CSCI 210: Computer Architecture
Lecture 25: Data Path 2

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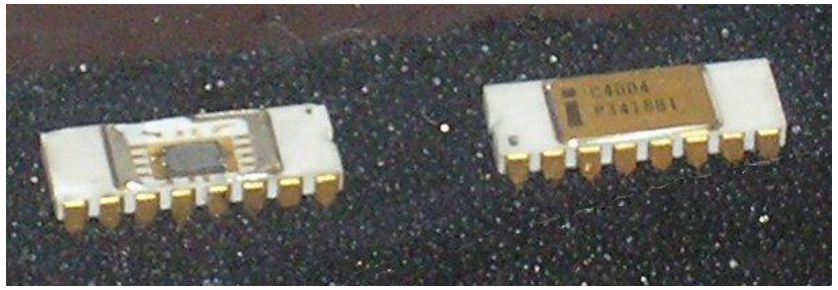
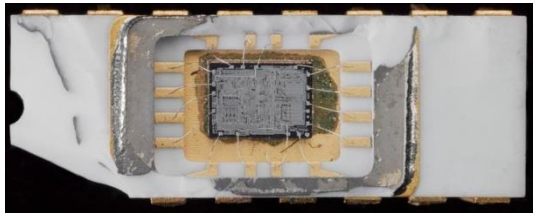
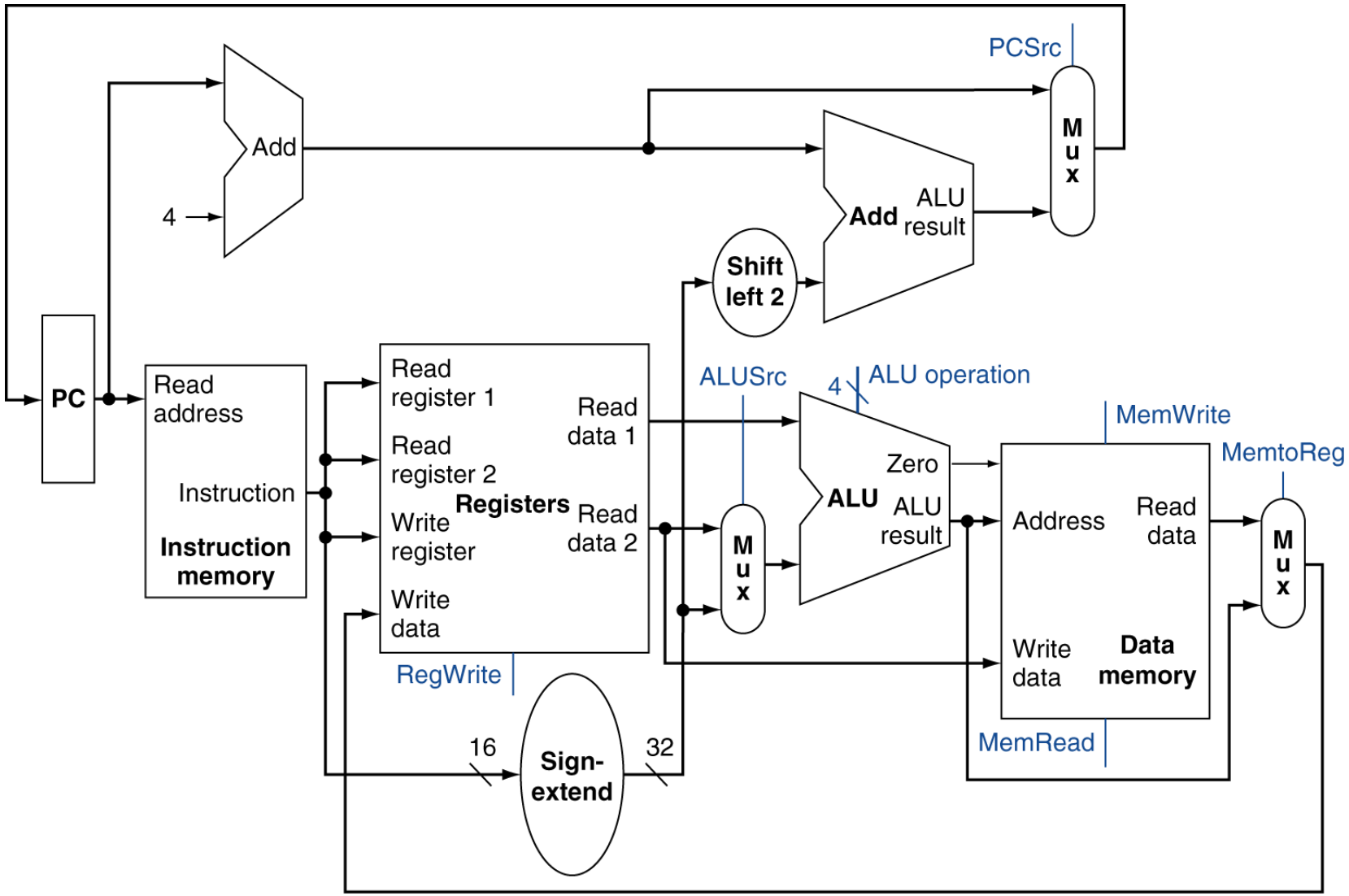
CS History: Intel 4004



