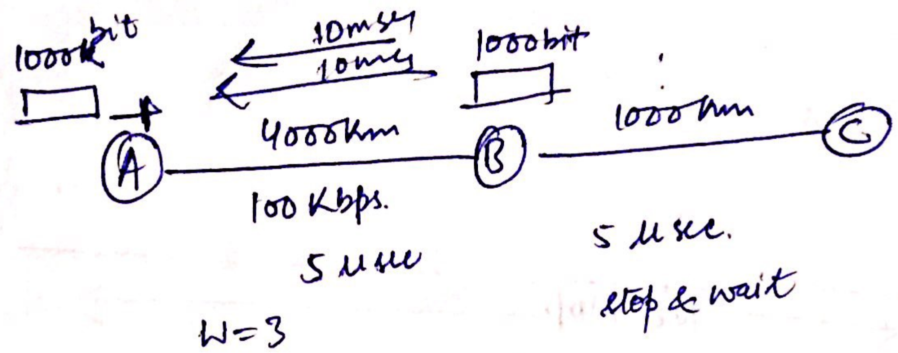
$$a = \frac{t_p}{t_f} = \frac{270 \times 10^{-3}}{1 \times 10^{-3}} = 270.$$

(i). $U = \frac{1}{1+2a} = \frac{1}{1+2\times270} = 1.848 \times 10^{-3}$.

(ii) $U = \frac{W}{1+2a} = \frac{7}{1+2\times270} = 1.2936\ \%$.

(iii) $U = \frac{W}{1+2a} = \frac{127}{1+2\times270} = 23.4696\%$ Ans.

(Que Y)



$s = \frac{d}{t}$

$t = \frac{d}{s}$

A–B ⇒ $t_p = 4000 \times 5\mu$
$= 20$ msec.

$t_f = \frac{1000}{1000 \times 10^3} = 10$ msec

$3 \times 10 = 30$ msec $+ 20$ msec
$= 50$ msec.

B–C $t_p = 1000 \times 5\mu$
$= 5$ msec.

$x = \frac{1000}{R}$.

$= 5 + x + 5$
$= 10 + x$.
$50 = 30 + 3x$

$x = \frac{20}{3} = 6.66$ msec.

$R = \frac{1000}{6.66} = 150$ kbps.

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4 Mbps 10 msec

$f.c = 4 \times 10^6 \times 10 \times 10^{-3} = 40000$ bits

$4.5 \times 10^{-9} \frac{sec}{mt} \times 10 \times 10^3 = 4.5 \times 10^{-5}$ sec

100 Mbps

10,000 mt

$L = 400$ bytes

Ack = 64 byte.

$t_p = 5 \times 10^{-9} \frac{sec}{m}$.

10×10^{-6} sec - Frame

5×10^{-6} sec - Ack

$t_p = \frac{d}{v}$ | $t_f = \frac{L}{R}$.

$\frac{L}{R} = \frac{8 \times 400}{10^{-5}} = 32 \times 10^{-7}$

$t_p = 10000 \times \cancel{10}\, 5 \times 10^{-9}$