**Tutorial 3: WRES1201 Computer System Architecture**

1. A benchmark program is run on an 80 MHz processor. The executed program consists of 100,000 instruction execution, with the following instruction mix and clock cycle count:

|  |  |  |
| --- | --- | --- |
| Instruction Type | Instruction Count | Cycle per Instruction |
| Integer Arithmetic | 45000 | 1 |
| Data Transfer | 32000 | 2 |
| Floating Point | 15000 | 2 |
| Control Transfer | 8000 | 2 |

Determine the effective CPI, MIPS rate, and execution time for this program

CPI = fT/N and MIPS = f/CPI

CPI = 1.55, MIPS 51.61, Exec Time = 1.93ms

1. The performance of a 100MHz microprocessor P is measured by executing 10,000,000 instruction of benchmark code, which is found to take 0.25s. What are the values of CPI and MIPS for this performance experiment? Is P likely to be superscalar?

CPI = 2.5, MIPS 40, P not superscalar bcos CPI not < 1

1. Suppose that a single-chip microprocessor P operating at clock frequency of 50MHz is replaced by a new model P’, which has the same architecture as P but has a clock frequency of 75MHz.
   1. If P has a performance rating of p MIPS for a particular benchmark program Q, what is the corresponding MIPS rating p’ for P

Same archi = same CPI = c

p=50/c & p'=75/c;

p' = (75/50)p = 1.5p

* 1. P takes 250s to execute Q in a particular personal computer system C. On replacing P by P’ in C, the execution time of Q drops only to 220s. Suggest a possible reason for this disappointing performance improvement.

Let Q = 250/1.5 = 167s

1. Suppose we have two implementations of the same instruction set architecture. Computer A has a clock cycle time of 250 ps and a CPI of 2.0 for a given benchmark program, and computer B has a clock cycle time of 500ps and a CPI of 1.2 for the same program. Which computer is faster for this program and by how much?

**Given Computer CycleTime(ps) CPI**

**A 250 2.0**

**B 500 1.2**

**we have, assuming I instructions are executed:**

**CPUtime(A) = I  clockCycles(A)  cycleTime (A)**

**= I  2.0  250 ps = 500  I ps**

**CPUtime(B) = I  clockCycles(B)  cycleTime (B)**

**= I  1.2  500 ps = 600  I ps**

**Hence A is faster by 600/500 or 1.2**

1. When a CPU and its main memory M operate at similar speeds, a one-word load or store can be completed in a single CPU clock cycle. The CPU is often designed to function properly with slower memory technologies. Why and how to do that?
2. A compiler designer is deciding between two codes for a particular machine. Based on the hardware implementation, there are three different classes of instructions: Class A, Class B, and Class C, and they require one, two, and three cycles respectively.

First code has 5 instructions: 2 of A, 1 of B, and 2 of C.

Second code has 6 instructions: 4 of A, 1 of B, and 1 of C.

Which code is faster?

By how much?

What is the CPI for each code?

# of cycles1 = 2 x 1 + 1 x 2 + 2 x 3 = 10

# of cycles2 = 4 x 1 + 1 x 2 + 1 x 3 = 9 So, sequence 2 is 1.1 times faster

CPI1 = 10 / 5 = 2

CPI2 = 9 / 6 = 1.5