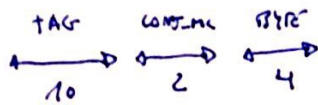


# PROBLEMAS AC

3.2) tamaño bloque = 16 B asociatividad = 2 (LRU) N° líneas = 8 PE = WT + NWA

$$\text{conj-mc} = \frac{8 \text{ bloques}}{2 \text{ bloques/conj}} = 4 \Rightarrow 2^2 \text{ \#conj} \quad 16 \text{ Bytes/bloque} \Rightarrow 2^4 \Rightarrow \text{\#Byte}$$



| Tipo   | @hex | BM  | conj-mc | H/M  | Lectura de MP |      |     | Escritura de MP |      |     |
|--------|------|-----|---------|------|---------------|------|-----|-----------------|------|-----|
|        |      |     |         |      | si/no         | @    | tam | si/no           | @    | tam |
| R Byte | 8890 | 889 | 1       | Miss | si            | 8890 | 16  | No              | —    | —   |
| W word | ECS1 | EC5 | 1       | Hit  | No            | —    | —   | si              | ECS1 | 2   |
| W Byte | EC62 | EC6 | 2       | Hit  | No            | —    | —   | si              | EC62 | 1   |
| W word | 23D3 | 23D | 1       | Miss | No            | —    | —   | si              | 23D3 | 2   |
| W Byte | ABA4 | ABA | 2       | Miss | No            | —    | —   | si              | ABA4 | 1   |
| R word | ABAS | ABA | 2       | Miss | si            | ABAS | 16  | No              | —    | —   |
| R Byte | 23D6 | 23D | 1       | Miss | si            | 23D6 | 16  | No              | —    | —   |
| W word | EC57 | EC5 | 1       | Hit  | No            | —    | —   | si              | EC57 | 2   |
| R Byte | EC68 | EC6 | 2       | Hit  | No            | —    | —   | No              | —    | —   |
| R word | 8898 | 889 | 1       | Miss | si            | 8898 | 16  | No              | —    | —   |

| Conjunto 0 |   | Conjunto 1 |   | Conjunto 2 |   | Conjunto 3 |   |
|------------|---|------------|---|------------|---|------------|---|
| EC8        | 1 | EC5        | 0 | EC6        | 1 | EC7        | 1 |
| ABA        | 0 | 889        | 1 | ABA        | 0 | —          | 0 |

# PROBLEMA AC:

3.10)

a)  $V = 1,2V$   $F = 2GHz$   $corrente I_{bus} = 3A$   $C_E = 5mF$

$P_{comutacao} = C \cdot V^2 \cdot F = 5 \cdot 10^{-9} F \cdot (1,2V)^2 \cdot 2 \cdot 10^9 = 14,4W$

$P_{bus} = I \cdot V = 3 \cdot 1,2 = 3,6W$

$P_{total} = P_{comutacao} + P_{bus} = 14,4W + 3,6W = 18W$

b) L-associativa de 128 KB, tam bloco = 64B, direcao ~~bits~~ 48, ~~corrente~~ RAM = 3uA/bit

$E_{consumida Mem tag} = 5mJ_{/vira}$ ,  $E_{com Mandada} = 25mJ_{/vira}$

# conjuntos =  $2048 / 2 = 1024$  conjuntos  $vira \rightarrow 2$  (permutat)

$2^{17} B / 2^6 B_{/vira} = 2^8$  blocos = 256 blocos  $bloco/vira = 1024$

c)  $64KB \rightarrow 2^{16} \rightarrow 64Kbits$   $conj = 1024 = 2^{10}$ 

|     |      |      |
|-----|------|------|
| RAM | cont | bits |
| 32  | 10   | 6    |

 $40 \cdot 16 \cdot 32$

d)  $vira \rightarrow 1024$  blocos  $M dados = 1024 blocos \cdot 64 B_{/bloco} \cdot 8 bits = 524288 bits$

$Metrs = 1024 blocos \cdot 32 bits_{/bloco} = 32768 bits$

e)  $P_{media total} (I_{bus} MC)$   $bits total = 557056 bits$

$I_{bus} = 557056 \cdot 3 \cdot 10^{-6} A/bit = 1,671 A$   $P_{bus} = I \cdot V \cdot \#vira = 1,671 \cdot 1,2 \cdot 2 = 4W$

f)  $MFlops = \frac{2 \cdot 10^9 ops}{5 s} \cdot 10^{-6} MFlops_{/ops} = 400 MFlops$

g)  $CPI$  paralelo,  $CPI$  ideal

$ciclos totais = 5s \cdot 2 \cdot 10^9 Hz = 10 \cdot 10^9$  ciclos  $CPI$  paralelo =  $\frac{10 \cdot 10^9 ciclos}{4 \cdot 10^9 ops} = 2,5$   $\frac{ciclos}{instr}$

