→ Fundamentos de Comunicação de dados - Ficha 3

1-

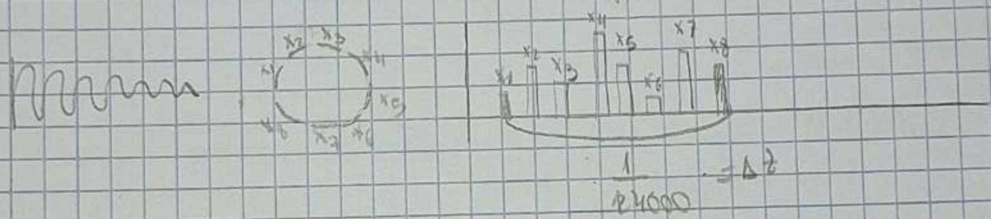
$f_a = 8000$ amostras/seg $\Leftarrow B = 4\,kHz$ $\begin{cases} x_1 \\ \vdots \\ x_6 \end{cases}$

$f_a = 24000$ amostras/seg $\Leftarrow B = 12\,kHz$ $\begin{cases} x_7 \\ x_8 \end{cases}$

a) $r_c = N \times f_a$

$r_c = 8 \times 24000 = 192\,000$ amostras/seg

* tem de ser o maior porque os menores podem ter a mais mas, não pode haver nenhum a ter menos



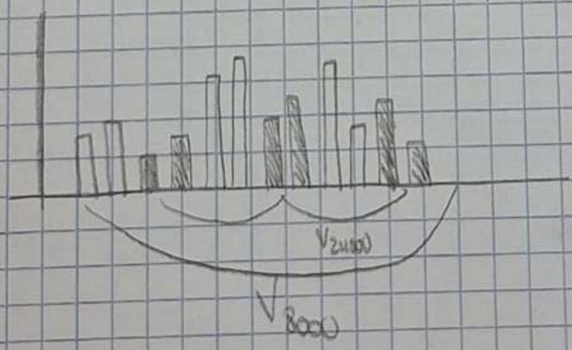
b) $r_c = 6 \times 8000 + 2 \times 24000$
$= 96000$ amostras/seg

c)

$x_7 - x_8$

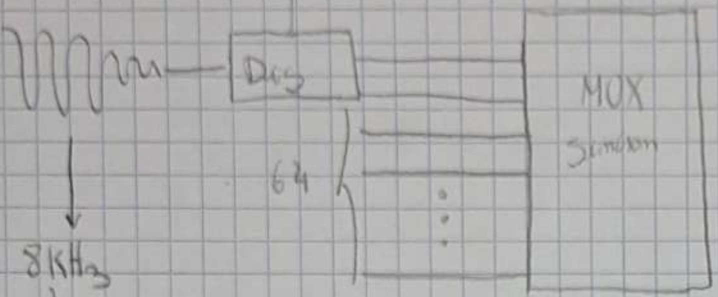
$x_1 - x_6$

* 8000 amostras/seg
* Como o 7 e o 8 têm 3 entradas acaba por ser 24000



2-

$\rightarrow q = 1024$ níveis quânticos $\Rightarrow k = \log_2 1024 = 10$ bits/amostra



$\Delta t = \frac{1}{16000}$

8 kHz

$\hookrightarrow f_a = 16000$ amostras/seg

n_{bs} = nº de colunas $\times f_a \times k$

$= 64 \times 16000 \times 10$

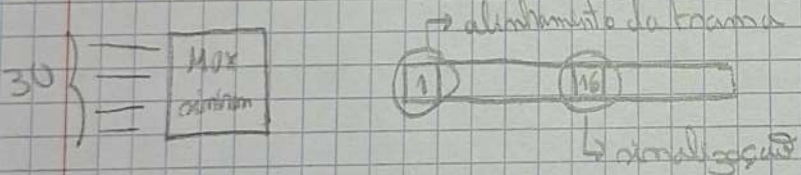
$= 1024\,0000$ bps $= 10{,}24$ Mbits

3-

a) PDH - sistemas antigos

SDH/SONET - apareceu com a fibra óptica (mais rápido)

b) powerpoint slide 140



$16 \times 125 \times 10^{-4}$ s ——— 4 bits

$\Rightarrow x = 2000$ bits

1 s ——— x

1 byte = 8 bits

c)

- Bruto: 8000×90 colunas $\times 9$ linhas $\times 1$ byte

- SPE: 8000×87 colunas $\times 8$

- UTIL: $8000 \times 86 \times 8$

5-

$N = 60$

$K = 80$ bits/DU

$r_{bo} = 60$ bytes/seg $= 480$ bps

A1- V

- $\bar{t}_q = 0{,}25$ seg

↳ atraso médio

?