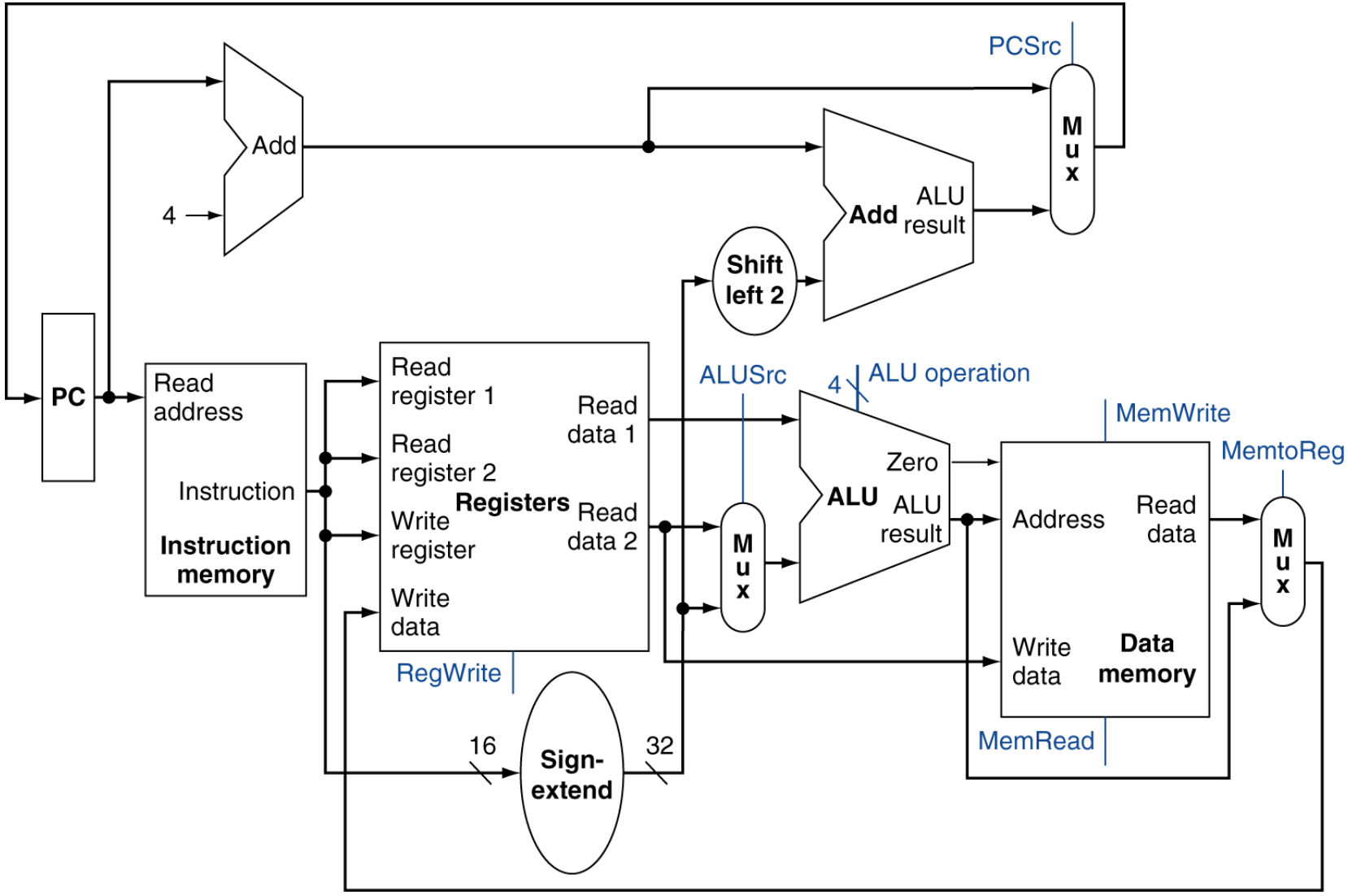


- First commercially available microprocessor (single chip with both data processing logic and control)
- Released in 1971
- Had 12-bit addresses, 8-bit instructions, and 4-bit data words
- 16 4-bit registers
- Designed for Binary-Coded Decimal, in which every decimal digit is stored as a 4-bit value
  - Still present in x86

