Simple Questions

- How many cycles will it take to execute this code?

```
            lw $t2, 0($t3)
            lw $t3, 4($t3)
            beq $t2, $t3, Label  <-------  #assume not
            add $t5, $t2, $t3
            sw $t5, 8($t3)
Label:      ...
```

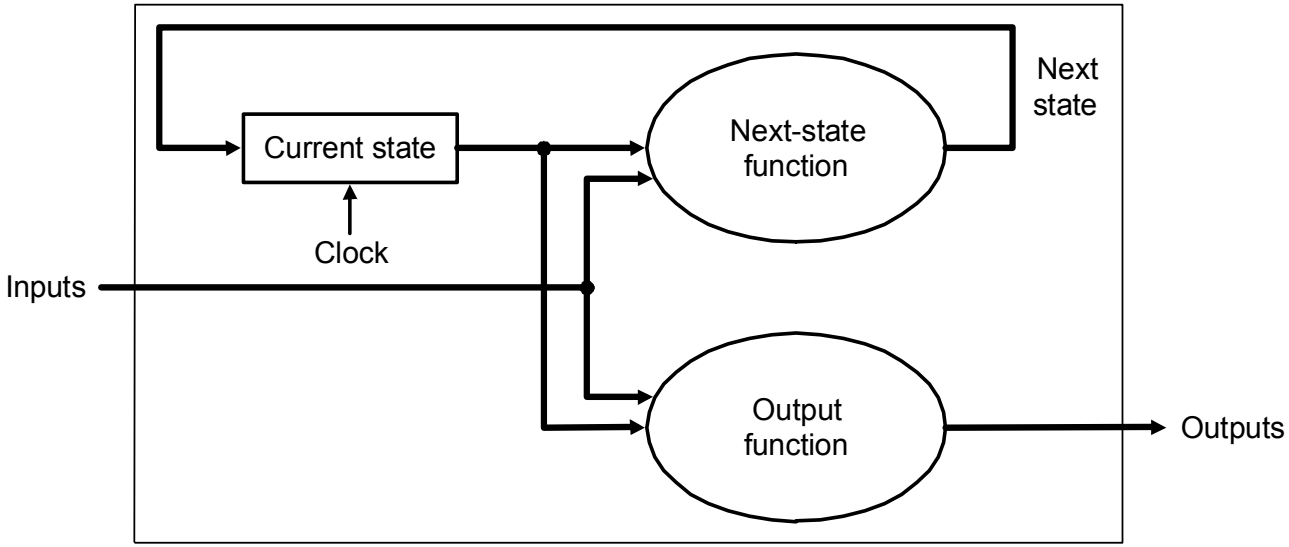
- What is going on during the 8th cycle of execution?
- In what cycle does the actual addition of `$t2` and `$t3` takes place?

Implementing the Control

- Value of control signals is dependent upon:
  - what instruction is being executed
  - which step is being performed
- Use the information we've accumulated to specify a finite state machine
  - specify the finite state machine graphically, or
  - use microprogramming
- Implementation can be derived from specification

