Computer Architecture
Practical session - Week 1, Sping Semester 2019

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Question 1.

a.

$$IPS_{P1} = \frac{Clock\ rate}{CPI} = \frac{3\times10^9}{1.5} = 2\times10^9$$

$$IPS_{P2} = \frac{2.5\times10^9}{1.0} = 2.5\times10^9$$

$$IPS_{P2} = \frac{4.0\times10^9}{2.2} = 1.818\times10^9$$

So processor P2 has highest performance.

b.

$$Number\ of\ cycles_{P1} = Clock\ rate \times Time = 3\times10^9\times10 = 3\times10^{10}\ cycles$$

$$Number\ of\ cycles_{P2} = 2.5\times10^9\times10 = 2.5\times10^{10}\ cycles$$

$$Number\ of\ cycles_{P3} = 4.0\times10^9\times10 = 4.0\times10^{10}\ cycles$$

$$Number\ of\ instructions_{P1} = IPS \times Time = 2\times10^9\times10 = 2\times10^{10}\ instructions$$

$$Number\ of\ instructions_{P2} = 2.5\times10^9\times10 = 2.5\times10^{10}\ instructions$$

$$Number\ of\ instructions_{P3} = 1.818\times10^9\times10 = 1.818\times10^{10}\ instructions$$

c.

$$Clock\ rate_2 = \frac{ClockCycles_2}{Time_2} = \frac{Instructions\times CPI_2}{Time_2} = \frac{Instructions\times1.2\times CPI_1}{0.7\times Time_1}$$

$$. = \frac{1.2\times Clock\ rate_1}{0.7} = 1.71\times Clock\ rate_1$$

Question 2.

a.

$$IPC_{P1} = \frac{No.\ Instructions}{Clock\ rate\times Time} = \frac{20\times10^9}{3\times10^9\times7} = 0.952$$

$$IPC_{P2} = \frac{30\times10^9}{2.5\times10^9\times10} = 1.2$$

$$IPC_{P3} = \frac{90\times10^9}{4.0\times10^9\times9} = 2.5$$

b.

$$Clock\ rate_{P2} = \frac{Clock\ cycle}{Time} = \frac{Instructions}{Time \times IPC} = \frac{30 \times 10^9}{7 \times 1.2} = 3.57\,GHz$$

c.

$$No.\,Instruction_{P2new} = \frac{No.\,Instruction_{P2} \times Time_{P3}}{Time_{P2}} = \frac{30 \times 10^9 \times 9}{10} = 27 \times 10^9$$

Question3.

a.

$$CPU\ Time_{P1} = \frac{10^6 \times (0.1 \times 1 + 0.2 \times 2 + 0.5 \times 3 + 0.2 \times 3)}{2.5 \times 10^9} = 1.04\ ms$$

$$CPU\ Time_{P2} = \frac{10^6 \times 2}{3 \times 10^9} = 0.667\ ms$$

So the P2 is faster

b.

$$Global\,CPI_{P1} = 0.1 \times 1 + 0.2 \times 2 + 0.5 \times 3 + 0.2 \times 3 = 2.6$$

$$GlobalCPI_{P2} = 2$$

c.

$$Clock_{P1} = 10^6 \times 2.6 = 2.6 \times 10^6\ clock\ cycles$$

$$Clock_{P2} = 2 \times 10^6\ clock\ cycles$$

Question 4.

$$Exe.time = \frac{Instructions \times CPI}{Clock\ rate} = \frac{1000 \times (0.2 \times 2.5 + 0.1 \times 1 + 0.2 \times 2 + 0.5 \times 2)}{2 \times 10^9} = 9.5 \times 10^{-7}\ seconds$$

$$Average\,CPI = 0.2 \times 2.5 + 0.1 \times 1 + 0.2 \times 2 + 0.5 \times 2 = 1.9$$

$$t_2 = \frac{1000 \times (\frac{0.2 \times 2.5}{2} + 0.1 \times 1 + 0.2 \times 2 + 0.5 \times 2)}{2 \times 10^9} = 8.25\ s$$

$$Speedup: \frac{t_1}{t_2} = \frac{9.5}{8.25} = 1.15$$

Question 5.

$$Original\ model\ CPI: 0.25 \times 4 + 0.02 \times 20 + 0.73 \times 1.33 = 2.3709$$

$$Alternative\ 1: 0.25 \times 4 + 0.02 \times 2 + 0.73 \times 1.33 = 2.0109$$

$$Alternative\ 2: 0.25 \times 2.5 + 0.02 \times 20 + 0.73 \times 1.33 = 1.9959$$

So alternative model 2 is faster

$$\frac{H_2}{H_1} = \frac{CPI_1}{CPI_2} = \frac{2.0109}{1.9959} = 1.0075$$

Question 6.

a.

$$\frac{Time_1}{Time_2} = \frac{CPI_1}{CPI_2} = \frac{50\times10^6\times1 + 110\times10^6\times1 + 80\times10^6\times4 + 160\times10^6\times2}{50\times10^6\times NewCPI_{FP} + 110\times10^6\times1 + 80\times10^6\times4 + 160\times10^6\times2}$$

$$= \frac{8\times10^8}{50\times10^6\times NewCPI_{FP} + 7.5\times10^8} = 2$$

$$\Rightarrow No\ solution$$

b.

$$\frac{Time_1}{Time_2} = \frac{8\times10^8}{80\times10^6\times NewCPI_{L/S} + 4.8\times10^8} = 2$$

$$\Rightarrow No\ solution$$

c.

$$\frac{Time_2}{Time_1} = \frac{CPI_2}{CPI_1}$$

$$= \frac{50\times10^6\times1\times0.6 + 110\times10^6\times1\times0.6 + 80\times10^6\times4\times0.7 + 160\times10^6\times2\times0.7}{50\times10^6\times1 + 110\times10^6\times1 + 80\times10^6\times4 + 160\times10^6\times2}$$

$$= \frac{5.44\times10^8}{8\times10^8} = 0.68$$

$$\Rightarrow The\ exe.\ time\ is\ reduced\ 32\%$$