Datapath (still simplified a bit)



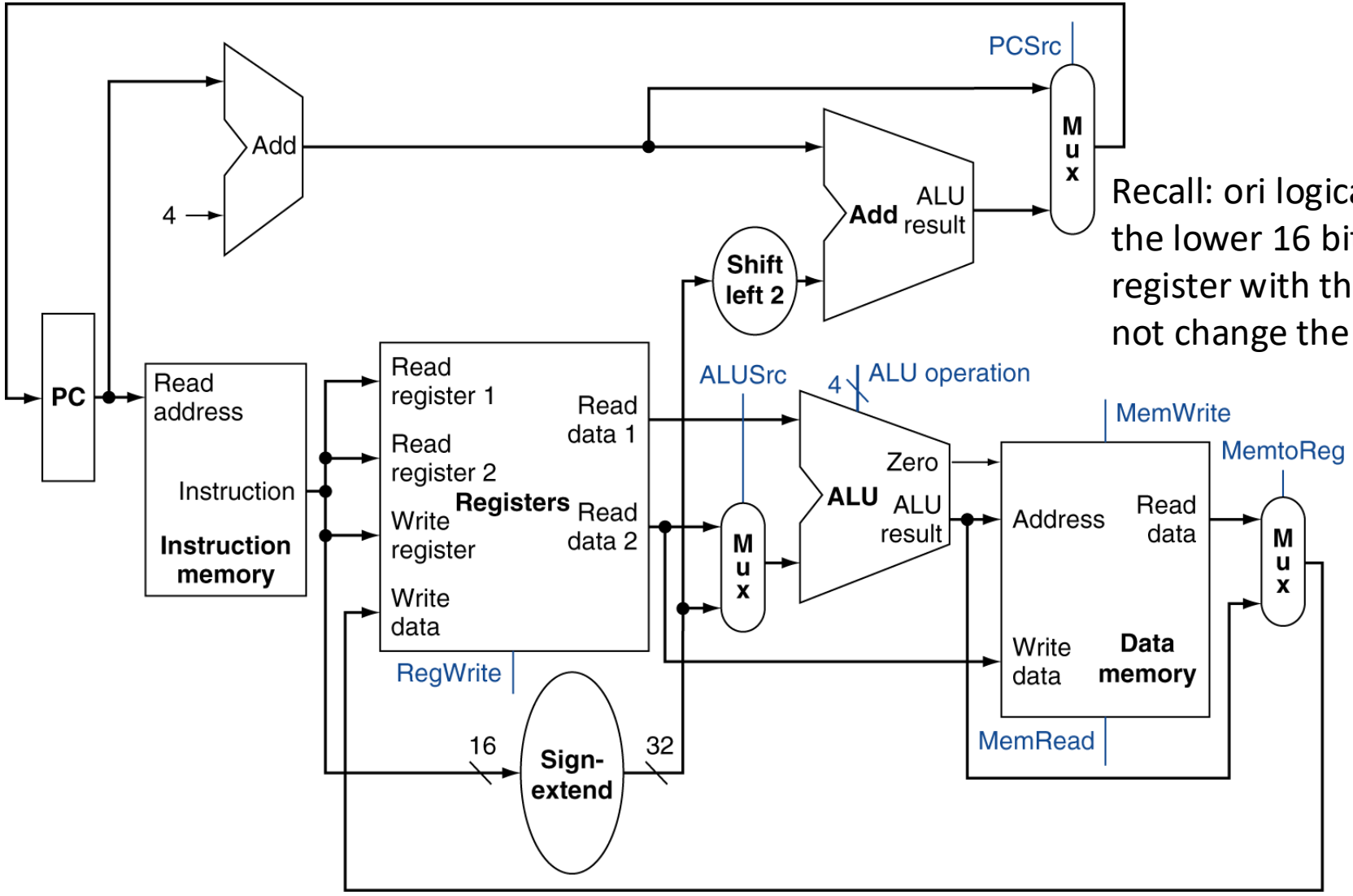
addi $t1, $t0, -1



$t0 holds 10

op = 0x08	rs = 8	rt = 9	imm = 0xFFFF

What do we need to add to support ori?