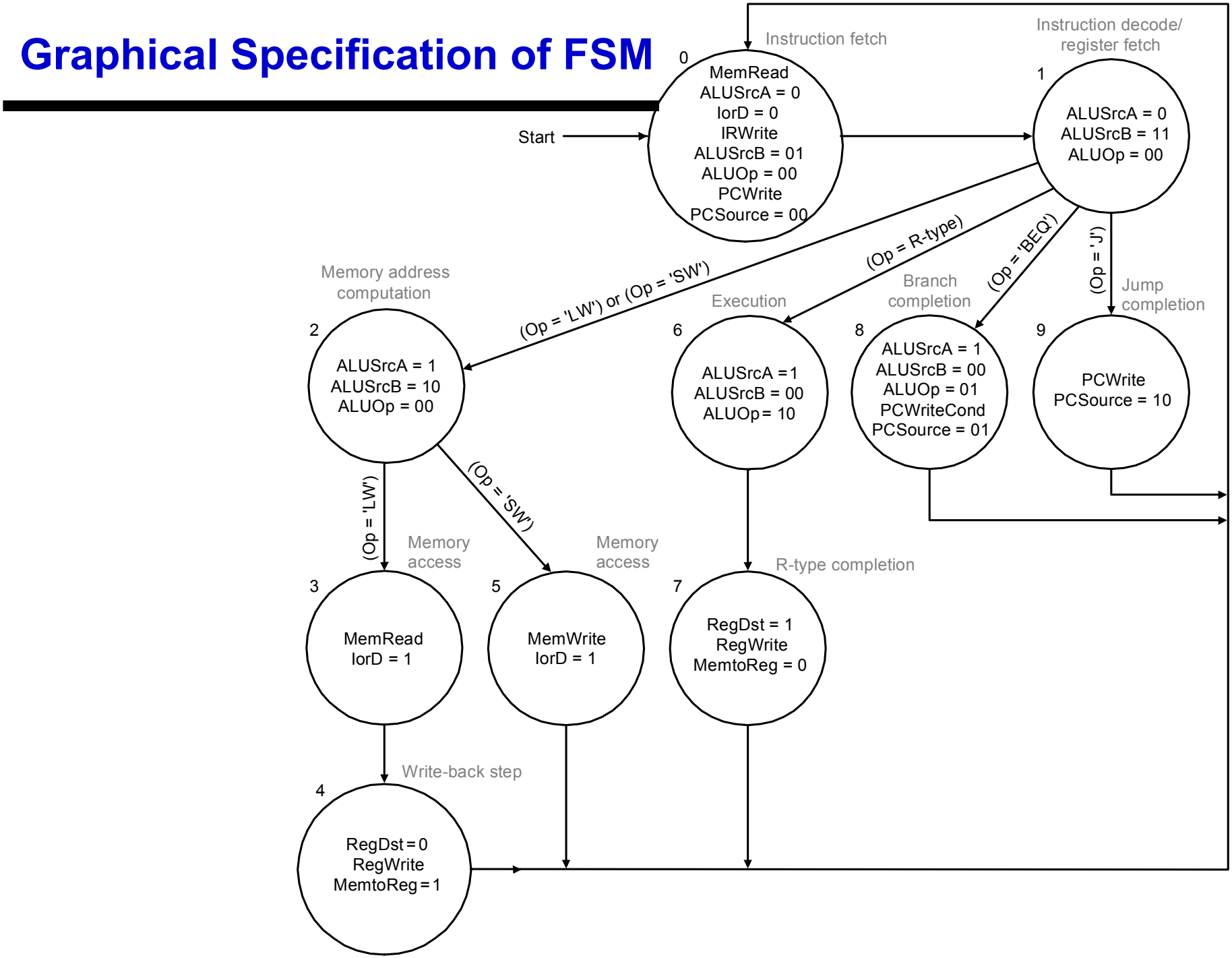
Review: finite state machines

- **Finite state machines:**
  - **a set of states and**
  - **next state function (determined by current state and the input)**
