

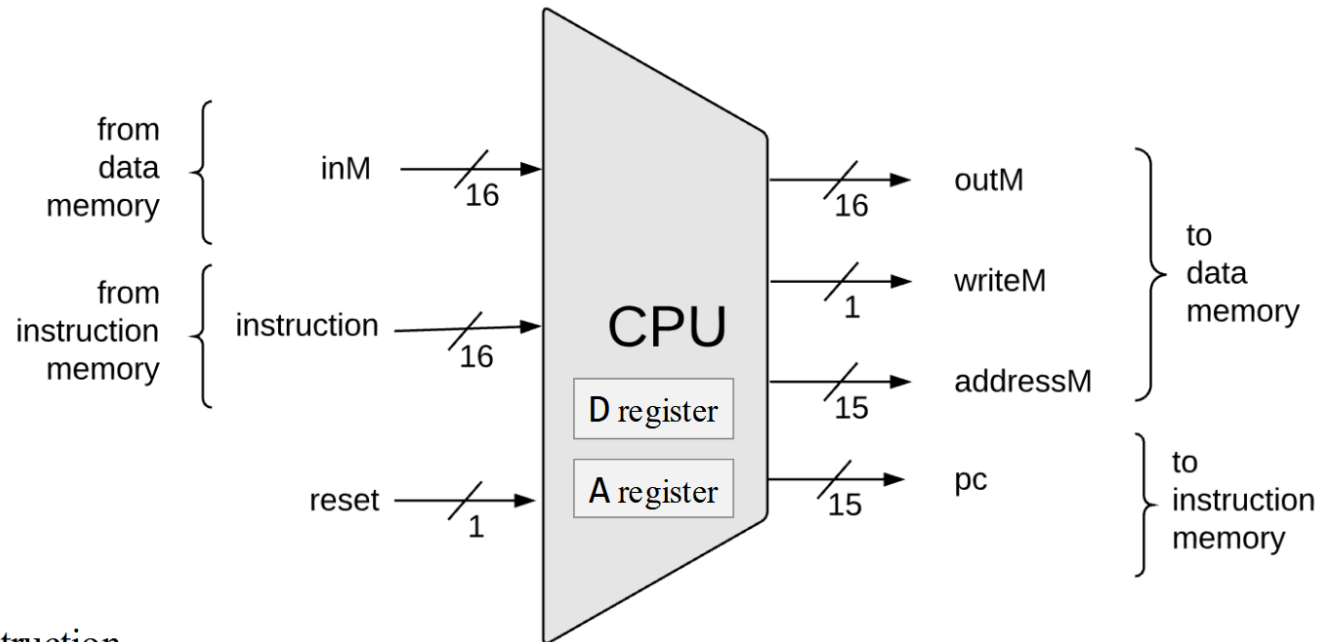
Agenda

CPU review and design

- Understanding CPU inputs/outputs
- Connecting machine code to control signals

NOTE: With slides from nand2tetris.org

Review CPU: Abstraction



Instruction examples:

```
// D = RAM[5] + 1
@5
DM=M+1
...
// goto 200
@200
0; JMP
...
```

1. Executes the current instruction:

If it's an A-instruction (`@xxx`), sets the A register to `xxx`

Else (C-instruction):

- Computes the ALU function specified by the instruction (on the values of `A`, `D`, `inM`)
- Puts the ALU output in `A`, `D`, `outM`, as specified by the instruction
- If the instruction writes to `M`, sets `addressM` to `A` and asserts `writeM`

Exercise: CPU inputs/outputs

CPU State:

