CSE 340

Assignment 1

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sec: 08

Ans to Q 1

(1)

Cycles for play station = $0.3 \times 10^6 \times 7 + 0.5 \times 10^6 \times 2$
$+ 0.1 \times 10^6 \times 3 + 0.1 \times 10^6 \times 6$
$= 4000000$

Cycles for Xbox = $0.3 \times 10^6 \times 5 + 0.5 \times 10^6 \times 4 +$
$0.1 \times 10^6 \times 2 + 0.1 \times 10^6 \times 1$
$= 3800000$

$\therefore$ Avg CPI (Playstation) $= \frac{4 \times 10^6}{10^6} = 4$

Avg CPI (Xbox) $= \frac{3.8 \times 10^6}{10^6} = 3.8$

$\therefore$ Play station takes $(4 - 3.8) = 2$ clock cycles per instruction on average.

(2)

Execution time (Play station) $= \frac{\text{cycles}}{\text{Clock rate}} = \frac{4 \times 10^6}{2.7 \times 10^9}$

$= 1.48 \times 10^{-3}$ s

$= 1.48$ ms

Ex time (xbox) $= \frac{38 \times 10^5}{3 \times 10^9} = 1.26$ ms

∴ Difference $= 1.48 - 1.26 = \underline{0.22 \text{ ms}}$

(3)

Playstation SPEC Ratio $= \frac{120}{1.48} = \underline{81.08}$

a) Algorithm: Algorithm determins how many instruction count there will be along with other time complexities which affects CPU time or performance.

b) Compiler can affect IC by reducing redundant instructions which decreases avg CPI as well.

c) ISA determins set of instructions and it affects IC, CPI (based on ISA design) CCT which affects the CPU time.

Ans to Q 2

(1)

$$CPI = \frac{CPU\ time}{IC \times CCT} = \frac{540}{1.35 \times 10^{12} \times 0.25 \times 10^{-9}}$$

$$= \underline{1.6}$$

(2)

$$\text{New } CPI = \frac{105 \times 1.6}{100} = 1.68$$

$$\text{New } IC = \frac{115}{100} \times 1.35 \times 10^{12} = 1.55 \times 10^{12}$$

$$CCT = 0.25 \times 10^{-9} s$$

$$CPU\ time = 1.68 \times 1.55 \times 10^{12} \times 0.25 \times 10^{-9}$$

$$= 652.05 s$$

$$\text{Spec ratio} = \frac{1394}{652.05} = \underline{2.137}$$

Ans to Q 3

① $x20 \quad x20 \quad x21$
$X = 2X + Y;$

$\Rightarrow X = X + X + Y;$ (X → $x20$, Y → $x21$)

RISC-V :

```
add x5, x20, x20
add x20, x5, x21
```

② $x21 \quad x9$
$Y = 20 + A[5];$

RISC-V :

```
lw x9, 20(x22)
addi x21, x9, 20
```

x9

③ A[4] = A[2] + x20;

Risc-v:

lw x9, 8(x22)

add x9, x9, x20

sw x9, 16(x22)

(4)

a) Algorithm: Algorithm determins how many instruction count there will be along with other time complexities which affects CPU time or performance.

b) Compiler can affect IC by reducing redundant instructions which decreases avg CPI as well.

c) ISA determins set of instructions and it affects IC, CPI (based on ISA design), CCT which affects the CPU time.

BRAC University

CSE340: Computer Architecture

Assignment 1 [MSDH]

Chapter 1 (Computer Abstractions and Technology)
Chapter 2 (Till Immediate Operands)

Total Marks: 15 (Marks are indicated in third brackets after each question)

[CO1] Question 1 [Marks: 7]

Suppose gaming consoles PlayStation 5 and Xbox Series X use different implementations of AMD's Zen 2 architecture. The instructions they support can be divided into four classes according to their CPI (class A, B, C, and D).

PlayStation has a clock rate of 2.7 GHz and the instruction classes have CPIs of 7, 2, 3 and 6 respectively whereas Xbox has a clock rate of 3.0 GHz and the instruction classes have CPIs of 5, 4, 2 and 1 respectively.

Now suppose, a program has a instruction count of 1.0 ∗ 10^6 and the instructions are divided into classes as follows:
30% class A,
50% class B,
10% class C,
10% class D.

Now answer the following questions:

1. **Calculate** how many more clock cycles per instruction on average does the PlayStation take compared to the Xbox? **[2 Marks]**
2. **Calculate** the difference between the execution time in these two consoles in milliseconds **[2 Marks]**
3. If the program runs on a reference PC with an execution time of 120 milliseconds, **calculate the** SPECRatio for the Playstation **[1 Mark]**
4. **Explain** how the performance is affected by Algorithm, Compiler and ISA. **[2 Marks]**

[CO1] Question 2 [Marks: 3]

Suppose you are calculating the performance of a program in your PC using the SPEC CPU2006 hjig benchmark program. Your pc is running on an intel Core i9 and it takes 540s to execute the program which has an instruction count of $1.35 * 10^{12}$. The reference time which is provided is 1394 s.

1. **Calculate** the CPI if the clock cycle time is 0.25 ns. **[1.5 Marks]**
2. If the number of instructions of the program is increased by 15%, the CPI is increased by 5% and the clock cycle time is 0.25 ns, then **calculate** the new SPECRatio for this change. **[1.5 Marks]**

[CO2] Question 3 [Marks: 5]

Let us consider a set of C Code instructions given below. Here, X and Y are in registers x20, x21 and the base address of A is in register x22. Convert the following C Code to its equivalent RISC-V Code using the 32-Bit Architecture. ***(Remember, you cannot use the mul/div functions or any shift operations)***:

X = 2X + Y;

Y = 20 + A[5];

A[4] = A[2] + X;