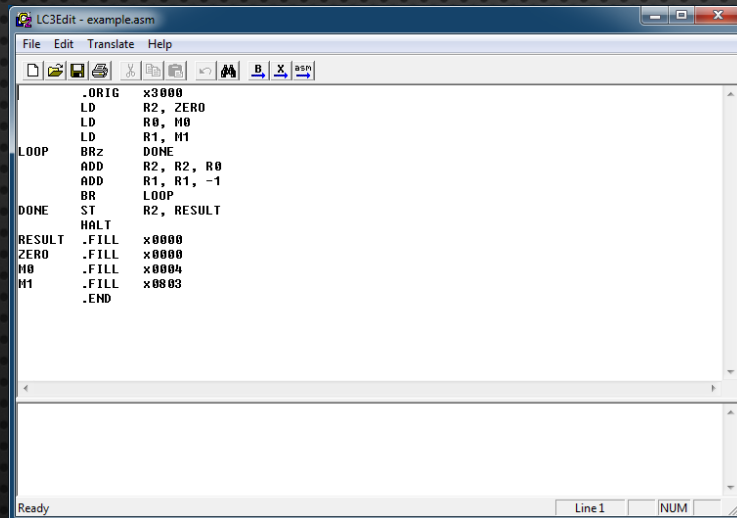


# TUTORIAL THREE

LC-3

# LC-3 SIMULATOR & LC-3 EDITOR

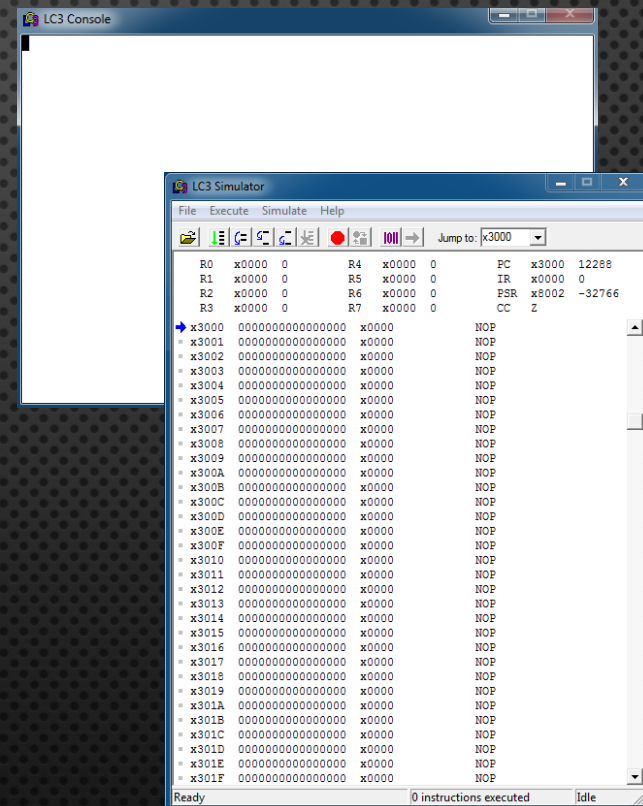


LC3Edit - example.asm

File Edit Translate Help

LC3Edit window showing assembly code for example.asm. The code includes labels .ORIG, LD, LOOP, BRz, DONE, ST, HALT, RESULT, ZERO, M0, M1, and .END. The status bar shows 'Ready', 'Line 1', and 'NUM'.

```
.ORIG x3000
LD R2, ZERO
LD R0, M0
LD R1, M1
LOOP BRz DONE
ADD R2, R2, R0
ADD R1, R1, -1
BR LOOP
DONE ST R2, RESULT
HALT
RESULT .FILL x0000
ZERO .FILL x0000
M0 .FILL x0004
M1 .FILL x0803
.END
```



LC3 Console

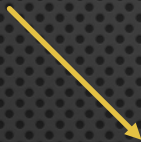
LC3 Simulator

LC3 Simulator window showing the execution of the assembly code. The status bar shows 'Ready', '0 instructions executed', and 'Idle'.

