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CSIS 2810
T R 8:00-9:50 class

Complete Exercises 1.5 and 1.6 (p. 55)

1.5 Compare the following 3 processors:

P1:	3 GHz clock rate	CPI of 1.5
P2:	2.5 GHz clock rate	CPI of 1.0
P3:	4.0 GHz clock rate	CPI of 4.0

a. Which processor has the highest performance in instructions per second?

Clock rate = cycles/second

CPI = cycles/instruction

Seconds = (instructions * CPI)/(Clock rate) => seconds/instructions = CPI/Clock rate

=> instructions/second = clock rate/CPI

P1 = 3GHz / 1.5 = $2*10^9$

P2 = 2.5GHz/1.0 = $2.5*10^9$

P3 = 4GHz/4/0 = 10^9

So P2 has the highest performance in instructions per second.

b. Each processor executes a program in 10 seconds find the number of cycles and instructions.

P1 clock cycles = $10 * 3* 10^9 = 30*10^9$

P1 instructions = $(30 * 10^9)/1.2 = 25*10^9$

P2 clock cycles = $10 * 2.5* 10^9 = 25*10^9$

P2 instructions = $(25 * 10^9)/1.0 = 25*10^9$

P3 clock cycles = $10 * 4* 10^9 = 40*10^9$

P3 instructions = $(40 * 10^9)/4.0 = 10*10^9$

c. Reducing the execution time by 30% increases the CPI by 20%. What clock rate should we have to get this time reduction?

P1 CPI = 1.8

P1 time = 7

P1 clock rate = $(25*10^9 * 1.8)/7 \approx 6.42857*10^9$ or about 6.4 GHz

P2 CPI = 1.2

P2 time = 7

P2 clock rate = $(25*10^9 * 1.2)/7 \approx 4.2857*10^9$ or about 4.3 GHz

P3 CPI = 4.8

P3 time = 7

P3 clock rate = $(10*10^9 * 4.8)/7 \approx 6.857*10^9$ or about 6.9 GHz

1.6 Compare the following implementations of instruction set architecture:

P1: 2.5 GHz CPIs A,B,C and D are 1,2,3 and 3.

P2: 3 GHz CPIs A,B,C and D are 2,2,2 and 2.

Given program has instruction count of $1*10^6$

Instructions are divided into classes as follows:

A = 10%; B = 20%; C = 50%; D = 20%

$A = 1*10^5$; $B = 2*10^5$; $C = 5*10^5$; $D = 2*10^5$

Which implementation is faster?

P1 time = $[(1*10^5*1)+(2*10^5*2)+(5*10^5*3)+(2*10^5*3)]/(2.5*10^9)$

$= (10^5+4*10^5+15*10^5+6*10^5)/(2.5*10^9) = (2.6*10^6)/ (2.5*10^9)$

$= 1.04 * 10^{-3}$ seconds

P2 time = $[(1*10^5*2)+(2*10^5*2)+(5*10^5*2)+(2*10^5*2)]/3*10^9$

$= (2* 10^5+4*10^5+10*10^5+4*10^5)/(3*10^9) = (2*10^6)/ (3*10^9)$

$= 0.667 * 10^{-3}$ seconds

The implementation on P2 is about 1/3 faster than the implementation on P1

a. What is the global CPI for each implementation?

$CPI_1 = (2.5*10^9)/(10^6*1.04*10^3) = 2.5/1.04 \approx 2.4$

$CPI_2 = (3*10^9)/(10^6*0.667*10^3) = 3/0.667 \approx 4.5$

b. Find the clock cycles required in both cases.

P1 clock cycles = $2.4*10^6$

P2 instruction count = $4.5*10^6$