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ECE 4300 Hw1

1.3 1.4 1.5 1.6 1.7 1.11 1.12

#1.3 Describe high level C into PC

C language

↓

compiler

↓

Assembly language

↓

Assembler

↓

Binary Machine language

1.4) 8 bits for each 3 color

1280×1024

a) bytes for frame 3 bytes color

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

b) 100 Mbits/s for the frame

$3,932,160 \cdot 8 = 31457280$ bits

$31.457280 \text{ Mbits} \cdot \dfrac{1 \text{ s}}{100 \text{ Mbits}}$

$\boxed{0.3145728 \text{ seconds.}}$

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

P1 $\frac{3\times10^9}{1.5} = 2\times10^9$ I/s

P3 $= \frac{4.0\times10^9}{2.2} = 1.82\times10^9$ I/s

P2 $\frac{2.5\times10^9}{1.0} = 2.5\times10^9$ I/s

P2 is highest

b)

P1 $10\cdot10^9\cdot3\cdot\frac{1}{1.5} =$ 20×10^9 Ins 30×10^9 cycles

P2 $= 10\cdot10^9\cdot2.5\cdot\frac{1}{1} =$ 25×10^9 Ins 25×10^9 cycles

P3 $= 10\cdot4\times10^9\cdot\frac{1}{2.2} =$ 18.18×10^9 Ins 40×10^9 cycles

c)

$10 = \frac{1}{CR}\cdot CPI$

$7 = A\cdot CR\cdot1.2\cdot CPI$

$\frac{7}{10} = \frac{1.2\cdot \cancel{CPI}\cdot CR}{\cancel{CPI}\cdot A\cdot CR}$

$A = \frac{12}{7}$

New clock rate $\frac{12}{7}\cdot CR$ 1.71 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

$\frac{2.5\times10^9}{1} = 2.5\times10^9$ 1.25×10^9 0.833×10^9

4e5 1.6e-4 8.4e-4 = 0.0014 s

$\frac{3\times10^9}{2} =$ 1.5×10^9 I/s $\frac{1.0\times10^6}{1.5\times10^9} = 6.67\times10^{-4}$ s

Implementation 2 is faster

a) $(0.1\cdot1) + (0.2\cdot2) + (0.5\cdot3) + (0.2\cdot3)$

P1 = CPI = 2.6

P2 = CPI = 2

b) P1 CPI = 2.6 $2.6\cdot1\times10^6 = 2.6\times10^6$

P2 CPI = 2.0 $2.0\cdot1\times10^6 = 2.0\times10^6$

P1 = 2.6×10^6 cycles

P2 = 2.0×10^6 cycles

1.7) 1 GHz A) ~~1.0e~~ 1.0e9 1

exec = 1.1

B) 1.2E9 exec 1.5

a) $_A CPI = \frac{1\times10^9 \cdot 1.1s}{1.0e9} = \boxed{1.1 = CPI_A}$

$B\ CPI = \frac{1.0\times10^9 \cdot 1.5}{1.2e9} = \boxed{1.25 = CPI_B}$

b)

$CR = \frac{CPI \cdot Ins}{sec}$

$\frac{CR_A}{CR_B} = \frac{CPI_A \cdot Ins_A}{CPI_B \cdot Ins_B} = \frac{1.0e9 \cdot 1.1}{1.2e9 \cdot 1.25}$

$\boxed{\frac{CR_A}{CR_b} = \frac{1.1}{1.5} = 0.733}$

B is 36% faster.

c) 6.0×10⁸ CPI 1.1 1 GHz

$Sec = \frac{6.0\times10^8 \cdot 1.1}{1\times10^9} = 0.66$

$A = \frac{1.1}{0.66} = 1.66 \quad \frac{1.5}{0.66} = 2.37$

faster than A by 66% and B by 137%

Clock = 0.333 ns = 3 GHz

1.11) 2.389E12   750 s   ref 9650

1.11.1) $CPI = \frac{750 \cdot 3 \cdot 10^9}{2.389e12} = \boxed{0.941}$

1.11.2) $\text{SPEC Ratio} = \frac{\text{Ref}}{\text{Exec}} = \frac{9650}{750} = \boxed{12.87\text{s}}$

1.11.3)

$2.389e12 \cdot 1.1 = 2.6279e12$

$\text{CPU Time} = 750 \times 1.1 = \boxed{825\text{s}}$

1.11.4) $(0.941)(1.1) = 0.988$

$\text{Time} = \frac{2.6271 \times 10^{12} \cdot 0.988}{3 \times 10^9} = \boxed{864.4\text{s}}$

1.11.5)

$\text{ratio} = \frac{9650}{864.4} = \boxed{11.16}$

1.11.6) $(0.85) \, 2.389 \times 10^{12} = 2.03 \times 10^{12}$

Exec = 700 secs   4 GHz

$CPI = \frac{700 \cdot 4 \cdot 10^9}{2.03 \times 10^{12}} = 1.38$

1.11.7) 3 ⇒ 4 ghz

33% increase

CPI 0.941 ⇒ 1.38 $\frac{1.38}{0.971} = 1.47$

~~49~~ 47% Increase

1.11.8) 750 − 700 = 50 seconds

$\frac{50}{750} = 0.0667 = 6.67\%$ reduction

1.11.9) exec = 960 (0.9)(960) = 864

clockrate 3 GHz CPI = 1.61

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

1.11.10) $\frac{3 \times 10^{9}}{0.9} = 3.33 \times 10^{9}$ $\boxed{3.33 \text{ GHz}}$

1.11.11) 0.85 · 1.61 = 1.3685

0.8 · 960 = 768

$\text{rate} = \frac{1.61 \cdot 10^{3} \cdot 1.3685}{768 \times 10^{-9}} = 2.87 \times 10^{9} \text{ Hz}$

$\boxed{2.87 \text{ GHz}}$

1.12 P1 4 GHz CPI 0.9 5.0e9

P2 3 GHz CPI 0.75 1.0e9

P1 exec time $= \frac{Ins \cdot CPI}{CR} = \frac{5\times10^9 \cdot 0.9}{4\times10^9} = 1.125$ seconds

P2 $= \frac{0.75 \times 1\times10^9}{3\times10^9} = 0.25$ seconds

P2 is faster despite slower clock

1.12.2) P1 1.0×10^9

$\frac{1.0\times10^9 \cdot 0.9}{4\times10^9} = 0.225$ seconds

Ins $= \frac{Time \times CR}{CPI} = \frac{0.225 \cdot 3\times10^9}{0.75} = 9\times10^8$ ins

P2 9e9 > P1 1×10^9

1.12.3) $MIPS = \frac{CR}{CPI} \times 10^{6} = \frac{4\times10^{9}}{0.4} \times 10^{6} = 4.44\times10^{6}$

$$P_2 = \frac{3\times10^{9}}{0.75} \times 10^{6} = 4\times10^{6} \text{ MIPS}$$

P2 and better for print due to instruction count

1.12.4) $MFlops = \frac{FP}{Exec \times 10^{6}}$

$P1 \quad 0.4 \times 10^{9} \cdot 5.0 = 2.0\times10^{9}$

$P2 \quad 0.4 \cdot 1 \cdot 1.0^{9} = 4.0\times10^{8}$

$$P1 \quad \frac{2.0\times10^{9}}{1.125\times10^{6}} = 1.78\times10^{3} \text{ MFlops}$$

$$P2 = \frac{4.0\times10^{8}}{0.25\times10^{6}} = 1.6\times10^{3} \text{ MFlops}$$

P1 is larger