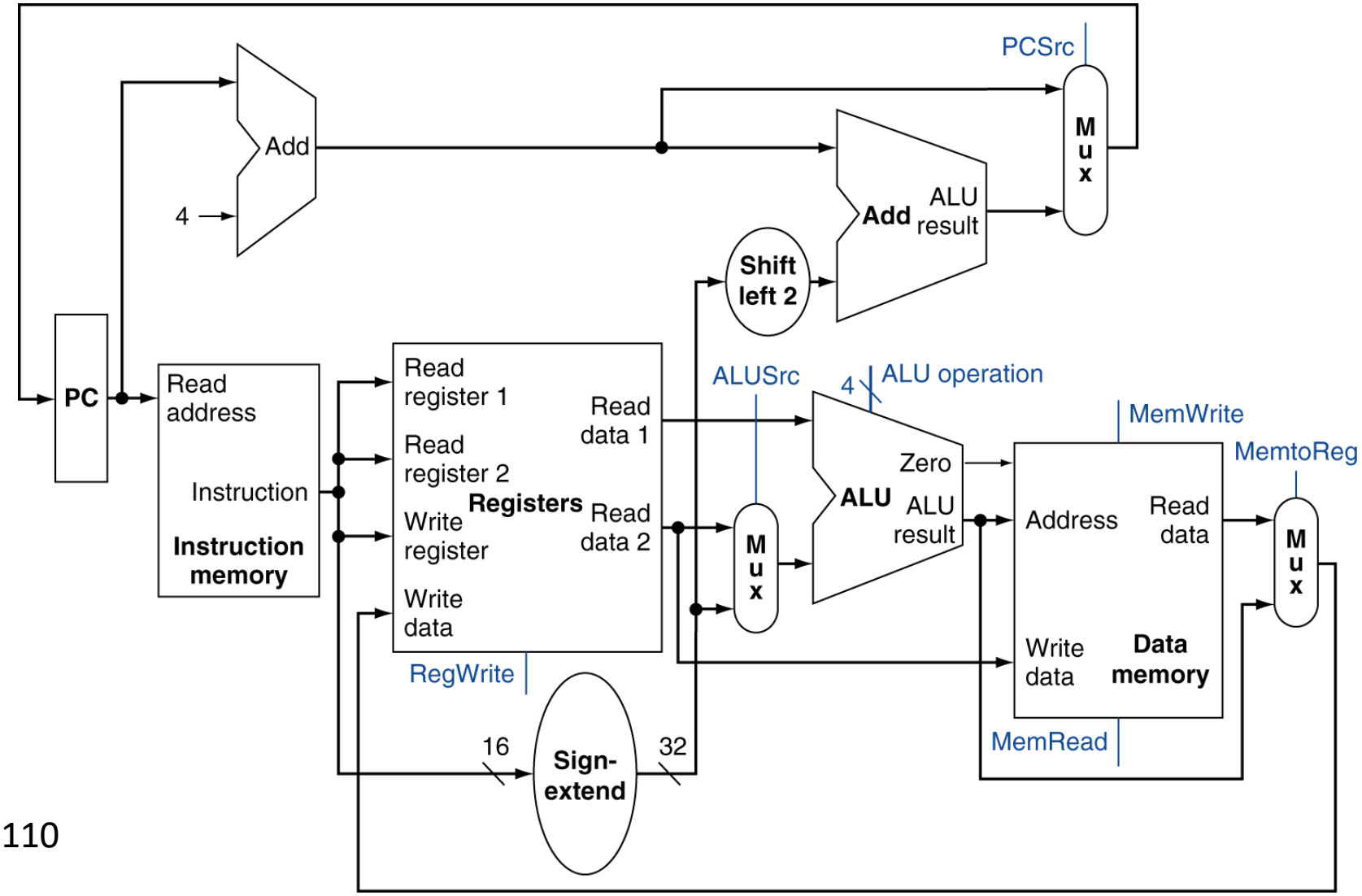


Recall: ori logically ors the lower 16 bits of the specified register with the immediate. It does not change the upper 16 bits.

ori $t0, $t1, -3
$t1 holds 5

op = 0x0D	rs = 9	rt = 8	imm = 0xFFFD

sw $t1, 8($t0)



$t0 holds 0x07AB8110

$t1 holds 5

op = 0x2B	rs = 8	rt = 9	imm = 0x0008

Composing the Elements

- Data path does an instruction in one clock cycle
  - Each data path element can only do one function at a time
  - Hence, we need separate instruction and data memories, ALU and adders, etc
- Use multiplexers where alternative data sources are used for different instructions
  - Each multiplexer will need select inputs to choose which input to use as the output

Key Points

- CPU is just a collection of state and combinational logic
- We just designed a very rich processor, at least in terms of functionality
- ET = IC * CPI * Cycle Time
  - Where cycle time is determined by how much work the processor has to do each clock cycle for one iteration of fetch, decode, execute

Reading

- Next lecture: Control Path
  - Section 5.4