  - **output function (determined by current state and possibly input)**



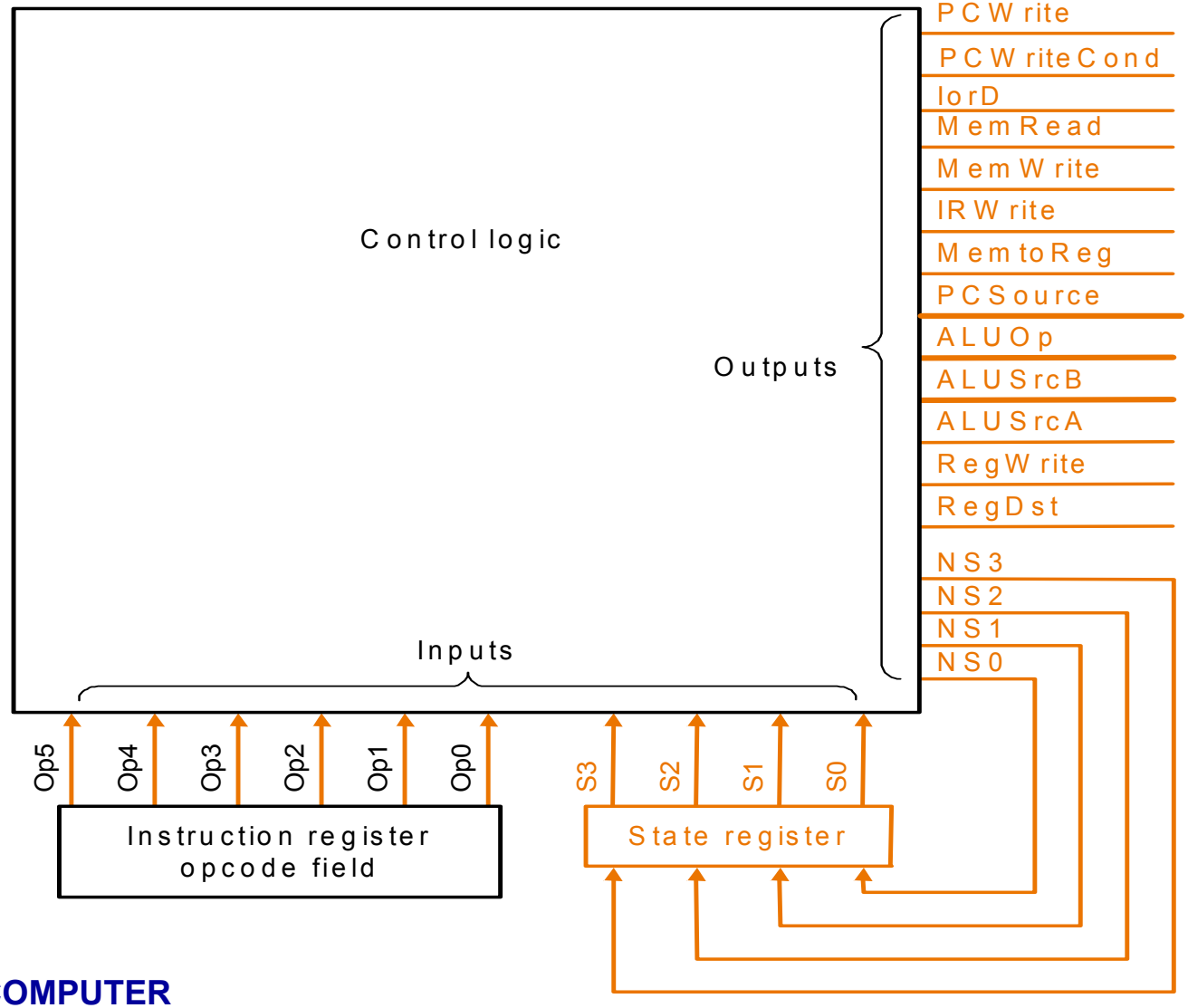
  - **We'll use a Moore machine (output based only on current state)**

