

Homework#1 Solutions

1.2

- A. Performance via pipelining
- B. Dependability via redundancy
- C. Performance via prediction
- D. Make the common case fast
- E. Hierarchy of memory
- F. Performance via parallelism
- G. Use abstraction to simplify design

1.7

Instruction Class	P1	P2
A	1	2
B	2	2
C	3	2
D	3	2

We first calculate the instruction count for each class :

$$IC(ClassA) = 10\% \times 1.0 \times 10^6 = 1.0 \times 10^5$$

$$IC(ClassB) = 20\% \times 1.0 \times 10^6 = 2.0 \times 10^5$$

$$IC(ClassC) = 50\% \times 1.0 \times 10^6 = 5.0 \times 10^5$$

$$IC(ClassD) = 20\% \times 1.0 \times 10^6 = 2.0 \times 10^5$$

To calculate the time for each implementation, we need to multiply the instruction count with CPI and CT.

$$ET = IC \times CPI \times CT$$

$$CT(P1) = \frac{1}{frequency} = \frac{1}{2.5GHz} = \frac{1}{2.5 \times 10^9} = 4 \times 10^{-10}s$$

$$CT(P2) = \frac{1}{frequency} = \frac{1}{3GHz} = \frac{1}{3 \times 10^9} = 3.3333 \times 10^{-10}s$$

$$ET(P1) = (1.0 \times 10^5 \times 1 + 2.0 \times 10^5 \times 2 + 5.0 \times 10^5 \times 3 + 2.0 \times 10^5 \times 3) \times 4 \times 10^{-10} = 1.04 \times 10^{-3}s$$

$$ET(P2) = (1.0 \times 10^5 \times 2 + 2.0 \times 10^5 \times 2 + 5.0 \times 10^5 \times 2 + 2.0 \times 10^5 \times 2) \times 3.3333 \times 10^{-10} = 6.67 \times 10^{-4}s$$

$$CPI(P1) = \frac{\text{total cycles}}{\text{total IC}} = \frac{ET(P1) \times \text{frequency}}{IC(P1)}$$

$$CPI(P2) = \frac{\text{total cycles}}{\text{total IC}} = \frac{ET(P2) \times \text{frequency}}{IC(P2)}$$

$$CPI(P1) = \frac{1.04 \times 10^{-3} \times 2.5 \times 10^9}{10^6} = 2.6$$

$$CPI(P2) = \frac{6.67 \times 10^{-4} \times 3.0 \times 10^9}{10^6} = 2.0$$

$$\text{Clock cycles}(P1) = CPI \times IC = 2.6 \times 10^6$$

$$\text{Clock cycles}(P2) = CPI \times IC = 2.0 \times 10^6$$

1.8

A.

$$ET = IC \times CPI \times CT$$

$$CPI = \frac{ET}{CT \times IC}$$

$$CPI(\text{compiler A}) = \frac{1.1}{1 \times 10^{-9} \times 1.0 \times 10^9} = 1.1$$

$$CPI(\text{compiler B}) = \frac{1.5}{1 \times 10^{-9} \times 1.2 \times 10^9} = 1.25$$

B.

Let's assume the CT(A)

$$\frac{ET(B)}{ET(A)} = \frac{IC(B) \times CPI(B) \times CT(B)}{IC(A) \times CPI(A) \times CT(A)}$$

$$\frac{ET(B)}{ET(A)} = \frac{1.2 \times 10^9 \times 1.25 \times CT(B)}{1.0 \times 10^9 \times 1.1 \times CT(A)} = 1.36 \frac{CT(B)}{CT(A)}$$

Also, we know that $ET(B)$ is equal to $ET(A)$, so we have

$$1.36 \frac{CT(B)}{CT(A)} = 1$$

Simplifying this gives us:

$$\frac{CT(B)}{CT(A)} = \frac{1}{1.36}$$

This implies :

$$\frac{frequency(B)}{frequency(A)} = 1.36$$

C.

$$\frac{ET(A)}{ET(new)} = \frac{1.1}{1.1 \times 6 \times 10^8 \times 10^{-9}} = 1.67$$

$$\frac{ET(B)}{ET(new)} = \frac{1.5}{1.1 \times 6 \times 10^8 \times 10^{-9}} = 2.27$$