

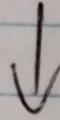
ECE 4300 HW1 Hyosung Kim

1.3 1.4 1.5 1.6 1.7 1.11 1.12

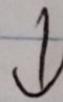
#1.3 Describe high level C into PC

C language

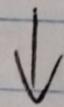
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Compiler



Assembly language



Assembler



Binary Machine language

1.4) 8 bits for each 3 color

$$1280 \times 1024$$

a) bytes for frame 3 bytes color

$$1280 \cdot 1024 \cdot 3 = [3,932,160 \text{ bytes}]$$

b) 100 Mbytes/s for the frame

$$3,932,160 \cdot 8 = 31,457,280 \text{ bits}$$

$$31,457,280 \text{ Mbits} \cdot \frac{1 \text{ s}}{100 \text{ Mbits}}$$

$$[0.3145728 \text{ seconds.}]$$

1.5) P1 3 GHz CPI 1.5

P2 2.5 GHz CPI 1.0

P3 4.0 GHz CPI 2.2

a) highest performance

$$P_1 \frac{3 \times 10^9}{1.5} = 2 \times 10^9 \text{ I}_S \quad P_3 = \frac{4.0 \times 10^9}{2.2} = 1.82 \times 10^9 \text{ I}_S$$

$$P_2 \frac{2.5 \times 10^9}{1.0} = 2.5 \times 10^9 \text{ I}_S$$

P2 is highest

b) $P_1 10 \cdot 10^9 \cdot 3 \cdot \frac{1}{1.5} = 20 \times 10^9 \text{ I}_NS \quad 30 \times 10^9 \text{ cycles}$

$$P_2 = 10 \cdot 10^9 \cdot 2.5 \cdot \frac{1}{1} = 25 \times 10^9 \text{ I}_NS \quad 25 \times 10^9 \text{ cycles}$$

$$P_3 = 10 \cdot 4 \times 10^9 \cdot \frac{1}{2.2} = 18.18 \times 10^9 \text{ I}_NS \quad 40 \times 10^9 \text{ cycles}$$

c) $I_0 = \frac{1}{CR} \cdot CPI$

$$\tau = A \cdot CR + 1.2 \cdot CPI$$

$$\frac{\tau}{I_0} = \frac{1.2 \cdot CPI \cdot CR}{CPI \cdot A \cdot CR}$$

$$A = \frac{I_0}{\tau}$$

New clock rate $\frac{12}{7} \cdot CR \quad 1.71 \text{ times faster}$

A B C D

1.b) P1 2,5 GHz CPI 1,2,3,3

P2 3 GHz CPI 2,2,2,2

1.0×10^6 I 0,1 A 0,2 B 0,5 C 0,2 D

1.0×10^5 2×10^5 5×10^5 2×10^5

$$\frac{2,5 \times 10^6}{I} = 2,5 \times 10^4 \frac{1,25 \times 10^9}{4e5} \frac{0,833 \times 10^9}{1,6e-4} \frac{0,4e-4}{8,4e-4} = 0,0014 \text{ } \text{S}$$

$$\frac{3 \times 10^6}{I} = 1,5 \times 10^6 \text{ } \text{S} \quad \frac{1,0 \times 10^6}{1,5 \times 10^9} = 6,67 \times 10^{-9} \text{ } \text{S}$$

Emple workstation 2 is faster

a) $(0,1 \cdot 1) + (0,2 \cdot 2) + (0,5 \cdot 3) + (0,2 \cdot 3)$

$$P1 = \boxed{CPI = 2,6}$$

$$P2 = \boxed{CPI = 2}$$

b) $P1 \quad CPI = 2,6 \quad 2,6 \cdot 1 \times 10^6 = 2,6 \times 10^6$

$P2 \quad CPI = 2,0 \quad 2,0 \cdot 1 \times 10^6 = 2,0 \times 10^6$

$$P1 = 2,6 \times 10^6 \text{ cycles}$$

$$P2 = 2,0 \times 10^6 \text{ cycles}$$

1.7) (6 GHz A) ~~1,0e9~~ 1
 $\text{exec} = 1,1$

(B) $1,2 \times 10^9$ exec 1,5

a) $A \text{ CPI} = \frac{1 \times 10^9 \cdot 1,1}{1,0 \times 10^9} = 1,1 = \text{CPI}_A$

$B \text{ CPI} = \frac{1,0 \times 10^9 \cdot 1,5}{1,2 \times 10^9} = 1,25 = \text{CPI}_B$

b) $CR = \frac{\text{CPI} \cdot T_{ns}}{\text{sec}}$

$$\frac{CR_A}{CR_B} = \frac{\text{CPI}_A \cdot T_{ns,A}}{\text{CPI}_B \cdot T_{ns,B}} = \frac{1,0 \times 10^9 \cdot 1,1}{1,2 \times 10^9 \cdot 1,25}$$

$$\frac{CR_A}{CR_B} = \frac{1,1}{1,5} = 0,733$$

B is 36% faster.

