38/40

1.5 P1: 3 GHz & CPI of 1.5

P2: 2.5 GHz & CPI of 1.0

P3: 4.0 GHz & CPI of 2.2

a P1 = 3 GHz / 1.5 = 2×10^9 instruct/sec

P2 = 2.5 GHz / 1.0 = 2.5×10^9 instruction/sec best?

P3 = 4.0 GHz / 2.2 = 1.81×10^9 instruction/sec (-1)

b Cycles

P1: 3 GHz · 10 = 3×10^{10} cycles

P2: 2.5 GHz · 10 = 2.5×10^{10} cycles

P3: 4.0 GHz · 10 = 4.0×10^{10} cycles

Instructions

P1: $2 \times 10^9 \cdot 10 = 2 \times 10^{10}$ instructions

P2: $2.5 \times 10^9 \cdot 10 = 2.5 \times 10^{10}$ instructions

P3: $1.81 \times 10^9 \cdot 10 = 1.81 \times 10^{10}$ instructions

c Execution Time · 0.7 = (# of Instr · CPI · 1.2)/CR

0.7 · (# of instr · CPI)/ClockRate = # of Instr · CPI · 1.2/NCR

0.7 · # of instr · CPI · NCR = CR · # of instr · CPI · 1.2

NCR = New Clock Rate NCR = CR · 1.2/0.7

CR = Clock Rate

P1: 3 GHz · $\frac{1.2}{0.7}$ = 5.143 GHz

P2: 2.5 GHz · $\frac{1.2}{0.7}$ = 4.286 GHz

P3: 4.0 GHz $\frac{1.2}{0.7}$ = 6.857 GHz

1.6 a P1: 2.5GHz CPI: 1, 2, 3, 3

P2: 3GHz CPI: 2, 2, 2, 2

Class A: 1E5, Class B: 2E5

Class C: 5E5, Class D: 2E5

P1 Global time = $\frac{1 \times 1E5 + 2 \times 2E5 + 3 \times 5E5 + 3 \times 2E5}{2.5E9}$

= 1.04E-3 s → 10.4E-4 s

P2 Global time = $\frac{2 \times 1E5 + 2 \times 2E5 + 2 \times 5E5 + 2 \times 2E5}{3.0E9}$

= 6.6E-4 s

P1 Global CPI = 10.4E-4 s · 2.5E9 / 1E6

= 2.6

P2 Global CPI = 6.66E-4 · 3.0E9 / 1E6

= 2.0

b P1 Global Clock Cycle = 1E5 + 2×2E5 + 3×5E5 + 3×2E5

= 2.6E6

P2 Global Clock Cycle = 2E5 + 4E5 + 10E5 + 4E5

= 2.0E6

1.7 Compiler A: 1E9 instructions & 1.1 sec
Compiler B: 1.2E9 instructions & 1.5 sec

a $\text{ExecTime} = \frac{\#\text{ of Instr.} \cdot \text{CPI}}{\text{Clock Rate}} \rightarrow \#\text{of Instr.} \cdot \text{CPI} \cdot \text{ClockCycle}$

$\therefore \quad \text{CPI}_A = \frac{\text{ExecTime}}{\#\text{ of Instr.} \cdot \text{CPI}} = \frac{1.1}{1E9 \cdot 1E-9} = 1.1$

$\text{CPI}_B = \frac{1.5}{1.2E9 \cdot 1E-9} = 1.25$

b A B

$1E9 \cdot 1.1 \cdot \text{ClockCycle}_A = \text{ClockCycle}_B \cdot 1.25 \cdot 1.2E9$

$1.1E9 \ \text{ClockCycle}_A = \text{ClockCycle}_B \cdot 1.5E10$

$\text{ClockCycle}_A = \text{ClockCycle}_B \cdot 1.36$

Clock A is 36% times faster than Clock B

c New Compiler$_N$: 6.0E8 instructions & CPI of 1.1

Compiler A: $\frac{\text{CPUTime}_A}{\text{CPUTime}_N} = \frac{1E9 \cdot 1.1}{6E8 \cdot 1.1} = 1.667$

Compiler B: $\frac{\text{CPUTime}_A}{\text{CPUTime}_N} = \frac{1.2E9 \cdot 1.25}{6E8 \cdot 1.1} = 2.27$

1.13 250s : 70s FP , 85s L/S , 40s branch
& 55 sec (?)

1.13.1 $(70 \cdot 0.8) + 85 + 40 + 55 = 236$ seconds

1.13.2 $250s \cdot 0.8 = 70s + 85s + 40s + INT$

$200 = 70 + 85 + 40 + INT$

$INT = 5$ seconds

$55(x) = 5$

$x = 0.091 \rightarrow$ 9.1% reduced

1.13.3 $250 \cdot 0.8 = 70 + 85 + 40(x) + 55$

$200 = 70 + 85 + 55 + 40(x)$

$-10 = 40(x)$

$-0.25 = x$ → No it is not possible to reduce only the Branch instructions in order to meet the 20% reduction of the overall time

good.