PC	IR	PSR	CC	Z
x3000	12288	x0000	0	
x3001	0	x0000	0	
x3002	0	x0000	0	
x3003	0	x0000	0	
x3004	0	x0000	0	
x3005	0	x0000	0	
x3006	0	x0000	0	
x3007	0	x0000	0	
x3008	0	x0000	0	
x3009	0	x0000	0	
x300A	0	x0000	0	
x300B	0	x0000	0	
x300C	0	x0000	0	
x300D	0	x0000	0	
x300E	0	x0000	0	
x300F	0	x0000	0	
x3010	0	x0000	0	
x3011	0	x0000	0	
x3012	0	x0000	0	
x3013	0	x0000	0	
x3014	0	x0000	0	
x3015	0	x0000	0	
x3016	0	x0000	0	
x3017	0	x0000	0	
x3018	0	x0000	0	
x3019	0	x0000	0	
x301A	0	x0000	0	
x301B	0	x0000	0	
x301C	0	x0000	0	
x301D	0	x0000	0	
x301E	0	x0000	0	
x301F	0	x0000	0	

# LC-3 SIMULATOR & LC-3 EDITOR

Editor

The screenshot shows the LC3Edit window with the following assembly code:

```
.ORIG x3000
LD R2, ZERO
LD R0, M0
LD R1, M1
LOOP BRz DONE
ADD R2, R2, R0
ADD R1, R1, -1
BR LOOP
DONE ST R2, RESULT
HALT
RESULT .FILL x0000
ZERO .FILL x0000
M0 .FILL x0004
M1 .FILL x0003
.END
```

The screenshot shows two windows: the LC3 Console and the LC3 Simulator. The LC3 Console window is empty. The LC3 Simulator window displays the following state:

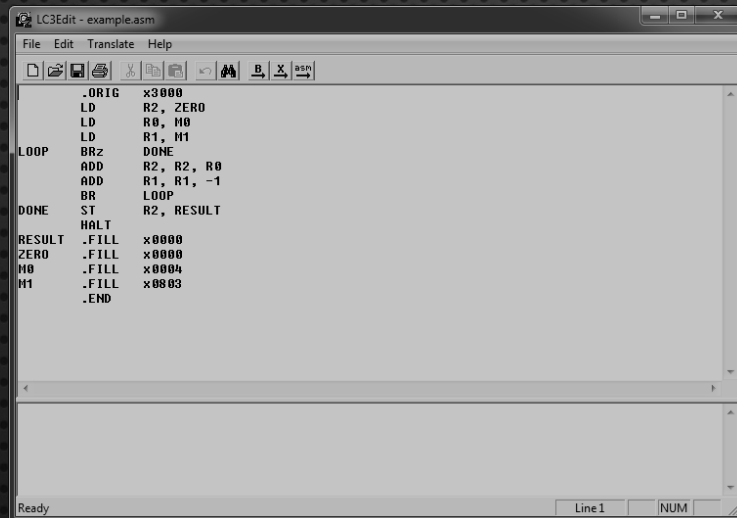
Register	Value	Register	Value	Register	Value			
R0	x0000	0	R4	x0000	0	PC	x3000	12288
R1	x0000	0	R5	x0000	0	IR	x0000	0
R2	x0000	0	R6	x0000	0	PSR	x8002	-32766
R3	x0000	0	R7	x0000	0	CC	Z	

  
The instruction list shows:

