[CprE 381] Computer Organization and Assembly-Level Programming, Fall 2018

Project A Report

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Section/Lab Time F

Refer to the highlighted language in the <u>Project A</u> instruction for the context of the following questions.

a. [Part 1.a] Provide a description of how each of the control values in the architecture (i.e., the outputs of the main control unit) is used.
   - For each output control signal, explain how it is used (i.e., what does it do?)
     - o_reg_dest-
       - select signal for mux to switch the input of the write select between bits 20-16 and 15-11 of the instruction.
     - o_jump-
       - select signal for mux to switch the input of the pc between the calculated instruction address and the output of a switch that is either pc+4 or pc+4+(imm*4)
     - o_branch
       - used in conjunction with the o_zero from the alu to set a mux for the pc input to switch between pc+4 and pc+4+(imm*4)
     - o_mem_to_reg
       - select signal for a mux for the write to register, switches between the ALU output and memory read
     - o_ALU_op
       - the operation for the alu
     - o_mem_write
       - enables writing into memory
     - o_ALU_src
       - select signal for a mux for the input for the second input of the alu, switches between read register 2 and sign extended immediate value
     - o_reg_write
       - enables writing to registers
   - For the 6 MIPS instructions to support, ADD, ADDI, LW, SW, BEQ and J, complete the following table.

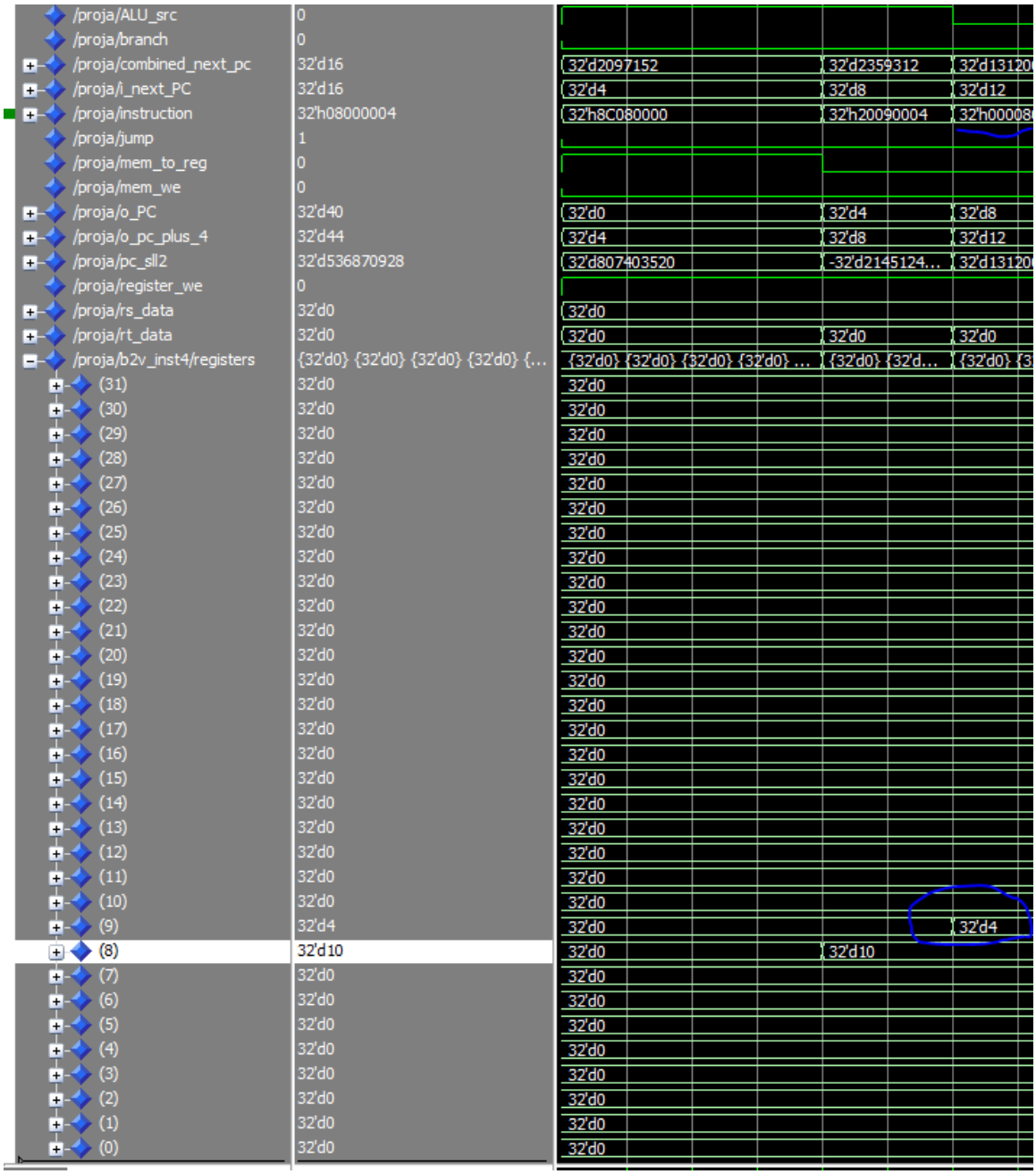
	ADD	ADDI	LW	SW	BEQ	J
o_reg_dest	0	0	0	d	d	D
o_jump	0	0	0	0	0	1
o_branch	0	0	0	0	1	0 (d)
o_mem_to_reg	0	0	1	d	d	d
o_ALU_op	b0000	B0000	B0000	B0000	B0001	D
o_mem_write	0	0	0	1	0	0
o_ALU_src	0	1	1	1	0	D
o_reg_write	1	1	1	0	0	0

