ASSIGNMENT 2

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1 Problem 1.6

- P1
  - CPU Clock Cycle

$$(1 \times 10\% \times 10^6) + (2 \times 20\% \times 10^6) + (3 \times 50\% \times 10^6) + (3 \times 20\% \times 10^6) = 2.6 \times 10^6 \tag{1}$$

  - CPU Time

$$\frac{2.6 \times 10^6}{2.5GHz} = 1.04 \times 10^{-3}s \tag{2}$$

- P2
  - CPU Clock Cycle

$$(2 \times 10\% \times 10^6) + (2 \times 20\% \times 10^6) + (2 \times 50\% \times 10^6) + (2 \times 20\% \times 10^6) = 2 \times 10^6 \tag{3}$$

  - CPU Time

$$\frac{2 \times 10^6}{3GHz} = 6.67 \times 10^{-4}s \tag{4}$$

P2 implementation is faster

(a) Global CPI

- P1

$$\frac{2.6 \times 10^6}{10^6} = 2.6 \tag{5}$$

- P2

$$\frac{2 \times 10^6}{10^6} = 2 \tag{6}$$

(b) Clock Cycles

- P1: 2.6×10^6
- P2: 2×10^6

2 Problem 1.9

(1) Execution Time

1 Processor

$$\frac{(1 \times 2.56 \times 10^9) + (12 \times 1.28 \times 10^9) + (5 \times 2.56 \times 10^8)}{2GHz} = 9.6s \tag{7}$$

2 Processors

$$\frac{\frac{(1 \times 2.56 \times 10^9) + (12 \times 1.28 \times 10^9)}{0.7 \times 2} + (5 \times 2.56 \times 10^8)}{2GHz} = 7.04s \tag{8}$$

Speed Up $9.6/7.04 = 1.36$

4 Processors

$$\frac{\frac{(1 \times 2.56 \times 10^9) + (12 \times 1.28 \times 10^9)}{0.7 \times 4} + (5 \times 2.56 \times 10^8)}{2GHz} = 3.84s \tag{9}$$

Speed Up $9.6/3.84 = 2.5$

8 Processors

$$\frac{\frac{(1 \times 2.56 \times 10^9) + (12 \times 1.28 \times 10^9)}{0.7 \times 8} + (5 \times 2.56 \times 10^8)}{2GHz} = 2.24s \tag{10}$$

Speed Up $9.6/2.24 = 4.29$

(2) Arithmetic Doubled

1 Processor

$$9.6s + \frac{(1 \times 2.56 \times 10^9)}{2GHz} = 10.88s \tag{11}$$

Slowed down $10.88/9.6 = 1.13$

2 Processors

$$7.04s + \frac{(1 \times 2.56 \times 10^9)}{0.7 \times 2 \times 2GHz} = 7.95s \tag{12}$$

Slowed down $7.95/7.04 = 1.13$

4 Processors

$$3.84s + \frac{(1 \times 2.56 \times 10^9)}{0.7 \times 4 \times 2GHz} = 4.30s \tag{13}$$

Slowed down $4.30/3.84 = 1.12$

8 Processors

$$2.24s + \frac{(1 \times 2.56 \times 10^9)}{0.7 \times 8 \times 2GHz} = 2.47s \tag{14}$$

Slowed down $2.47/2.24 = 1.10$

(3) Reduced Load function

$$\begin{gathered}\frac{(1 \times 2.56 \times 10^9) + (1.28 \times x \times 10^9)}{0.7 \times 4} = (1 \times 2.56 \times 10^9) + (1.28 \times x \times 10^9) \\ x = 3\end{gathered} \tag{15}$$

When the number of load instruction reduced to $\frac{|3-12|}{12} = 75\%$, a single processor will have same performance as 4 processors.

3 Problem 1.12

(1) Fallacy

P1 CPU Time

$$\frac{0.9 \times 5 \times 10^9}{4GHz} = 1.125 \tag{16}$$

P2 CPU Time

$$\frac{0.75 \times 1 \times 10^9}{3GHz} = 0.25 \tag{17}$$

It is not true for both P1 and P2

(2)

$$\begin{aligned} \frac{0.9 \times 1 \times 10^9}{4GHz} &= \frac{0.75 \times x}{3GHz} \\ x &= 0.9 \times 10^9 \end{aligned} \tag{18}$$

P2 can execute 0.9×10^9 instruction at the same time.

4 Problem 1.14

(1) Execution Time = $\frac{\text{Clock Cycles}}{\text{Clock rate}}$

$$\begin{aligned} \frac{(1\times5\times10^7)+(1\times1.1\times10^8)+(4\times8\times10^7)+(2\times1.6\times10^7)}{2GHz} &= 2.56\times10^{-1}s \\ 1.28\times10^{-1}s = \frac{(x\times5\times10^7)+(1\times1.1\times10^8)+(4\times8\times10^7)+(2\times1.6\times10^7)}{2GHz} \\ x &= -4.12 \end{aligned} \tag{19}$$

However, a negative CPI is not possible.

(2)

$$\begin{aligned} 1.28\times10^{-1}s = \frac{(1\times5\times10^7)+(1\times1.1\times10^8)+(x\times8\times10^7)+(2\times1.6\times10^7)}{2GHz} \\ x &= 0.8 \end{aligned} \tag{20}$$

(3)

$$\begin{aligned} \frac{(1\times(1-0.4)\times5\times10^7)+(1\times(1-0.4)\times1.1\times10^8)+(4\times(1-0.3)\times8\times10^7)+(2\times(1-0.3)\times1.6\times10^7)}{2GHz} \\ = 1.712\times10^{-1}s \end{aligned} \tag{21}$$

Speed up $\frac{2.56\times10^{-1}}{1.712\times10^{-1}} = 1.49$