$CPU时钟周期数 = 程序指令数 \times CPI$

$CPU时间 = 程序指令数 \times CPI$ ×时钟周期

CPI (Average Clocks Per Instruction)

表示每条计算机指令执行所需的时钟周期

1. If computer A and Computer B are 8Mhz and 3Ghz respectively, what is their clock times respectively?

Solution: A: 1/8 * 10 -6 sec.

B: 1/3 * 10-9 sec.

2.There are 4 classes of instructions, A, B, C, D. Suppose compiler has two choices: Sequence 1 and Sequence 2, as described below:

Class	A	B	C	D
CPI for class	1	2	1	3
IC in sequence 1	3	1	5	1
IC in sequence 2	2	4	1	3

Which choice will be better? Why?

Solution:
Sequence 1: IC =3+1+5+1=10.
Clock cycle = 3*1 + 1*2 + 5*1 + 1*3 = 13.
Avg CPI = 13/10 = 1.3
Sequence 2: IC = 2+4+1+3=10.
Clock cycle = 2*1 + 4*2 + 1*1 + 3*3 = 20.
Avg CPI = 20/10 = 2.
Sequence 1 has lower avg CPI, so it is better.

3. Computer A has 5GHz clock. It takes 100s CPU time to finish one given task. We want to design Computer B to finish the same task within 20s CPU time. The clock cycle number for computer B is 2 times as that of Computer A. So, what clock rate should be designed for Computer B?

$CPU时间 = 时钟周期数$ ×时钟周期

$CPU时间1 = 时钟周期数1 \times$时钟周期 1

$时钟周期数1 = CPU时间1/$时钟周期 1

$时钟周期数2 = 时钟周期数1 \times 2$

$CPU时间2 = 时钟周期数2 \times$时钟周期 2

$$时钟周期\ 2 = \frac{CPU时间2}{时钟周期数2} = \frac{20}{2 \times 时钟周期数1} = \frac{20}{2 \times 100 \times 5 \times 10^9}$$

$f2 = 50GHZ$

Clock rate (CR) = Clock Cycle/CPU Time

Clock CycleA = CRA * CPUA = 5*10^9 * 100s=500*10^9

Clock CycleB = 2 Clock Cycle A = 2*500*10^9=1000*10^9

CPUB = 20s

So Clock RateB = Clock CycleB /CPUB = (1000/20) * 10^9 = 50 GHz

4.There are two computers: A and B.

Computer A: Cycle Time = 500ps, CPI = 4.0

Computer B: Cycle Time = 200ps, CPI = 5.0

If they have the same ISA, which computer is faster? How many times it is faster than another? what clock rate should be designed for Computer B?

Solution:

CPU = IC * CPI * Cycle time
So
CPUA = IC*4*500 = 2000*IC
CPUB = IC*5*200 = 1000*IC
So B is (2000/1000) = 2 times faster.

5 <§1.6> Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3 GHz clock rate and a 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 has a CPI of 2.2.

a. Which processor has the highest performance expressed 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.

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?

If they have the same ISA, which computer is faster? How many times it is faster than another?

$$T_1 = \mathrm{I} \times 1.5 \times \frac{1}{3 \times 10^9}$$

$$T_2 = \mathrm{I} \times 1 \times \frac{1}{2.5 \times 10^9}$$

$$T_3 = \mathrm{I} \times 2.2 \times \frac{1}{4 \times 10^9}$$

performance of P1 (instructions/sec) ＝ 3 × 10^9/1.5=2* 10^9

performance of P2 (instructions/sec) ＝ 2.5 ×10^9/1.0 = 2.5 × 10^9

performance of P3 (instructions/sec) ＝ 4 × 10^9/2.2 ＝1.8 ×10^9

P2最好

b. cycles(P1) =10 * 3 *10^9 _=30 * 10^9 s

cycles(P2) =10 * 2.5 *10^9 = 25 * 10^9 s

cycles(P3) =10 *4 * 10^9 =40 *10^9 s

C:

No. instructions(P1) =30 * 10^9/1.5 = 20 *10^9

No. instructions(P2) = 25 * 10^9/1 = 25 * 10^9

No. instructions(P3) = 40 * 10^9/2.2 =18.18* 10^9

在指令数不变，CPI增加到原来的1.2倍的情况下，若需要CPU时间减少至原来的0.7倍，则时钟频率需增加到原来的12/7倍

即P1: 3*12/7=5.14GHz

P2: 2.5*12/7=4.18GHz

P3: 4.0*12/7=6.86GHz

P2最好　是P1的25/20=1.25倍　是P3的25/18.18=1.375倍