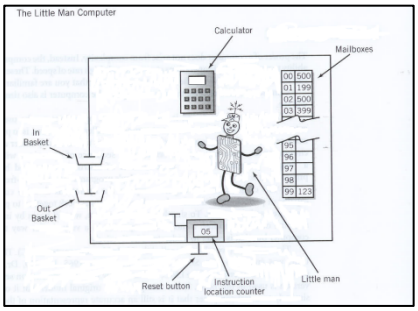
Name – Jay Kalyanbhai Savani
CWID - 20009207
Chapter 6 The Little Man Computer

Consider this model of the LMC and answer the questions below.



Discussion Questions

Please refer to this table of op codes for the discussion questions

Opcode	Definition
0	Halt
1	ADD
2	SUBTRACT
3	STORE
5	LOAD
6	BRANCH UNCONDITIONALLY
7	BRANCH ON ZERO
8	BRANCH ON POSITIVE
901	INPUT
902	OUTPUT

1) Using the LMC program below, add comments to explain what the result (value in the calculator) is after the completion of eachinstruction. The first one is completed as an example.

Mailbox	Contents	Result after completion
00	901	*Read contents from in basketand store in calculator*
01	319	
02	901	
03	320	
04	219	
05	709	
06	518	
07	902	
08	000	
09	517	

10	902
11	000
---	---
17	DAT
18	DAT
19	DAT
20	DAT

Sol:

Mailbox	Contents	Result after completion
00	901	Read contents from the basket and stores in calculator
01	319	Store the value of the calculator in the 19 mailbox
02	901	Read contents from the basket and stores in calculator
03	320	Store the value fo the calculator in the 20 mailbox
04	219	Subtract the value in the calculator by the value in 19 mailbox
05	709	Branch to 09 mailbox if calculator is 0
06	518	Load value in 09 mailbox to calculator
07	902	Move value in calculator to out basket
08	000	Halt
09	517	Load value in 17 mailbox to calculator
10	902	Move value in calculator to out basket
11	000	Halt
---	---	
17	DAT	
18	DAT	
19	DAT	
20	DAT	

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

2) Refer to the LMC program in question (1). Suppose the contents of mailbox 17 = 5; contents of mailbox 18 = 1.

a) What is the final value in outbasket if the first in basket is 56 and second in basket is 89?
b) What is the final value in outbasket if the first in basket is 75 and second in basket is 75?
c) What is the final value in outbasket if the first in basket is 89 and second in basket is 56?

Sol: The order of input does not matter.

a) 5
b) 1
c) 5

Section 6.2 Operation of the LMC

Section 6.4 An Extended Instruction Set

3) Describe what the LMC program in question (1) does. Suppose the contents of mailbox 17 = 5; contents of mailbox 18 = 1.

Sol: The output's order is unimportant. This program shows a "5" to the basket if the inputs are different and a "1" if they are the same.

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

4) Refer to the LMC program below and the table of op codes given above.
a) What is the first number placed in the outbasket?
b) What is the last number placed in the outbasket?

Mailbox	Contents	
00	517	
01	218	
02	902	
03	705	
04	601	
05	000	
……..		
17	100	DAT
18	2	DAT

Sol:
a) 98
b) 0

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

5) Refer to the LMC program in question (4). Change DAT in mailbox 18 to 4.
a) What is the first number placed in the out basket?
b) What is the last number placed in the out basket?

Sol:
a) 96
b) 0

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

6) Describe what the LMC program in question (4) does.

Sol: The initial number to be displayed in this software will be where the last number is zero, and it will count backwards from the number 98 to display even numbers to the out basket.

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

7) Refer to the LMC program below. Writedown what the calculator will hold after the instruction is complete in each loop. The first one is completed as an example.

Mailbox	Contents		Calculator after instruction is complete			
			Loop1	Loop2	Loop3	Loop4
00	517		*1*	*2*	*3*	*4*
01	118					
02	317					
03	219					
04	710					
05	600					
……..						
17	1	DAT				
18	1	DAT				
19	5	DAT				

Sol:

Mailbox	Contents		Calculator after instruction is complete			
			Loop1	Loop2	Loop3	Loop4
00	517		1	2	3	4
01	118		2	3	4	5
02	317		2	3	4	5
03	219		-3	-2	-1	0
04	710		-3	-2	-1	0
05	600		-3	-2	-1	N.A
……..						
17	1	DAT				
18	1	DAT				
19	5	DAT				

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

8) Refer to the LMC program in question (7). How did the contents of mailboxes 17-19 change for each loop?

Sol: The contents of address 17 will be as follows, with no changes to the order: 2 -3 -4 -5.

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

9) What instruction should be placed in mailbox 02 so the program loops 4 times? Refer to the table of op codes above.

Mailbox	Contents
00	517
01	218
02	???
03	317
04	902
05	600
06	000
……..	
17	10
18	2

Sol: This 02 address's contents should consist of a 706 loop that runs four times.

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

10) Describe what the following LMC program does. Refer to the table of op codes above.

Mailbox	Contents
00	901
01	309
02	207
03	902
04	708
05	602
06	000
07	1
08	000
09	DAT

Sol: This command takes a value from the user and loops by it to display the amount of items that have been added to the outgoing basket each time.

Section 6.2 Operation of the LMC
Section 6.4 An Extended Instruction Set

11) The contents in memory occasionally have to be moved to another area of memory. When that happens, the mailbox references must be adjusted so that the program continues tofunction properly. Rewrite the LMC code in problem (10) so that it occupies mailboxes 05 through 14 only; mailboxes 01 through 04 will be used by another program, so they can't be used. Assume that instruction 605 remains in mailbox 00.

Mailbox	Contents
00	605
01	used by other program
02	used by other program
03	used by other program
04	used by other program
05	???
06	???
07	???
08	???
09	???
10	???
11	???
12	???
13	???
14	???

Sol:

Mailbox	Contents
00	605
01	used by other program
02	used by other program
03	used by other program
04	used by other program
05	901
06	314
07	212
08	902
09	713
10	606
11	000
12	1
13	000
14	DAT

12) Describe the LMC three-digit instruction format. How does the LMC know what part of the value is an instruction, and what part is an address?

Sol: The three-digit format is in the shape XYY. where YY is the address from (00 to 99) and X is an op-code from (0 to 9) The remaining two digits represent an address, and the Little Man Computer simply needs to check the first digit for the op-code.

Section 6.2 Operation of the LMC

13) How does the LMC "know" if a particular mailbox contains data or instructions?

Sol: Whether the value in the mail box is an instruction or not is unknown to Little Man Computer. As a result, the first instruction location is 00, the program counter determines the next instruction location, and if the LMC discovers that the memory value that was supposed to be in an instruction is actually not there, it will attempt to execute the instruction. Or it will assume that a mailbox contains an instruction rather than data if the program counter points to that mailbox.

Section 6.5 The Instruction Cycle

14) What happens if the LMC is executing a program and never encounters a "HALT" command?

Sol: If the program never sees the "HALT" instruction, it will continue to run until it reaches a location containing "000" or one that begins with "4", which is an invalid operation code. And this is presuming that if the program counter is increased by more than 99, it is zero.

Section 6.2 Operation of the LMC

15) Describe how the LMC is von Neumann architecture.

Sol: We need three things:

1) Sequentially carrying out each instruction one at a time, one after the other.

2) The Central Processing Unit (CPU) and memory, along with input and output capabilities, make up the PC or computer.

3) Memory is where both the instruction and the data are stored.