c) $6,0 \times 10^8 \text{ CPI } 1,1 \quad | 6 \text{ GHz}$

$$\text{sec} = \frac{6,0 \times 10^8 \cdot 1,1}{1,0 \times 10^9} = 0,66$$

$$A = \frac{1,1}{0,66} = 1,66 \quad \frac{1,5}{0,66} = 2,33$$

faster than A by 66% and B by 137%

$$Clock = 0,333 \text{ ns} = 3 \text{ GHz}$$

1.11) $2,389 \cdot 10^{12} \rightarrow 750, \text{ ref } 9650$

$$1.11.1) CPI = \frac{750 \cdot 3 \cdot 10^9}{2,389 \cdot 10^{12}} = 0,941$$

$$1.11.2) SPEC Ratio = \frac{\text{Ref}}{T_{exec}} = \frac{9650}{750} = 12,875$$

$$1.11.3) 2,389 \cdot 10^{12} \cdot 1,1 = 2,6279 \cdot 10^{12}$$

$$CPU Time = 750 \times 1,1 = 825 \text{ s}$$

$$1.11.4) (0,941)(1,1) = 0,988$$

$$Time = \frac{2,6279 \times 10^{12} \cdot 0,988}{3 \times 10^9} = 864,9 \text{ s}$$

$$1.11.5) MUL = \frac{9650}{864,9} = 11,16$$

$$1.11.6) (0,85) 2,389 \times 10^{12} = 2,03 \times 10^{12}$$

$$T_{exec} = 700 \text{ s} \quad 4 \text{ GHz}$$

$$CPI = \frac{700 \cdot 4 \cdot 10^9}{2,03 \times 10^{12}} = 1,38$$

$$1,11,7) \quad 3 \Rightarrow 4 \text{ GHz}$$

33% increase

$$CPF = 0.941 \Rightarrow 1.38 \quad \frac{1.38}{0.971} = 1.47$$

$$1,11,8) \quad 750 - 700 = 50 \text{ seconds}$$

$$\frac{50}{780} = 0.0667 = 6.67\% \text{ reduction}$$

$$1,11,9) \quad exec = 960 \quad (0.9)(960) = 864$$

clockrate $\geq 0.7 \text{ Hz}$ $CPF \geq 1.61$

$$Ins = \frac{864 \times 10^{-9} \cdot 3 \cdot 10^9}{1.61} = 1.61 \times 10^3 \text{ instructions}$$

1,11,10)

$$\frac{3 \times 10^9}{0.9} = 3.33 \times 10^9 \quad 3.33 \text{ GHz}$$

$$1,11,11) \quad 0.85 \cdot 1.61 = 1.3685$$

$$0.85 \cdot 960 = 768$$

$$PWR = 1.61 \cdot 10^3 \cdot 1.3685 = 2.87 \times 10^3 \text{ Hz}$$

$$768 \times 10^{-9}$$

$$2.87 \text{ GHz}$$

1.12 P1 4GHz CPI 0.91 5.0×10^9

P2 3GHz CPI 0.75 1.0×10^9

$$P1 \text{ execute} = \frac{\text{Ins} \cdot CPI}{CR} = \frac{5 \times 10^9 \cdot 0.91}{4 \times 10^9} = 1.125 \text{ seconds}$$

$$P2 = \frac{0.75 \times 10^9}{3 \times 10^9} = 0.25 \text{ seconds}$$

P2 is faster despite slower clock

1.12.2) P1 1.0×10^9

$$\frac{1.0 \times 10^9 \cdot 0.9}{4 \times 10^9} = 0.225 \text{ seconds}$$

$$T_{ins} = \frac{\text{Ins} \cdot CPI}{CR} = \frac{0.225 \cdot 2 \times 10^9}{0.75} = 9 \times 10^8 \text{ ns}$$

P2 $9 \times 10^8 > P1 1 \times 10^9$

$$b, 12.3) \text{ MIPS} = \frac{C_A}{CPI} \times 10^6 = \frac{4 \times 10^9}{0.9} \times 10^6 = 4,44 \times 10^6$$

$$P_1 = \frac{3 \times 10^9}{0.75} \times 10^6 = 4 \times 10^9 \text{ MIPS}$$

P2 und höherer Br point due zu Instruction Out

$$b, 12.4) \text{ MFlop} = \frac{FP}{E_{sec} \times 10^6}$$

$$P_1 \quad \underline{0.4 \times 10^9 \times 5.0} = 2,0 \times 10^8$$

$$P_2 \quad 0.4 \times 10^9 = 4,0 \times 10^8$$

$$P_1 = \frac{2 \times 10^8}{1,125 \times 10^6} = 1,78 \times 10^3 \text{ MFlop}$$

$$P_2 = \frac{4,0 \times 10^8}{0,75 \times 10^6} = 1,6 \times 10^3 \text{ MFlop}$$

P1 is longer