$\bar{t}_q = \bar{S} + \bar{t}_w$

$\bar{t}_w = \bar{S} \times \frac{\rho}{2\times(1-\rho)}$

$\bar{S} = \frac{K}{r_{bo}}$

$\bar{S} = \frac{80}{480} = \frac{1}{6}$ seg

$\rho = \frac{K}{r_{bo}} \sum_{i=1}^{N} \lambda i$

$\frac{4}{5}$

B2- V

$\bar{n}_q = 0{,}75$

$\bar{n}_q = \rho + \frac{\rho^2}{2(1-\rho)}$

$\rho = \frac{80}{480}\left(30\times\frac{1}{15} + 30\times\frac{1}{30}\right) = 0{,}5$

$t_w = \frac{1}{6} \times \frac{0{,}5}{2(1-0{,}5)} = 0{,}08$ seg

$\bar{t}_q = \frac{1}{6} + 0{,}08 = 0{,}25$

$n_w = \frac{\rho^2}{2(m-\rho)} = \frac{(0{,}5)^2}{2(1-0{,}5)} = 0{,}25$ DU

$n_q = 0{,}5 + 0{,}25 = 0{,}75$ DU $\Rightarrow$ V

C3- F

- $r_{bo}' = 2r_{bo} \Rightarrow r_{bo}' = \frac{r_{bo}}{2}$

$\bar{t}_q = S' \times \left(1 + \frac{\rho}{2(1-\rho)}\right)$

isto é constante,

o $\bar{t}_q$ ñ depende linearmente de r_{bo}

D4-

$\overline{K'} = K/2$

$\lambda_i = 2\lambda_i$ $\Bigg] \Rightarrow \underbrace{\overline{nq}' = \overline{nq}}_{V}$, $\underbrace{\overline{tq}' = \frac{\overline{tq}}{2}}_{V}$

• $\overline{nq} = \rho + \overline{nw}$

6-

$r_{bps} = 1 Mbps = 1 \times 10^6 bps$

$\lambda = 5$ DU/2 ms

$\lambda_N = 2$ DU/ms

$N_{total} = 500 + N$

$K = 200$ bits/DU

a) $\rho \leq 0{,}7$

$0{,}7 \geq \frac{K}{r_{bps}} \left(500 \times 5/2 + N \times 2\right) \Rightarrow N \leq 112{,}5$

b) $\rho = 0{,}7$

$\overline{tq} = ?$

$\overline{nq} = ?$

BUFFER = ? bits

$\overline{tq} = \frac{K}{r_{bps}} \left(1 + \frac{\rho}{2(1-\rho)}\right) = \frac{200}{10^6} \left(1 + \frac{0{,}7}{2(1-0{,}7)}\right) = 0{,}43$ ms

$\overline{nw} = \frac{(0{,}7)^2}{2(1-0{,}7)} = 0{,}82$ DU

• $P = 0{,}7 \Rightarrow P_e \approx 10^{-3} \Rightarrow$ buffer $= 10$ DUs

$\Downarrow$

BUFFER $= 10 \times 200 = 2000$ bits

8- $N=10$ $\quad r_{bo}=2$ Mbp $\quad \alpha = 7\% = 0{,}07$ $\quad$ Buffer $= 4{,}25$ kbytes

a) r_{bo}?

$K = 1400$

$$P_e \leq \frac{1}{100\times 10^6} = \frac{1}{10^8} = 10^{-8}$$

$$\text{BUFFER} = 4{,}25 \text{ kbytes} = \frac{4{,}25\times 8 \times 2^{10}}{1400} = 25{,}00$$

· Pelo grafo | linha vertical 25,00
| linha horizontal 10^{-8}

$\Downarrow$

$\rho \approx 0{,}7$

$$\rho = \frac{1}{r_{bo}} \sum_{k=1}^{N} \alpha_i \, r_{boi} = \frac{N}{r_{bo}} = \frac{10}{r_{bo}} \times 0{,}07 \times 2\times 10^6 \Rightarrow r_{bo} = 2 \text{ Mbp}$$

b) $$\bar{t}_q = \bar{s} + \bar{t_w} = \frac{K}{r_{bo}} + \frac{K}{r_{bo}} \frac{\rho}{2(1-\rho)} = \frac{1400}{2\times 10^6} + \frac{1400}{2\times 10^6}\left(\frac{0{,}7}{2(1-0{,}7)}\right)$$

$\bar{t_w}$ ↳ tempo no buffer

$= 0{,}7 + 0{,}82 = 1{,}52$ milisegundos