Graphical Specification of FSM

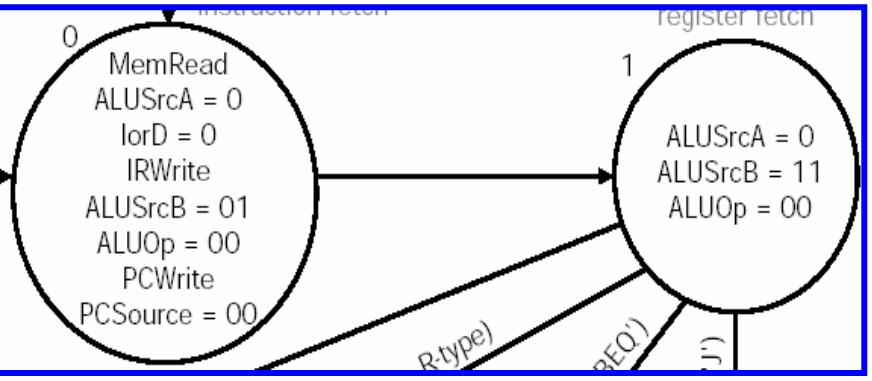


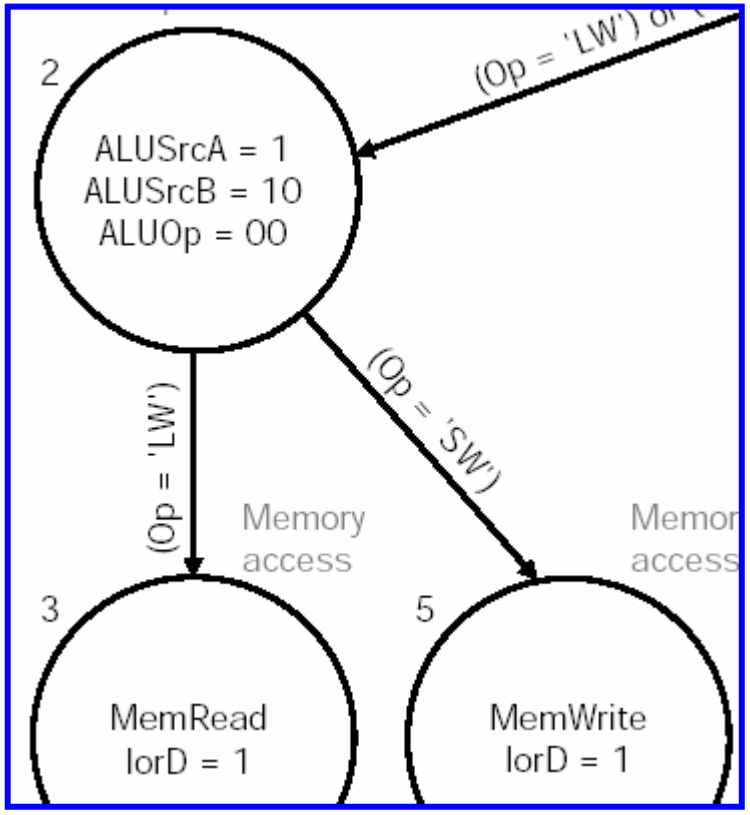
Finite State Machine for Control

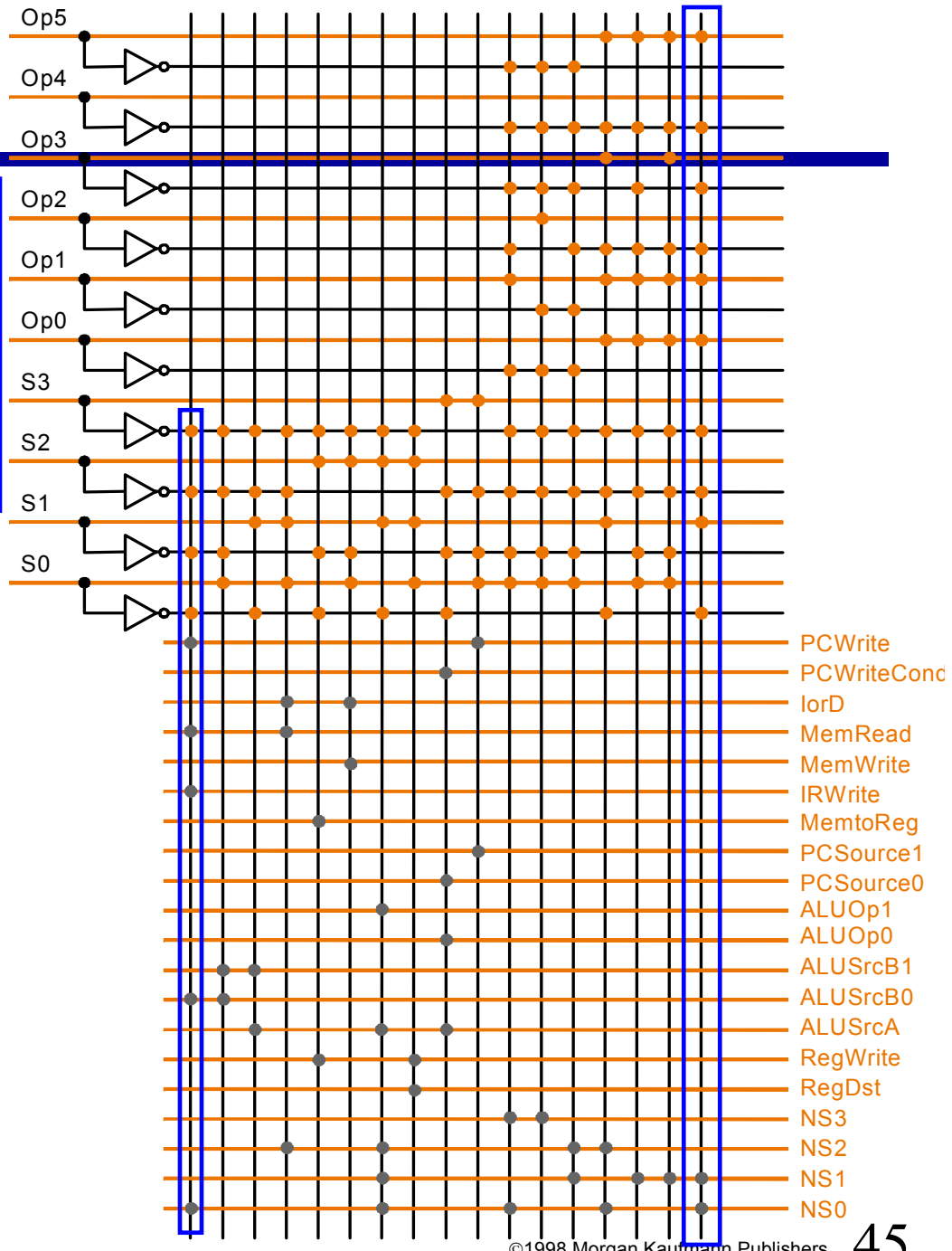
- Implementation:



PLA Implementation







Other Implementation

- ROM (read only memory)
  - Stores the truth table of inputs, states and outputs
  - PLA is much smaller in the amount of logic
- Mirocoprogramming
  - Executes microinstructions to generate signals
  - Suitable for large number of opcodes and complex control signals.