COMP2611: Computer Organization

Performance evaluation (Solution)

Question 1: Consider two hardware implementations (M1, M2) of the same instruction set. There are altogether four classes of instructions, for the instruction set, denoted them by A, B, C and D. Refer to the table below, answer the questions:

Hardware	Clock rate MHz	Clock Cycles required Per Instruction (CPI)			
		A	B	C	D
M1	500	1	2	3	4
M2	750	2	2	4	4

A) If the proportions of instructions in a program are ¼, ¼, ¼, ¼ for all the instruction classes. Which implementation is faster for this program? By how much?

B) What would be the clock rate for M1 so that it would have the same performance as M2 for the same program?

Exercises

Solutions

A) Assume the program has N instructions.

The total number of cycles required for M1 is (¼+2/4+3/4+4/4)*N, time required is (¼+2/4+3/4+4/4)*N/(500*10^6)

= 5N*10^-9

The total number of cycles required for M2 is (2/4+2/4+4/4+4/4)*N, time required is (2/4+2/4+4/4+4/4)*N/(750*10^6) = 4N*10^-9

=> M2 faster, 5/4-1=25%

B) 1.25*500=625MHz

- Question 2: A program runs on a machine with a clock rate of 1.5GHz. The program will be compiled by three different compilers, each compiler will generate a mixture of instructions as shown in the table below.

Instruction class	Clock cycles required	Compiler X Percentage of Instructions	Compiler Y Percentage of instructions	Compiler Z Percentage of Instructions
A	5	30%	Number of instructions reduced by 5% for all classes of instructions	Same no. of instructions as X
B	2	20%		Same no. of instructions as X
C	3	50%		60% as many as X

Exercises

A) What is the CPI of the instructions generated by compiler X?

B) What is the CPI of the instructions generated by compiler Y?

C) What is the CPI of the instructions generated by compiler Z?

D) Which compiler is the best in terms of execution time? Does that agree with the CPI numbers? For this case can we compare the performance by referring to CPIs, why?

Exercises

Solutions

A) CPI(x) = (5*.3*N+2*.2*N+3*.5*N)/N=3.4N/N=3.4 cycles

B) CPI(y)= (5*.3*N+2*.2*N+3*.5*N*.95)/N*9.5=3.4 cycles

C) CPI(z)=(5*.3*N+2*.2*N+3*.5*.6*N)/(.3+.2+.5*.6)N = 3.5 cycles

D) Execution time

T(x) = 3.4N/1.5G = 2.267N*10^-9

T(y) = 3.4*.95N/1.5G= 2.153N*10^-9

T(z) = 3.5*0.8N/1.5G = 1.867N*10^-9

Question 3: By referring to the following chart, answer the question

Program A	Instruction count	Clock rate	Execution Time (seconds)
Machine M1	$200*10^6$	200 MHz	X
Machine M2	$160*10^6$	300 MHz	Y

A) What are the CPIs of the program on M1 and M2 in terms of X and Y?

B) What is the ratio of CPI_M1/CPI_M2 that would give the same execution time for both M1 and M2?

Exercises

Solutions

A) M1 CPI: X*200*10^6/200*10^6=X
M2 CPI: Y*300*10^6/160*10^6=1.875Y

B) X=Y then CPI_M1/CPI_M2 = x/1.875x=1:1.875

Question 4: Judge whether the given information is adequate for solving the problem.

	Information provided	Question to answer
A)	1. Total number of instructions for a program 2. MIPS rating of the program on a machine	CPI of the program on the machine?
B)	1. A program is compiled by two compilers C1, C2. The sets of instructions are run on the same machine. 2. Ratio of CPI(C1)/CPI(C2) 3. No. of instructions generated by C1 and C2 are the same.	Which compiler gives a better performance (running time) for the program.
C)	1. Clock rates of two machines, A and B. 2. CPI of a program on machines A, and B	Which machine give better execution time for the program.

Exercises

Solutions

A) no coz don't know the clock rate

B) Yes, CPI_c1*# of instructions_c1/ CPI_c1*# of instructions_c1 can be derived, same machine, so question can be answered

C) No, # of instructions unknown