Address	Hex	Op-Code	Op
x3000	0000000000000000	x0000	NOP
x3001	0000000000000000	x0000	NOP
x3002	0000000000000000	x0000	NOP
x3003	0000000000000000	x0000	NOP
x3004	0000000000000000	x0000	NOP
x3005	0000000000000000	x0000	NOP
x3006	0000000000000000	x0000	NOP
x3007	0000000000000000	x0000	NOP
x3008	0000000000000000	x0000	NOP
x3009	0000000000000000	x0000	NOP
x300A	0000000000000000	x0000	NOP
x300B	0000000000000000	x0000	NOP
x300C	0000000000000000	x0000	NOP
x300D	0000000000000000	x0000	NOP
x300E	0000000000000000	x0000	NOP
x300F	0000000000000000	x0000	NOP
x3010	0000000000000000	x0000	NOP
x3011	0000000000000000	x0000	NOP
x3012	0000000000000000	x0000	NOP
x3013	0000000000000000	x0000	NOP
x3014	0000000000000000	x0000	NOP
x3015	0000000000000000	x0000	NOP
x3016	0000000000000000	x0000	NOP
x3017	0000000000000000	x0000	NOP
x3018	0000000000000000	x0000	NOP
x3019	0000000000000000	x0000	NOP
x301A	0000000000000000	x0000	NOP
x301B	0000000000000000	x0000	NOP
x301C	0000000000000000	x0000	NOP
x301D	0000000000000000	x0000	NOP
x301E	0000000000000000	x0000	NOP
x301F	0000000000000000	x0000	NOP



# LC-3 SIMULATOR & LC-3 EDITOR

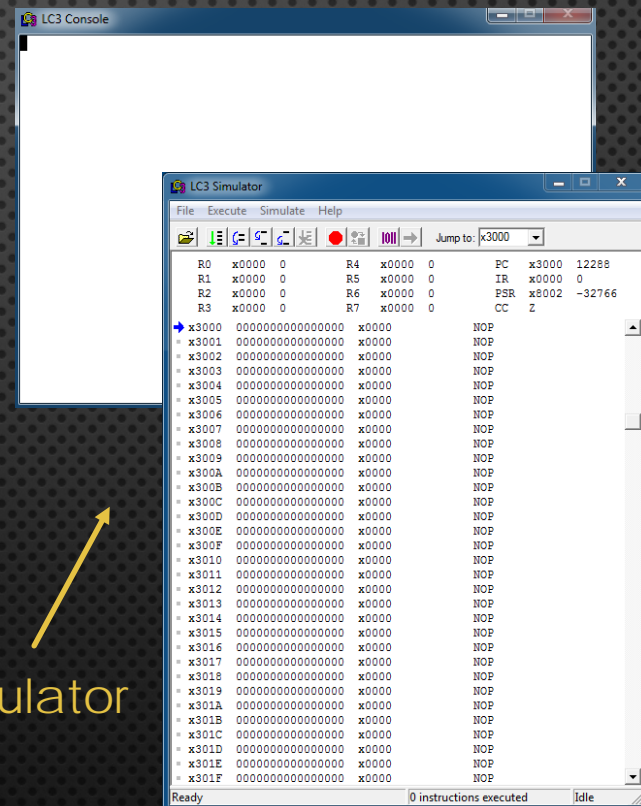


LC3Edit - example.asm

```
File Edit Translate Help
[Icons]
.ORIG x3000
LD R2, ZERO
LD R0, M0
LD R1, M1
LOOP BRz DONE
ADD R2, R2, R0
ADD R1, R1, -1
BR LOOP
DONE ST R2, RESULT
HALT
RESULT .FILL x0000
ZERO .FILL x0000
M0 .FILL x0004
M1 .FILL x0803
.END
```