$ciclos perdidos mem = 0,1 \frac{falha}{acesso} \cdot 10^9 acessos = 20 \frac{ciclos}{falha} = 2 \cdot 10^9 ciclos$

$ciclos ideal = 10 \cdot 10^9 - 2 \cdot 10^9 = 8 \cdot 10^9 ciclos \rightarrow CPI ideal = \frac{8 \cdot 10^9 ciclos}{4 \cdot 10^9 ops} = 2$   $\frac{ciclos}{instr}$

h)  $Accesso cache \rightarrow 2vira tag + 2vira dados$   $E = 2 \cdot 5mJ + 2 \cdot 25mJ = 60mJ$

i)  $P_{dinamica} = \frac{E}{T} = 60 \cdot 10^{-9} J \cdot \frac{10^9 acessos}{5 s} = 12W$

j)  $P_{media total} = P_{CPU} + P_{MC-bus} + P_{MC-comutacao} = 18W + 4W + 12W = 34W$

k)  $E = P \cdot t = 34W \cdot 5s = 170J$   $Eficiencia = \frac{400 MFlops}{34W} = 11,76 \frac{MFlops}{W}$



$$l) \text{ Cycles} = \text{ciclos ideal} + \text{ciclos fallo} + \text{ciclos acierto} = 10 \cdot 10^9 \text{ ciclos} + 0,9 \frac{\text{aciertos}}{\text{fallo}} \cdot 10^9 \text{ ciclos} = 10,9 \cdot 10^9 \text{ ciclos}$$

$$= 10,9 \cdot 10^9 \text{ ciclos} \quad \text{t}_{\text{exe}} = \frac{10,9 \cdot 10^9 \text{ ciclos}}{2 \cdot 10^9 \text{ Hz}} = 5,45 \text{ s} \quad \text{MFLOPS} = \frac{2 \cdot 10^9}{5,45} \cdot 10^{-6} = 367 \text{ MFLOPS}$$

$$m) E = 2,5 \text{ mJ} + 2,25 \text{ mJ} = 4,75 \text{ mJ}$$

$$n) \text{ Potencia max MC} = P = \frac{E}{t} = \frac{4,75 \cdot 10^{-3} \text{ J}}{5,45} = 8,72 \text{ W}$$

$$o) \text{ Potencia total} = P_{\text{CPU}} + P_{\text{MC loga}} + P_{\text{MC computa}} = 18 \text{ W} + 4 \text{ W} + 8,72 \text{ W} = 30,72 \text{ W}$$

$$p) \text{ Eficiencia} = \frac{367 \text{ MFLOPS}}{30,72 \text{ W}} = 12,91 \text{ MFLOPS/W}$$

q) No

$$r) \pm I_{\text{loga}} = 8192 \text{ bits} \cdot 3 \cdot 10^{-6} \text{ A}_{\text{bit}} = 24,6 \text{ mA} \quad F_{\text{loga}} = \pm V = 24,6 \cdot 10^{-3} \cdot 1,2 = 29,5 \text{ mW} \quad (\text{mem})$$

$$s) \text{ Cycles} = \text{ciclos ideal} + \text{ciclos fallo} + \text{ciclos acierto} = 10 \cdot 10^9 + 0,2 \cdot 10^9 = 10,2 \cdot 10^9 \text{ ciclos}$$

$$t_{\text{exe}} = \frac{10,2 \cdot 10^9}{2 \cdot 10^9} = 5,1 \text{ s} \quad \text{MFLOPS} = \frac{2 \cdot 10^9}{5,1} \cdot 10^{-6} = 392 \text{ MFLOPS}$$

$$t) E_{\text{aciertos}} = 1 \text{ mJ} + 5 \text{ mJ} + 25 \text{ mJ} = 31 \text{ mJ} \quad E_{\text{medias}} = 0,8 \cdot 31 \text{ mJ} + 0,2 \cdot 61 \text{ mJ} = 33,2 \text{ mJ}$$

$$E_{\text{fallo}} = 1 \text{ mJ} + 10 \text{ mJ} + 50 \text{ mJ} = 61 \text{ mJ}$$

$$u) P = \frac{E}{t} = \frac{0,146 \cdot 10^9 \text{ aciertos}}{5} \cdot 33,2 \cdot 10^{-3} \text{ J} = 7,25 \text{ W} = 7,25 \text{ W}$$

$$v) P_{\text{total}} = P_{\text{CPU}} + P_{\text{MC loga}} + P_{\text{red loga}} + P_{\text{cache computa}} = 18 \text{ W} + 4 \text{ W} + 0,02 \text{ W} + 7,25 \text{ W} = 29,27 \text{ W}$$

$$w) \text{ Eficiencia} = \frac{392 \text{ MFLOPS}}{29,27 \text{ W}} = 13,39 \text{ MFLOPS/W}$$

$$x) \text{ serie/paralelo} = 12,91 / 13,39 = 1,098 = 9,8\%$$

$$114/\text{serie} = 13,39 / 12,91 = 1,037 = 3,7\%$$