D means we don't care about the value

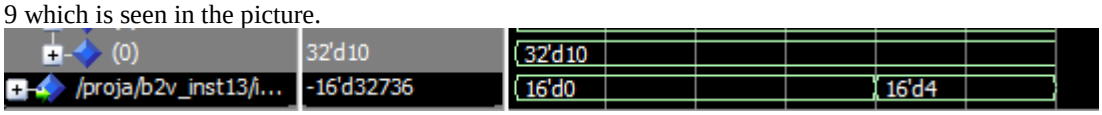
- (continuing from the previous question) For each of the 6 MIPS instruction, explain why you set the values as you described in the table above.
  - ADD
    - We don't want to change the order of instructions
    - Need to add
    - Only write to register
  - ADDI
    - We don't want to change the order of instructions
    - Need to add
    - Only write to register
    - Take in an immediate value by changing ALU_src
  - LW
    - Add immediate value and write to memory
  - SW
    - Add immediate value and read from memory, writing to the register
  - BEQ
    - Set branch to 1 to allow for branching
    - If A = B, then A – B = 0, which sets the alu o_ZER0 to 1
  - J
    - The only thing we care about is j = 1, everything else is handled regardless of inputs

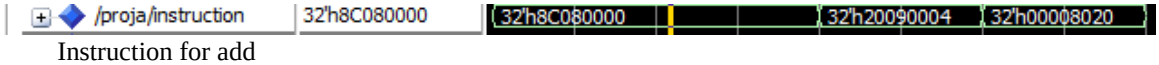
b. [Part 1.a] How is the zero flag from the ALU used?
If the output of the ALU is zero, this flag indicates as such, which is anded with the branch output to switch the pc increment to the calculated jump address.

c. [Part 2] Simulate your processor in ModelSim and run the provided program in imem.mif with the data in dmem.mif.
- The [projectA > ASM Files > test_with_data_seg.asm] file has the assembly code with data specified which is equivalent to the given imem/dmem.mif. Before simulating the final design, just by studying the code, please explain
  - What the code does
  - Which values will be written on DMEM at the locations of the first 11 words staring from the address 0.
  - Which values will be written on the following registers: $8 (=$t0), $9 (=$t1), $10 (=$t2), and $16 (=$s0).
- Provide a screenshot for each of the 6 MIPS instructions to support showing the correct functionality and explain how the instruction is working in accordance with the screenshot
  - ADDI

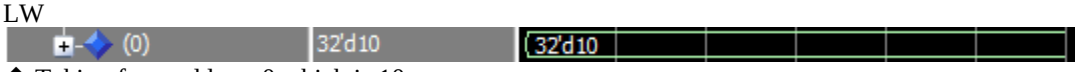


- The instruction is 0x00008020 which is addi. The addi is adding the immediate 4 to register 9 which is seen in the picture.

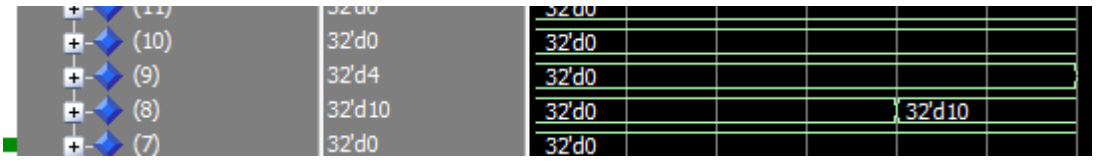


- ADD
- 

  Instruction for add

- LW
- 

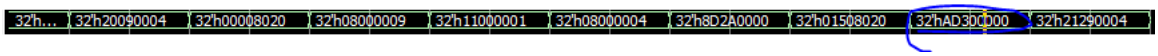
  ◆ Taking from address 0 which is 10



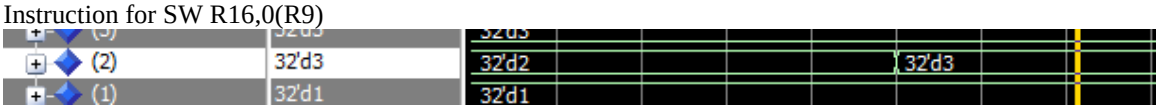
Storing it into register 8

Actual instruction

◆

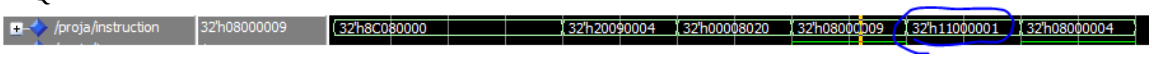
- SW
- 

Instruction for SW R16,0(R9)