Ready Line1 NUM

Simulator



LC3 Console

LC3 Simulator

File Execute Simulate Help

Jump to: x3000

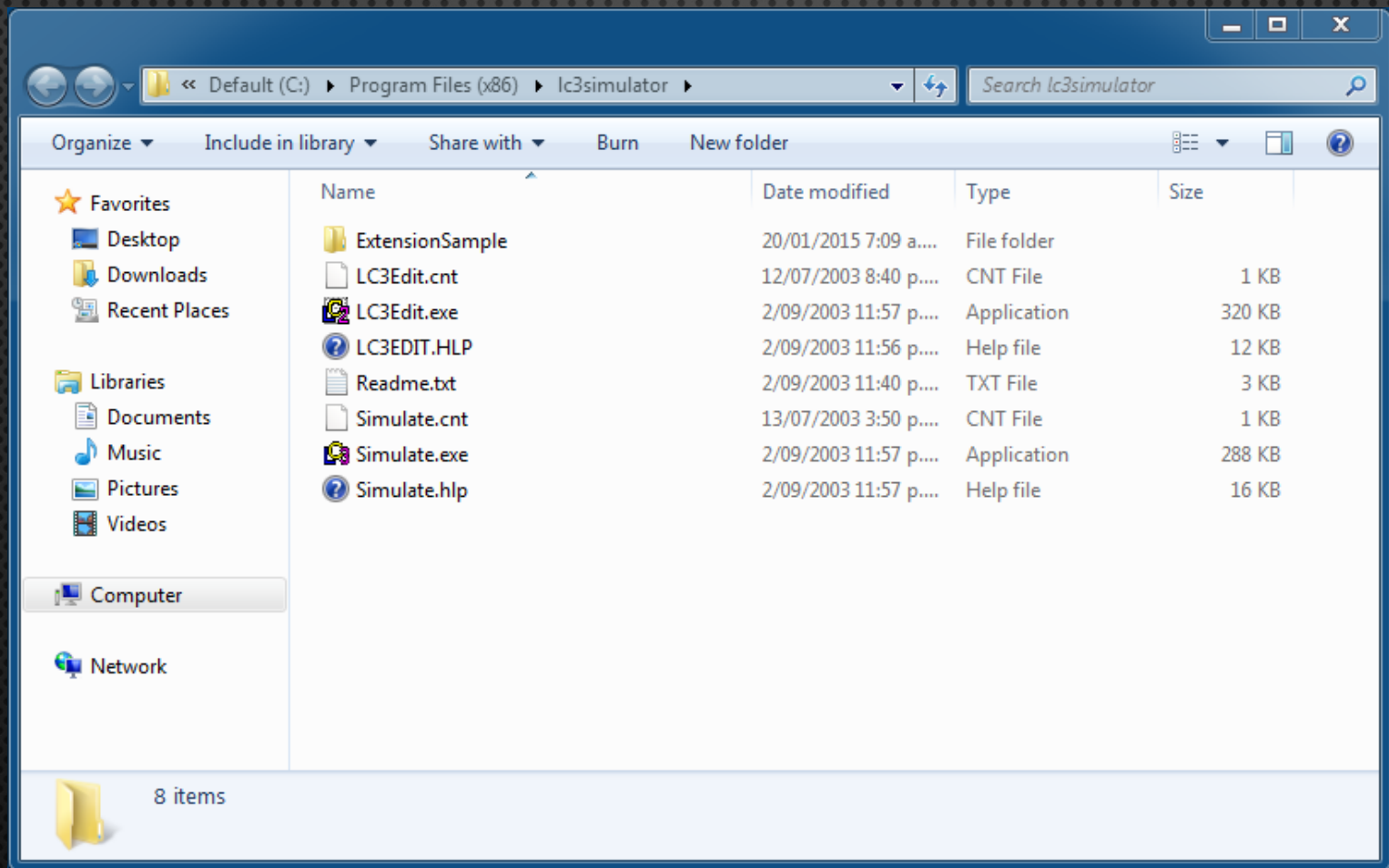
R0	x0000	0	R4	x0000	0	PC	x3000	12288
R1	x0000	0	R5	x0000	0	IR	x0000	0
R2	x0000	0	R6	x0000	0	PSR	x8002	-32766
R3	x0000	0	R7	x0000	0	CC	Z	

