CA3

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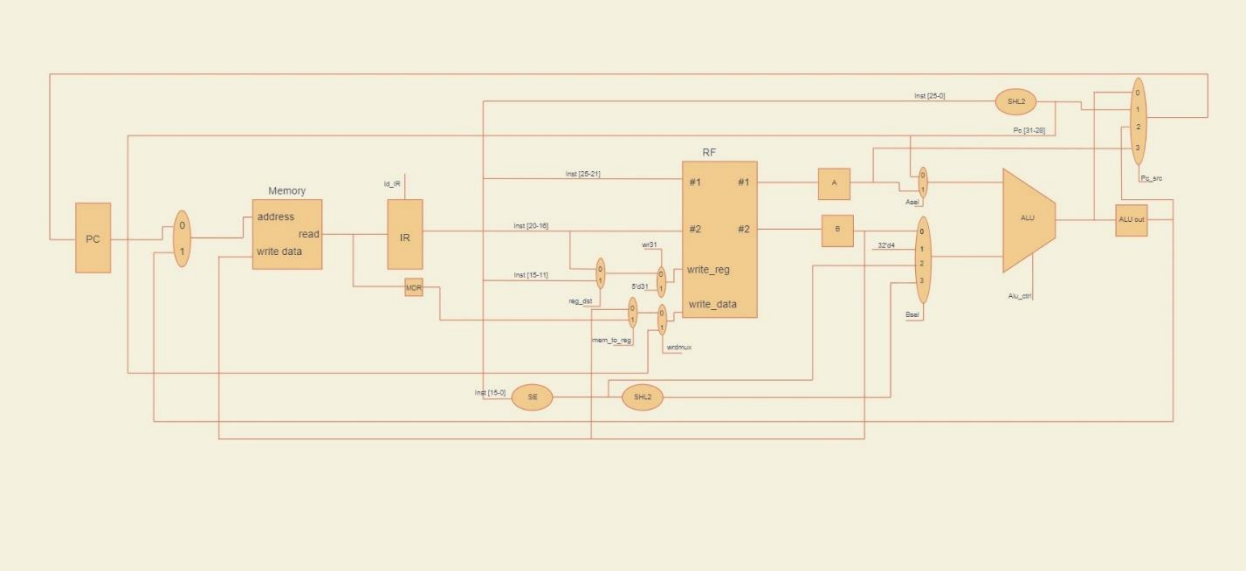
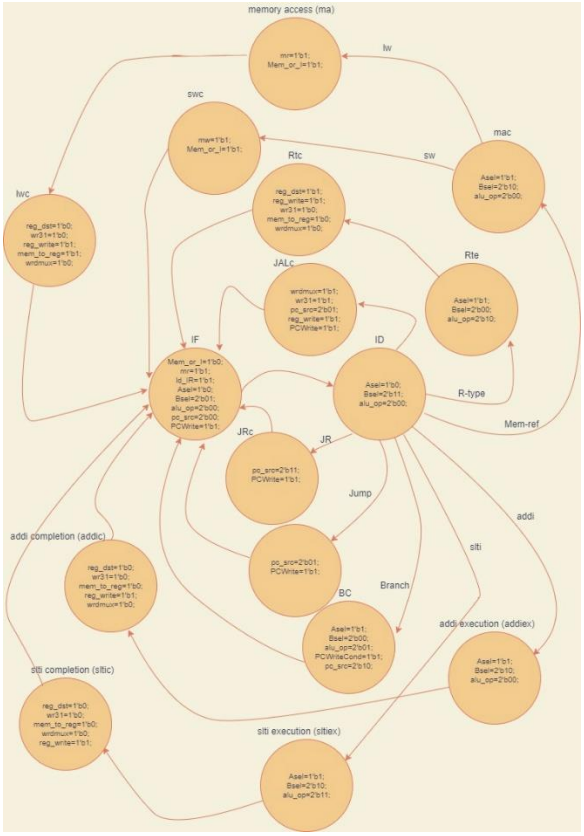
Datapath of MIPS multi-cycle is shown below:

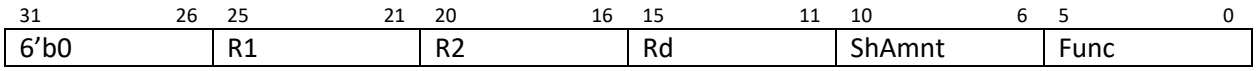


Controller corresponding to the datapath above is shown below:



ISA (instruction set architecture) for this processor is listed as below:

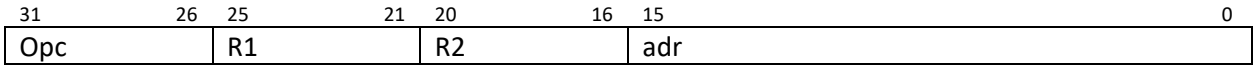
R-Type Instructions:



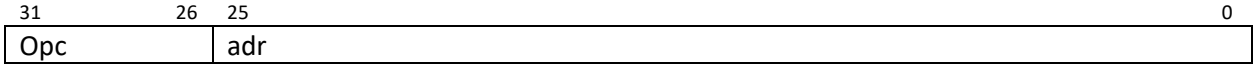
Function types is listed as below:

Function Opcode	Function
100000	Add
100011	Sub
100100	And
100101	Or
101010	Slt

Other Instructions (Except Jump):



Jump:



Instruction	Opc
lw R2, adr(R1)	100011
sw R2, adr(R1)	101011
addi R2, R1, adr	001001
slti R2, R1, adr	001010
beq R1, R2, adr	000100
j adr	000010
jal ??	000011
jr R1	000110

MIPS assembly code for the test program is shown below:

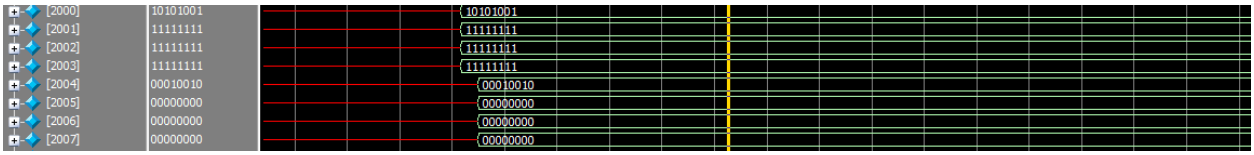
```
addi R1,R0,1000 #first data location initialization
lw R2,0(R) #loading first data and considering it the min value
addi R3,R0,0 #R3: index of the min data in list
addi R4,R0,0 #R4 : for loop index
loop: addi R1,R1,4 #next data
addi R4,R4,1 #i++
slti R5,R4,20 #check to see if list is finished
beq R5,R0,end #if i=20, program is done
lw R6,0(R1) #loading data to compare it with current min
slt R7,R6,R2 #comparing
beq R5,R0,loop #if it is not lower than the current min, go to the next data
add R2,R0,R6 #replacing new min value
add R3,R6,R4 #replacing new index
j loop
end: sw R2,2000(R0) #storing min value
sw R3,2004(R0) #storing index of the min value

```

We have to make a corresponding binary file according to this program and the ISA. This file is saved as instmem.txt .

Decimal values of memory data is shown below:

```
-74
14
46
52
-24
-46
-3
76
61
44
38
100
-58
-55
-26
-13
81
-18
-87
48
```

This is the result of the testbench:



If we append the 8 bit words together, values below will be reached:

Mem[2003-2000]=-87

Mem[2007-2004]= 19