

分支 数据依赖

2.	I_1	无
	I_2	a_0/a_2
	I_3	a_1, a_2, a_3 存在 RAW 依赖
	I_4	无
	I_5	a_1/a_2
1	I_6	a_3

4. 加速比 $\frac{1ns}{0.6ns} = 1.67$

(1) $CPI_A = 5 + \frac{1}{5} + 2 \times 5\% \times 20 = 5.22$

$CPI_B = 12 + \frac{3}{8} + 5 \times 5\% \times 20 = 12.425$

6. "1. RAW = addi a1, a1, 1 在 Id a1, o(a2) 等待

2. WBR = (3 读 a1, 读 a2) a. 发生 WBR

3. WBW = (3 写 a1, 4 写 a2) a. 发生 WBW

4. 分支冲突: bne a4, a4, Loop 3 读 a4, 3 读 a2, 3 写 a2, 5 读 a2, 5 读 a3, 5 写 a3, 6 读 a4, 6 读 a3, 6 写 a2, 7 读 a3, 7 读 a2, 7 写 a2, 8 读 a2, 8 读 a1, 8 写 a1

(2) Loop: ld a1, o(a2) IF ID EX MEM WB

addi a1, a1, 1 2F ID S S 2X MEM WB

sd a1, o(a2) 2F ID S S S S 2X MEM WB

addi a2, a2, 4 2F ID S S S S S S 2X MEM WB

sub a4, a3, a2 2F 2D S S S S S S S S

bne a4, a4, Loop 2F 2D

: 共 14 + 3 + 3 = 20 个时钟周期

7. 共 11 个周期

(2) 共存在分支预测的 7 个 bne 指令 + 抽样 3 个周期，共 10 个周期

loop:
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
 \$d a1, 0(a2) Jf, If, 2D, 2D, ZX, ZX, MB, M, WB, WR,
 addi a1, a1, 1 Jf, If, 2D, 2D, S S S ZX, ZX, M, M, WB, WB,
 sd a1, 0(a2) Jf, If, 2D, 2D, S S S S ZX, ZX, M, M, WB, WB,
 addi a2, a2, 4 Jf, If, 2D, 2D, S S S S S ZX, ZX, M, M, WB,
 sub a4, a3, a2
 bnez a4, Loop

$$(2) CP_{16} = \frac{20}{6} = \frac{10}{3} \quad CP_{17} = \frac{11}{6} = \frac{11}{6} \quad CP_{18} = \frac{22}{6} = \frac{11}{3}$$

19.11) add addi ld sd bne jal jalr
✓ ✗ ✗ ✗ ✗ ✗ ✗

(2) IF ID $\exists x \in M^2M$ WB

27 2D. 2D₂ S Ex M&M WB

27 S 2D S S S ZX MZM WB

27 S 2D S S S .S ZxMEMW13

IT IS 20 SS 5 SS 5. S ..

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13) 27 20 ZX M7M W13

27 20 . . .

：共 87 日期 2019