

4.8.1, 4.8.2, 4.9, 4.10.1, 4.10.2 e ~~4.10.3~~ 4.10.3

4.8) IF = 250ps, ID = 350ps, EX = 150ps, ME = 300ps, WB = 200ps

1) w/ Pipeline =
$$\begin{array}{r} 250 \\ 350 \\ + 150 \\ 300 \\ 200 \\ \hline 1250 \text{ps} \end{array}$$

c/pipeline = 350ps

ALU \downarrow 45%
 beq \downarrow 20%
 lue \downarrow 20%
 sue \downarrow 15%

Pipeline não reduz a latência!

2) w/ Pipeline = 1250ps

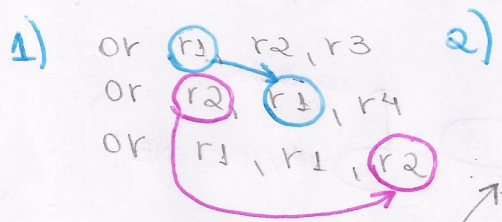
c/pipeline = $5 \cdot 350 = 1750 \text{ps}$

ME WB uma etapa

\downarrow
 etapas

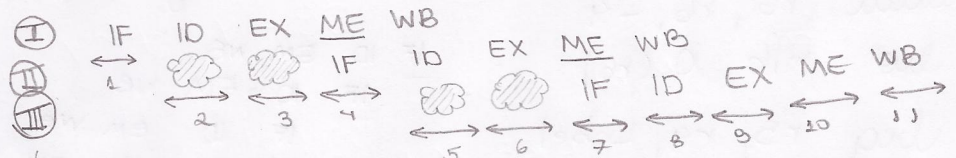
4.9) or r1, r2, r3 ①
 or r2, r1, r4 ②
 or r3, r1, r2 ③

w/ stalls = 250ps
 c/ todos os stalls = 300ps
 c/ALU-ALU = 290ps

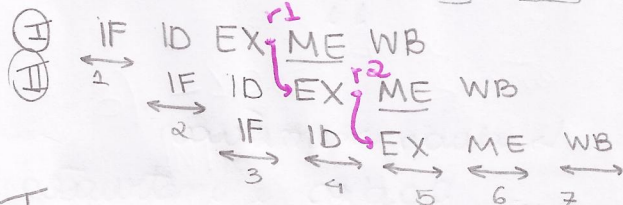
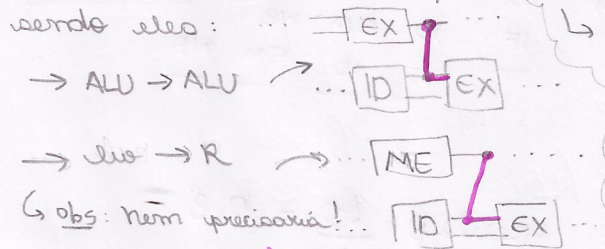


2) Hipóteses:

- ID: decodificação e leitura dos registradores na segunda metade do ciclo
- WB: escrita em registrador na primeira metade do ciclo
- ME: começa com a instrução ex.



3) c/ todos os stalls, mantendo as hipóteses



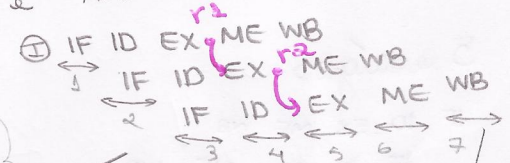
$T_{TOT} = 7 \cdot 300 = 2100 \text{ps}$

ou r1, r2, r3
 ou r2, r1, r4
 ou r1, r1, r2

4) speedup = $\frac{2100}{2750} = 0,76$

6) speedup = $\frac{2030}{2100} = 0,96$

5) mesmas hipóteses e ALU-ALU



$T_{TOT} = 7 \cdot 290 = 2030 \text{ps}$

igual ao 3 e mais rápido!

ou r1, r2, r3
 ou r2, r1, r4

ou r1, r1, r2

4.10) sw r16, 12(r6)
 lw r16, 8(r6)
 beq r5, r4, Label
 add r5, r1, r4
 slt r5, r15, r4

→ sem dependências

IF: 200ps
 ID: 120ps
 EX: 130ps
 ME: 190ps
 WB: 100ps

NAO VSA:
 sw: WB
 beq: ME e WB
 R: ME
 → add e slt

1) sempre r5 ≠ r4.

uma memória:

→ preferência: IF de

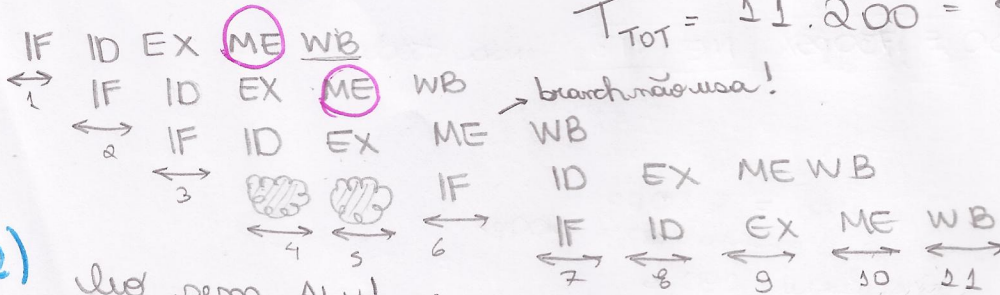
IF vs ME



→ Hipótese: sem atalhos

→ não tem como tratar hazard estrutural com rep

$$T_{Tot} = 11.200 = 2200ps$$



2) lw sem ALU!