0 instructions executed Idle

# LC-3 NOTES

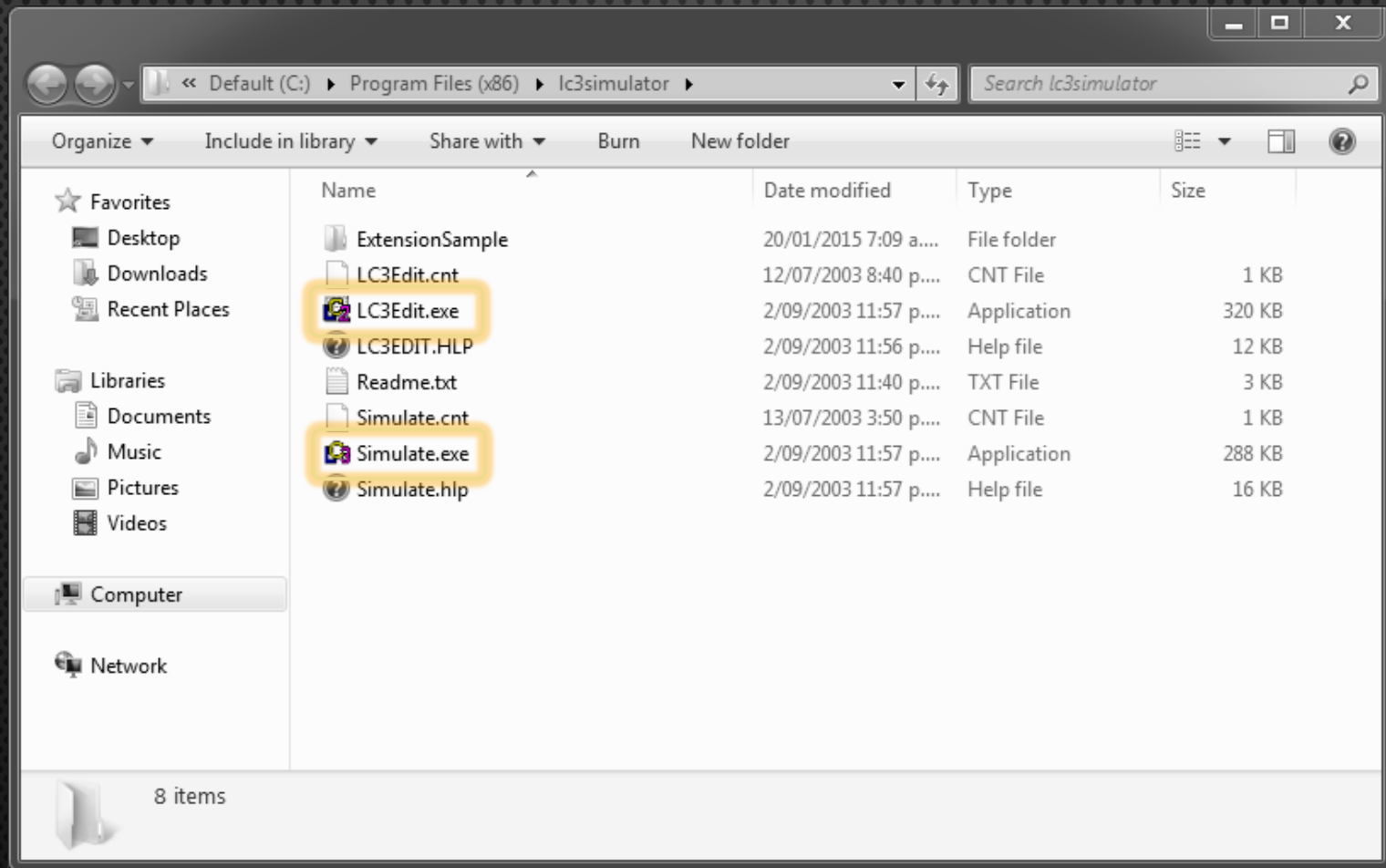
- THE SIMULATOR AND THE EDITOR ARE SEPARATE PROGRAMS
- THE SIMULATOR IS AVAILABLE FOR WINDOWS (MAYBE ALSO LINUX/JAVA/ETC)
- THE LAB COMPUTERS SHOULD HAVE LC-3 INCLUDED
- THE LC-3 SOFTWARE CAN BE EXECUTED FROM A FLASH DRIVE
- DOWNLOAD FROM CANVAS IF NEEDED

