

I pledge my honor that I have abided by the Stevens Honor System. -Eric Altenburg

## Chapter 2

1. // Assign a temp register to X9  
SUB X9, X2, #5  
ADD X0, X1, X9

3. // Assign a temp register to X9  
SUB X9, X3, X4  
LSL X9, X9, #3  
ADD X9, X9, X6  
LDUR X10, [X9, #0]  
STUR X10, [X7, #64]

4. B[g] = A[f] + A[f+1];

5. LSL X9, X0, #3  
ADD X9, X6, X9  
LSL X10, X1, #3  
ADD X10, X7, X10  
LDUR X0, [X9, #0]

LDUR X9, [X9, #8] // This is the combined LEGv8 code  
ADD X9, X9, X0  
STUR X9, [X10, #0]

9. f = &A[0] + &A[0];

10. ADDI X9, X6, #8

opcode	immediate	Rn	Rd
1001000100	000000001000	00110	01001
580	8	6	9

ADD X10, X6, XZR

opcode	Rm	shamt	Rn	Rd
10001011000	11111	000000	00110	01010
1112	31	0	6	10

STUR X10, [X9, #0]

opcode	address	op2	Rn	Rt
11111000000	000000000	00	01001	01010
1984	0	0	9	10

LDUR X9, [X9, #0]

opcode	address	op2	Rn	Rt
11111000010	000000000	00	01001	01001
1986	0	0	9	9

ADD X0, X9, X10

opcode	Rm	shamt	Rn	Rd
10001011000	01010	000000	01001	00000
1112	10	0	9	0

22.  $X1 = 2$

25. (1)  $X0 = 20$

41. All numbers are in terms of  $10^6$ , however, in the following equations, I removed it to make them more readable.

(1)

$$\begin{aligned}
 CPI_0 &= 1 * \frac{500}{900} + 10 * \frac{300}{900} + 3 * \frac{100}{900} \\
 &= \frac{500}{900} + \frac{3000}{900} + \frac{300}{900} \\
 &= \frac{3800}{900} \\
 &= 4.\bar{2}
 \end{aligned}$$

$$\begin{aligned}
 \text{Arithmetic Instructions} &= 0.75 * 500 \\
 &= 375
 \end{aligned}$$

$$\begin{aligned}
 CPU_0 &= CPI_0 * f * 900 \\
 &= 3800f
 \end{aligned}$$

$$\begin{aligned}
 CPI_{new} &= 1 * \frac{375}{775} + 10 * \frac{300}{775} + 3 * \frac{100}{775} \\
 &= \frac{375}{775} + \frac{3000}{775} + \frac{300}{775} \\
 &= \frac{3675}{775} \\
 &= 4.74
 \end{aligned}$$

$$\begin{aligned}
 CPU_{new} &= CPI_{new} * f * 775 * 1.10 \\
 &= 4042.5f
 \end{aligned}$$

This would not be a good idea as the total execution time has increased from what it used to be.

(2)

$$\begin{aligned}
 \text{Arithmetic } CPI_{new} &= 1 * \frac{1}{2} = \frac{1}{2} \\
 CPI_{new} &= \frac{1}{2} * \frac{500}{900} + 10 * \frac{300}{900} + 3 * \frac{100}{900} \\
 &= 3.9\bar{4} \\
 Speedup_{formula} &= \frac{high}{low} \\
 Speedup_{arithmetic} &= \frac{4.2}{3.9\bar{4}} = 1.07 \\
 &\text{7\% increase}
 \end{aligned}$$

$$\begin{aligned}
 \text{Arithmetic } CPI_{10 \text{ times}} &= 1 * \frac{1}{10} = \frac{1}{10} \\
 CPI_{10 \text{ times}} &= \frac{1}{10} * \frac{500}{900} + 10 * \frac{300}{900} + 3 * \frac{100}{900} \\
 &= 3.7\bar{2} \\
 Speedup_{10 \text{ times}} &= \frac{4.2}{3.7\bar{2}} = 1.13 \\
 &\text{13\% increase}
 \end{aligned}$$

42. (1)

$$\begin{aligned}
 CPI_{avg} &= 0.7 * 2 + 0.1 * 6 + 0.2 * 3 \\
 &= 2.6
 \end{aligned}$$

(2)

$$\begin{aligned}
 IPC_0 &= 1/2.6 = 0.3846 \\
 IPC_{new} &= IPC_0 * 1.25 = .4808 \\
 CPI_{new} &= \frac{1}{IPC_{new}} = 2.08 \\
 CPI_{new} &= 0.7 * \text{Arithmetic Cycles} + 0.1 * 6 + 0.2 * 3 \\
 2.08 &= 0.7 * \text{Arithmetic Cycles} + 1.2 \\
 0.7 * \text{Arithmetic Cycles} &= 0.88 \\
 \text{Arithmetic Cycles} &= 1.2571 \approx 1
 \end{aligned}$$

It doesn't make sense to have a float for the number of cycles, so it was approximated to 1.