4 estágios → EX e ME = EM Hipótese: com atalhos

ALU → ALU e lw → ALU.

addi r6, r6, 12

sw r16, 0(r6)

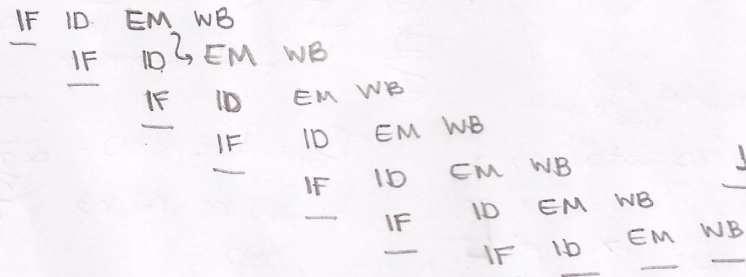
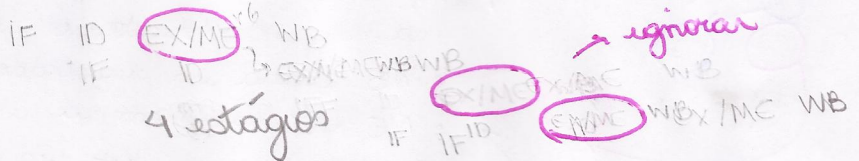
addi r6, r6, -4

lw r16, 0(r6)

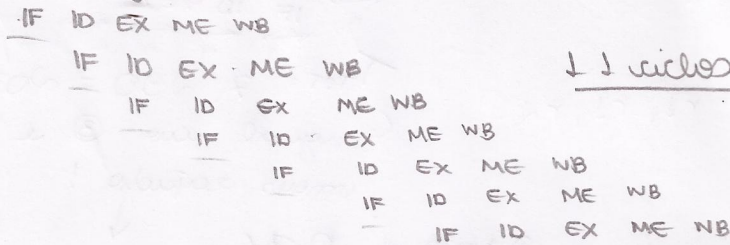
beq r5, r4, Label

add r5, r1, r4

slt r5, r15, r4



5 estágios



11 ciclos

$$speedup = \frac{10}{11} = 0,9$$

→ duas memórias
 dados e instruções

4.10.3)

resultado do branch: ① ID
② EX

↳ duas memórias

①

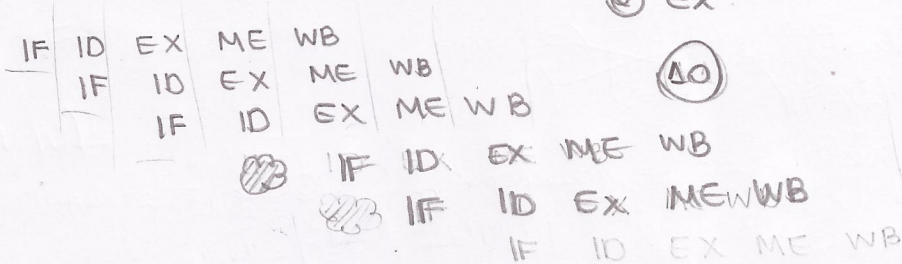
sw

lw

beg

add

set



①

②

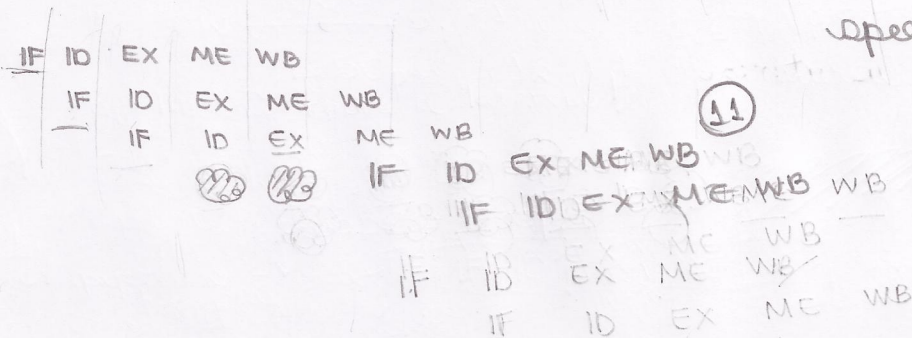
sw

lw

beg

add

set



①

$$\text{speedup} = \frac{11}{10} = 1.1$$