# THE LC-3 FILES

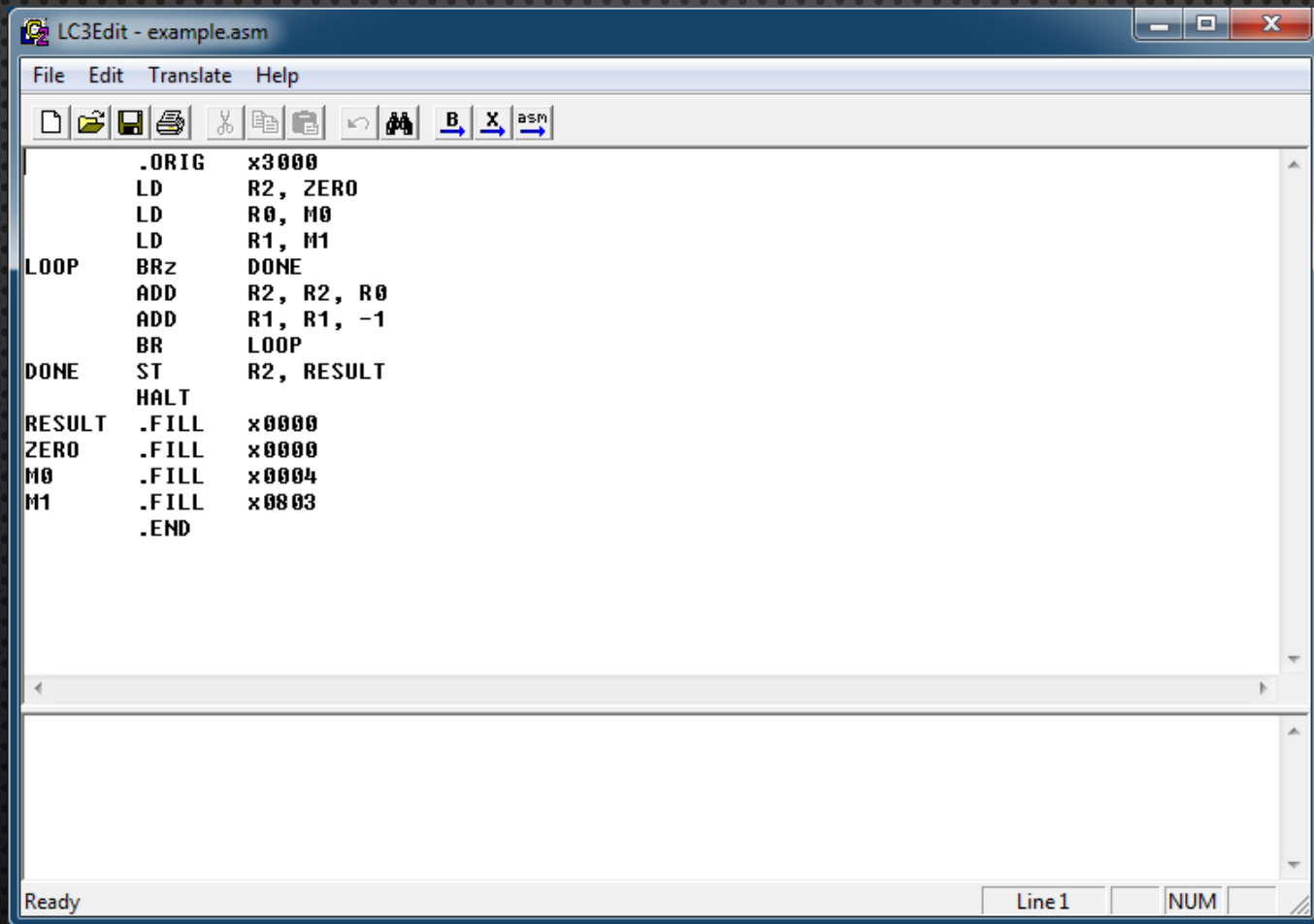




# THE LC-3 FILES



# LC-3 EDITOR



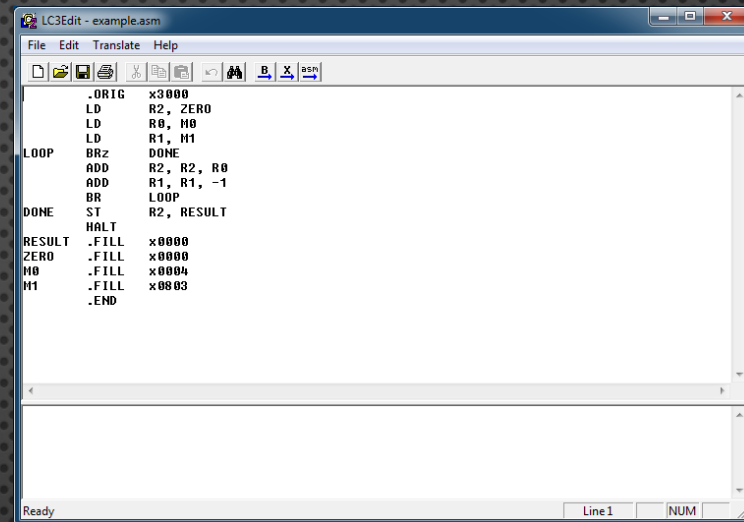
The screenshot shows a window titled "LC3Edit - example.asm" with a menu bar (File, Edit, Translate, Help) and a toolbar. The main text area contains the following assembly code:

```
.ORIG    x3000
LD      R2, ZERO
LD      R0, M0
LD      R1, M1
LOOP    BRz    DONE
        ADD    R2, R2, R0
        ADD    R1, R1, -1
        BR     LOOP
DONE     ST     R2, RESULT
        HALT
RESULT  .FILL   x0000
ZERO    .FILL   x0000
M0      .FILL   x0004
M1      .FILL   x0003
.END
```

The status bar at the bottom shows "Ready", "Line 1", and "NUM".



# LC-3 EDITOR



The screenshot shows a window titled "LC3Edit - example.asm" with a menu bar (File, Edit, Translate, Help) and a toolbar. The main text area contains the following assembly code:

```
.ORIG x3000
LD R2, ZERO
LD R0, M0
LD R1, M1
LOOP BRz DONE
ADD R2, R2, R0
ADD R1, R1, -1
BR LOOP
DONE ST R2, RESULT
HALT
RESULT .FILL x0000
ZERO .FILL x0000
M0 .FILL x0004
M1 .FILL x0803
.END
```

At the bottom of the window, there is a status bar with "Ready" on the left and "Line 1" and "NUM" on the right.

- THE EDITOR IS USED TO ENTER YOUR LC-3 INSTRUCTIONS
- YOU WILL SAVE YOUR PROGRAMS INTO THE **.asm** FORMAT
- THE EDITOR WILL ALSO ASSEMBLE YOUR **.asm** FILES INTO **.obj** FILES WHICH CAN BE RUN ON THE SIMULATOR

# example.asm

```

        . ORIG      x3000
        LD          R2, ZERO
        LD          R0, M0
        LD          R1, M1
LOOP     BRz        DONE
        ADD         R2, R2, R0
        ADD         R1, R1, -1
        BR         LOOP
DONE     ST          R2, RESULT
        HALT
RESULT   . FILL      x0000
ZERO     . FILL      x0000
M0       . FILL      x0004
M1       . FILL      x0803
        . END
```

# LC-3 SIMULATOR

The image displays two windows from the LC-3 Simulator. The 'LC3 Console' window on the left is empty. The 'LC3 Simulator' window on the right shows the state of the processor and a list of instructions.

