CPTG445 HW 1

1. Assume a color display using 8 bits for each of the primary colors (red, green, blue) per pixel and a frame size of 1280 x 1024.

   a) What is the minimum size in bytes of the frame buffer to store a frame?

   b) How long would it take, at a minimum, for the frame to be sent over a 100 Mbit/s network?

   Answer

   1.4

   a. \(1280 \times 1024 \text{\ pixels} = 1,310,720 \text{\ pixels} = 3,932,160 \text{\ bytes/frame.}\)

   b. \(3,932,160 \text{\ bytes} \times (8 \text{\ bits/byte}) / 100 \times 10^6 \text{\ bits/second} = 0.31 \text{\ seconds}\)

2. Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2.

   a) Given a program with a dynamic instruction count of \(1.0 \times 10^6\) instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which is faster: P1 or P2?

   b) What is the global CPI for each implementation?

   c) Find the clock cycles required in both cases.

   Answer

   1.6

   a. Class A: \(10^6\) instr. Class B: \(2 \times 10^6\) instr. Class C: \(5 \times 10^6\) instr. Class D: \(2 \times 10^6\) instr.

   \[
   \text{Time} = \text{No. instr.} \times \text{CPI/clock rate}
   \]

   Total time P1 = \(\frac{10^6 + 2 \times 10^6 \times 2 + 5 \times 10^6 \times 3 + 2 \times 10^6 \times 3}{2.5 \times 10^6} = 10.4 \times 10^{-4} \text{\ seconds}\)

   Total time P2 = \(\frac{2 \times 10^6 \times 2 + 2 \times 10^6 \times 2 + 5 \times 10^6 \times 2 + 2 \times 10^6 \times 2}{3 \times 10^6} = 6.66 \times 10^{-4} \text{\ seconds}\)

   CPI(P1) = \(10.4 \times 10^{-4} 	imes \frac{2.5 \times 10^6}{10^6} = 2.6\)

   CPI(P2) = \(6.66 \times 10^{-4} \times \frac{3 \times 10^6}{10^6} = 2.0\)

   b. clock cycles(P1) = \(10^6 \times 1 + 2 \times 10^6 \times 2 + 5 \times 10^6 \times 3 + 2 \times 10^6 \times 3 = 26 \times 10^9\)

   clock cycles(P2) = \(10^6 \times 2 + 2 \times 10^6 \times 2 + 5 \times 10^6 \times 2 + 2 \times 10^6 \times 2 = 20 \times 10^9\)
3. Consider a computer running a program that requires 250 s, with 70 s spent executing Floating Point (FP) instructions, 85 s executing Load/Store (L/S) instructions, 40 s spent executing branch (BR) instructions, and 55 s spent executing Integer (INT) instructions.

a) By how much is the total time reduced if the time for FP instructions is reduced by 20%?

b) By how much is the time for INT instructions reduced if the total time is reduced by 20%?

c) Can the total time be reduced by 20% by reducing only the time for branch instructions?

**Answer**

1.13

1.13.1 $T_{fp} = 70 \times 0.8 = 56$ s. $T_{new} = 56 + 85 + 55 + 40 = 236$ s. Reduction: 5.6%

1.13.2 $T_{new} = 250 \times 0.8 = 200$ s. $T_f + T_{ls} + T_{branch} = 165$ s. $T_{int} = 35$ s. Reduction time INT: 58.8%

1.13.3 $T_{new} = 250 \times 0.8 = 200$ s. $T_f + T_{int} + T_{ls} = 210$ s. NO