1.3. Describe the steps that transform a program written in a high-level language such as C into a representation that is directly executed by a computer processor.

Compiler reads the high-level source code and translates it into a program in assembly language.

Then assembler transforms the program in assembly language into a program in machine language, which is what a computer understands and can execute directly.

1.5. Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3.0 GHz clock rate and CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and a CPI of 2.2.

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

*CPU time =*

*= = IPS*

1GHz = 109 Hz

IPS1 = 3/1.5 = 2109

IPS2 = 2.5/1 = 2.5109

IPS3 = 4/2.2 = 1.82109

Therefor P2 has the higher performance in instructions per second.

  b. If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

*Instructions = IPSCPU time*

*CPU time =*

*clock cycles = CPU time clock rate*

p1: instructions = IPS1 CPU time =2 109  10

clock cycles = CPU time clock rate = 10 3 109

p2: instructions = IPS2 CPU time =2.5 109  10

clock cycles = CPU time clock rate = 10 2.5 109

p3: instructions = IPS3 CPU time =1.82 109  10

clock cycles = CPU time clock rate = 10 4 109

|  |  |  |
| --- | --- | --- |
| Processor | instructions | cycles |
| P1 | 21010 | 31010 |
| P2 | 2.51010 | 2.51010 |
| P3 | 1.821010 | 41010 |

  c. We are trying to reduce the execution time by 30% but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

*Execution time =*

*clock cycles = instructions CPI*

*Execution time =*

*1.2/0.7 – 1* ≈ *71%*

It must be increased by ≈ 71%

*f* = No. instr. x CPI / (execution time), then

*f*(P1) = 3.0x109 x 1.2 / 0.7 = 5.14 GHz

*f*(P2) = 2.5x109 x 1.2 / 0.7 = 4.29 GHz

*f*(P3) = 4.0x109 x 1.2 / 0.7 = 6.86 GHz