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**EE488 - Computer Architecture**

**Quiz #1**

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1. Assuming that there are three different processors, *Proc1, Proc2* and *Proc3* for the same instruction set, *Proc1* has a CPI of *2.5* with *4* GHz clock rate, a CPI of *2.0* with *3* GHz clock rate in *Proc2*, and a CPI of *2.1* with *3.8* GHz clock rate in *Proc3*
   1. Which processor has the highest performance for the instructions per second?
   2. If each processor executes a program in 12 seconds, what is the number of cycles and the number of instructions respectively?
   3. When reducing the execution time by 25% but this leads to an increase of 22% in the CPI, what clock rate should have for the time reduction?

**Answer:**

According to question’s data,

For *Proc1*: CPI is = 2.5,

Clock rate = 4 GHz

For *Proc2*: CPI = 2.0,

Clock rate = 3 GHz

For *Proc3*: CPI = 2.1,

Clock rate = 3.8 GHz

1. Which processor has the highest performance for the instructions per second?

We know,

The formula is: Instruction per second (IPS), IPS= (Clock Rate / CPI)

For *Proc1*:

IPS for *Proc1* ​= (4×109​ / 2.5) = 1.6×109

For *Proc2*:

IPS for *Proc2* = (3×109​ / 2.0) = 1.5×109

For *Proc3*:

IPS for *Proc3* ​= (3.8×109​ / 2.1) = 1.8095×109

We can write,

*Proc3* has the highest performance with 1.8095×109 instructions per second.

1. If each processor executes a program in 12 seconds, what is the number of cycles and the number of instructions respectively?

We know,

Number of Cycles = (Clock Rate x Execution Time)

Number of Instructions = (Number of Cycles / CPI)

For *Proc1*:

Number of Cycles for *Proc1* = (4 x 109 x 12) = 48 x 109

Number of Instructions for *Proc1* = (48 x 109 / 2.5) = 19.2 x 109

For *Proc2*:

Number of Cycles for *Proc2* = (3 x 109 x 12) = 36 x 109

Number of Instructions for *Proc2* = (36 x 109 / 2.0) = 18 x 109

For *Proc3*:

Number of Cycles for *Proc3* = (3.8 x 109 x 12) = 45.6 x 109

Number of Instructions for *Proc3* = (45.6 x 109 / 2.1) = 21.7143 x 109

We can write,

The number of cycles and number of instructions for each processor:

For *Proc1*: 48 billion cycles, 19.2 billion instructions.

For *Proc2*: 36 billion cycles, 18 billion instructions.

For *Proc3*: 45.6 billion cycles, 21.7143 billion instructions.

1. When reducing the execution time by 25% but this leads to an increase of 22% in the CPI, what clock rate should have for the time reduction?

Given data,

Reduce execution time = 25%

Original time = 12 seconds

CPI increase = 22%

And,

New execution time = 75% of original time = (0.75 x 12) = 9 seconds

For *Proc1*:

New CPI for *Proc1* = (2.5 x 1.22) = 3.05

Required Clock Rate:

We know,

Clock Rate = (Number of Cycles / Execution Time)

Number of Instructions=19.2 x 109

Again, we know,

Number of Cycles = New CPI x Number of Instructions

= (3.05 x 19.2 x 109)

= 58.56 x 109

Required Clock Rate = (58.56 x 109 / 9) = 6.5067 GHz

For *Proc2*:

New CPI for *Proc2* = (2.0 x 1.22) = 2.44

Required Clock Rate:

We know,

Clock Rate = (Number of Cycles / Execution Time)

Number of Instructions=18 x 109

Again, we know,

Number of Cycles = New CPI x Number of Instructions

= (2.44 x 18 x 109)

= 43.92 x 109

Required Clock Rate = (43.92 x 109 / 9) = 4.88 GHz

For Proc3:

New CPI for *Proc3* = (2.1 x 1.22) = 2.562

Required Clock Rate:

We know,

Clock Rate = (Number of Cycles / Execution Time)

Number of Instructions=21.7143 x 109

Again, we know,

Number of Cycles = New CPI x Number of Instructions

= (2.562 x 21.7143 x 109)

= 55.63 x 109

Required Clock Rate = (55.63 x 109 / 9) = 6.1811 GHz

Therefore, we can write,

After reducing execution time by 25% and increasing CPI by 22%, then Required

clock rates will be:

Required clock rate for *Proc1*: 6.5067 GHz

Required clock rate for *Proc2*: 4.88 GHz

Required clock rate for *Proc3*: 6.1811 GHz