**LC3 Simulator Window:**

File Execute Simulate Help

Jump to: x3000

Register	Value	Register	Value	Register	Value			
R0	x0000	0	R4	x0000	0	PC	x3000	12288
R1	x0000	0	R5	x0000	0	IR	x0000	0
R2	x0000	0	R6	x0000	0	PSR	x8002	-32766
R3	x0000	0	R7	x0000	0	CC	Z	

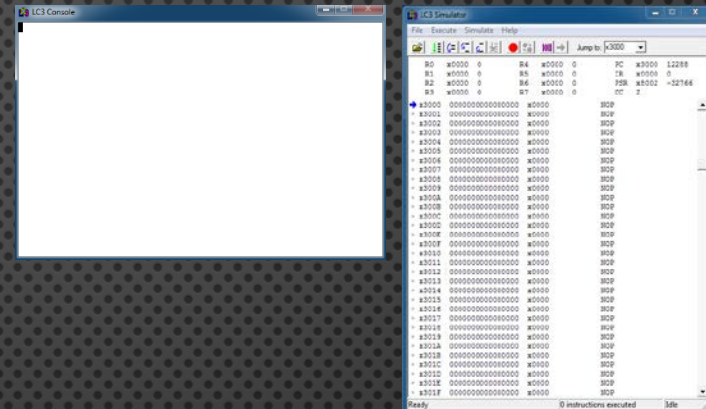
Instructions:

Address	Hex	Op-Code	Instruction
x3000	0000000000000000	x0000	NOP
x3001	0000000000000000	x0000	NOP
x3002	0000000000000000	x0000	NOP
x3003	0000000000000000	x0000	NOP
x3004	0000000000000000	x0000	NOP
x3005	0000000000000000	x0000	NOP
x3006	0000000000000000	x0000	NOP
x3007	0000000000000000	x0000	NOP
x3008	0000000000000000	x0000	NOP
x3009	0000000000000000	x0000	NOP
x300A	0000000000000000	x0000	NOP
x300B	0000000000000000	x0000	NOP
x300C	0000000000000000	x0000	NOP
x300D	0000000000000000	x0000	NOP
x300E	0000000000000000	x0000	NOP
x300F	0000000000000000	x0000	NOP
x3010	0000000000000000	x0000	NOP
x3011	0000000000000000	x0000	NOP
x3012	0000000000000000	x0000	NOP
x3013	0000000000000000	x0000	NOP
x3014	0000000000000000	x0000	NOP
x3015	0000000000000000	x0000	NOP
x3016	0000000000000000	x0000	NOP
x3017	0000000000000000	x0000	NOP
x3018	0000000000000000	x0000	NOP
x3019	0000000000000000	x0000	NOP
x301A	0000000000000000	x0000	NOP
x301B	0000000000000000	x0000	NOP
x301C	0000000000000000	x0000	NOP
x301D	0000000000000000	x0000	NOP
x301E	0000000000000000	x0000	NOP
x301F	0000000000000000	x0000	NOP

Ready 0 instructions executed Idle



# LC-3 SIMULATOR



- THE SIMULATOR IS USED TO EXECUTE YOUR ASSEMBLED LC-3 MACHINE CODE
- YOU WILL LOAD THE **.obj** FILES YOU CREATE INTO THE EDITOR
- THE EDITOR GIVES YOU A VERY DETAILED VIEW OF WHAT IS HAPPENING AS YOUR MACHINE CODE IS EXECUTED

# DEMONSTRATION

COMPLETE THE FOLLOWING TASKS IN LC-3.

1. WRITE A PROGRAM IN THE LC-3 EDITOR.
2. ASSEMBLE A PROGRAM IN THE LC-3 EDITOR.
3. LOAD AND EXECUTE A PROGRAM IN THE LC-3 SIMULATOR.
4. SET BREAKPOINTS IN THE SIMULATOR TO PAUSE EXECUTION.
5. STEP FORWARD THROUGH YOUR EXECUTING PROGRAM ONE LINE AT A TIME.
6. MODIFY A REGISTER VALUE DURING PROGRAM EXECUTION.