1.5 P1: 3GHz & CPI of 1.5

P2: 2.5 GHz & CPI of 1.0

P3: 4.0 GHz & CPI of 2.2

a $P1 = 3\text{GHz}/1.5 = 2\times10^{9}$ instruct/sec

$P2 = 2.5\text{GHz}/1.0 = 2.5\times10^{9}$ instruction/sec

$P3 = 4.0\text{GHz}/2.2 = 1.81\times10^{9}$ instruction/sec

b Cycles

P1: $3\text{ GHz}\cdot 10 = 3\times10^{10}$ cycles

P2: $2.5\text{ GHz}\cdot 10 = 2.5\times10^{10}$ cycles

P3: $4.0\text{GHz}\cdot 10 = 4.0\times10^{10}$ cycles

Instructions

P1: $2\times10^{9}\cdot 10 = 2\times10^{10}$ instructions

P2: $2.5\times10^{9}\cdot 10 = 2.5\times10^{10}$ instructions

P3: $1.81\times10^{9}\cdot 10 = 1.81\times10^{10}$ instructions

c Execution Time $\cdot\ 0.7 = (\#\text{ of Instr} \cdot CPI \cdot 1.2)/$

$0.7\cdot(\#\text{ of instr}\cdot CPI)/\text{Clock Rate} = \#\text{ of Instr}\cdot CPI\cdot 1.2/NCR$ Clock Rate

$0.7\cdot\cancel{\#\text{ of instr}\cdot CPI}\cdot NCR = CR\cdot\cancel{\#\text{ of instr}\cdot CPI}\cdot 1.2$

NCR = New Clock Rate $\qquad NCR = CR\cdot 1.2/0.7$

CR = Clock Rate

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

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

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

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

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

$$= 1.04E{-3}\ s \rightarrow 10.4E{-4}\ s$$

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

$$= 6.6E{-4}\ s$$

$$\text{P1 Global CPI} = 10.4E{-4}\ s \cdot 2.5E9 / 1E6$$

$$= 2.6$$

$$\text{P2 Global CPI} = 6.66E{-4} \cdot 3.0E9 / 1E6$$

$$= 2.0$$

b

$$\text{P1 Global Clock Cycle} = 1E5 + 2\times 2E5 + 3\times 5E5 + 3\times 2E5$$

$$= 2.6E6$$

$$\text{P2 Global Clock Cycle} = 2E5 + 4E5 + 10E5 + 4E5$$

$$= 2.0E6$$

1.7 Compiler A : 1E9 instructions & 1.1 sec

Compiler B : 1.2E9 instructions & 1.5 sec

a

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

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

$$CPI_B = \frac{1.5}{1.2E9 \cdot 1E{-9}} = 1.25$$

b

A B

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

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

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

Clock A is 36% times faster than Clock B

c New Compiler_N : 6.0E8 instructions & CPI of 1.1

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

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

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