Stores into DMEM the result

◆ Attach a screenshot & explain

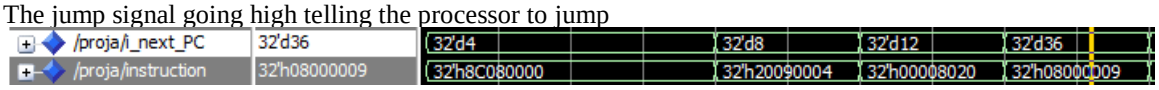
- BEQ
- 

Instruction saying to branch if equal.

Added signal indicating that the ALU isn't outputting 0 (that they are equal)

- J

The jump signal going high telling the processor to jump



The PC goes from 12 to 36 showing that there was a jump that happened.

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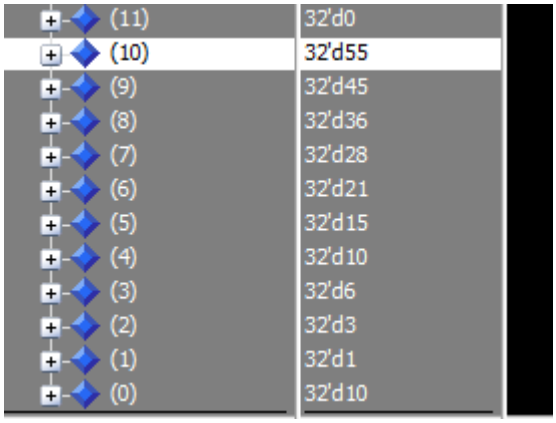
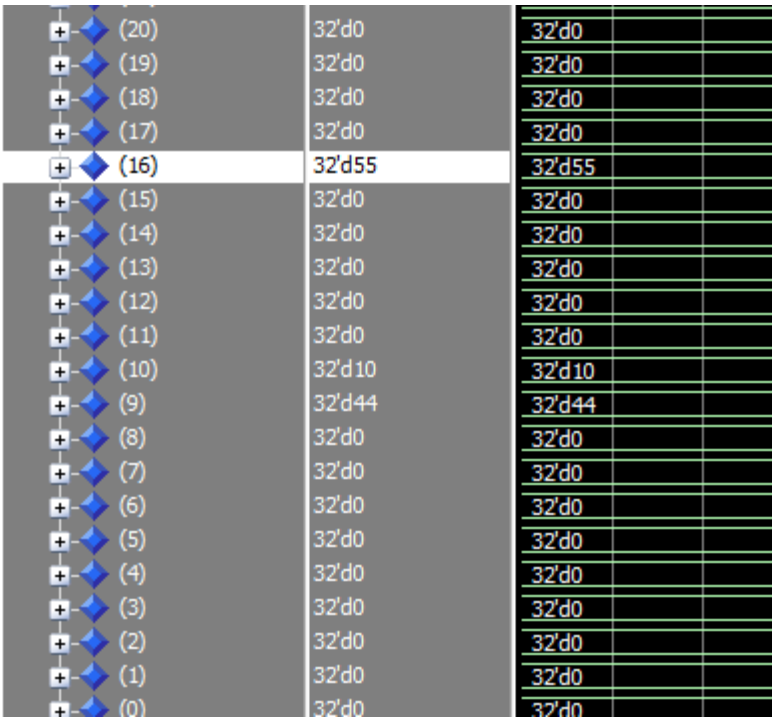


Value stored in DMEM

- REGISTERS

- 
(20) 32'd0 32'd0
(19) 32'd0 32'd0
(18) 32'd0 32'd0
(17) 32'd0 32'd0
(16) 32'd55 32'd55
(15) 32'd0 32'd0
(14) 32'd0 32'd0
(13) 32'd0 32'd0
(12) 32'd0 32'd0
(11) 32'd0 32'd0
(10) 32'd10 32'd10
(9) 32'd44 32'd44
(8) 32'd0 32'd0
(7) 32'd0 32'd0
(6) 32'd0 32'd0
(5) 32'd0 32'd0
(4) 32'd0 32'd0
(3) 32'd0 32'd0
(2) 32'd0 32'd0
(1) 32'd0 32'd0
(0) 32'd0 32'd0