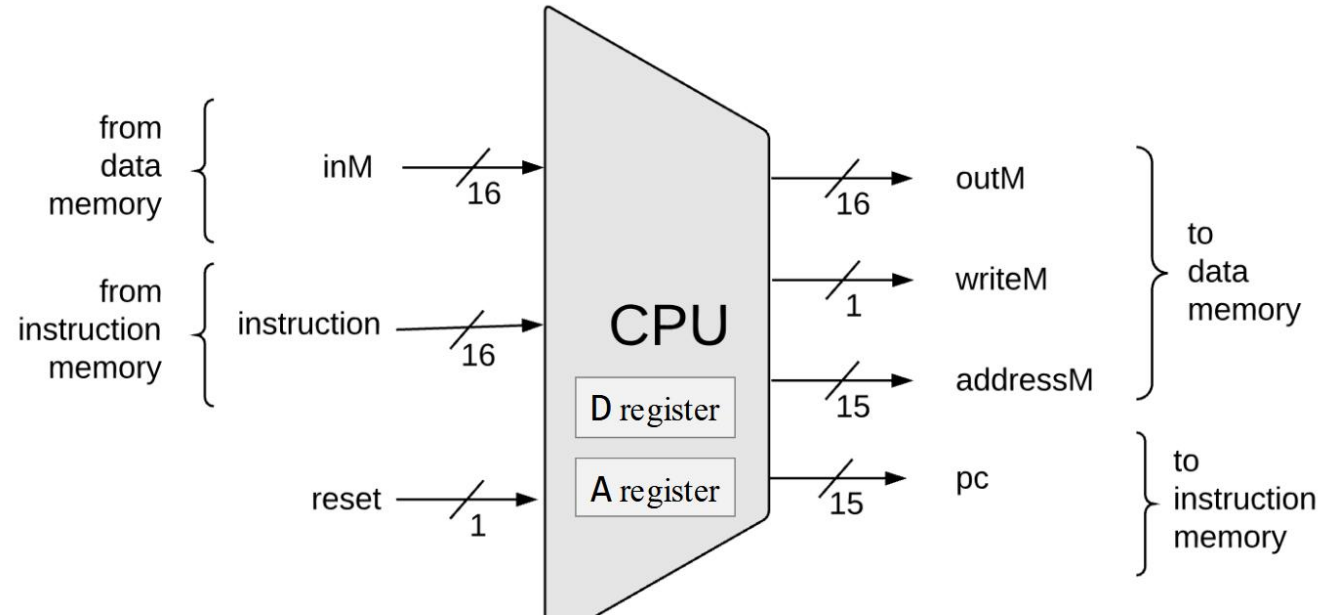
- D = 0x13
- A = 0x4
- PC = 0x3

Inputs:

- inM = 0x34
- instruction: @9
- reset = 0

Outputs/New State:

- outM =
- writeM =
- address =
- D =
- A =
- PC =



TODO: Change the value of A to 8 (not 0x4)

Exercise: CPU inputs/outputs

CPU State:

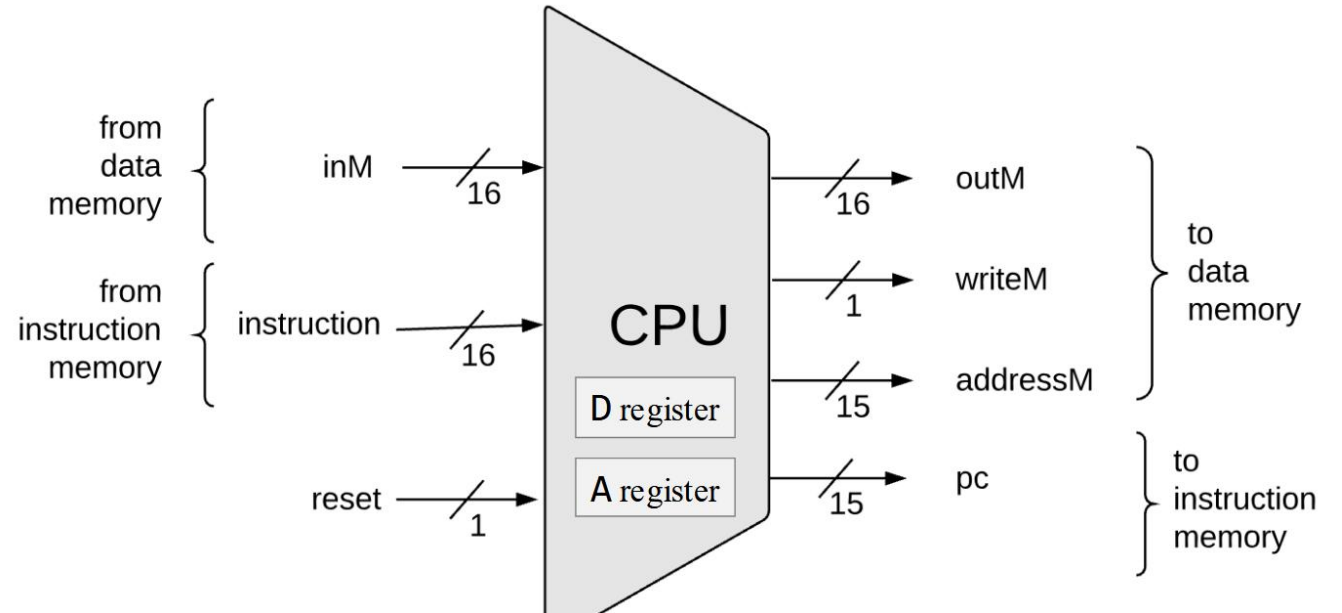
- D = 0x13
- A = 0x4
- PC = 0x3

Inputs:

- inM = 0x34
- instruction: D;JMP
- reset = 0

Outputs:

- outM =
- writeM =
- address =
- D =
- A =
- PC =



Exercise: CPU inputs/outputs

CPU State:

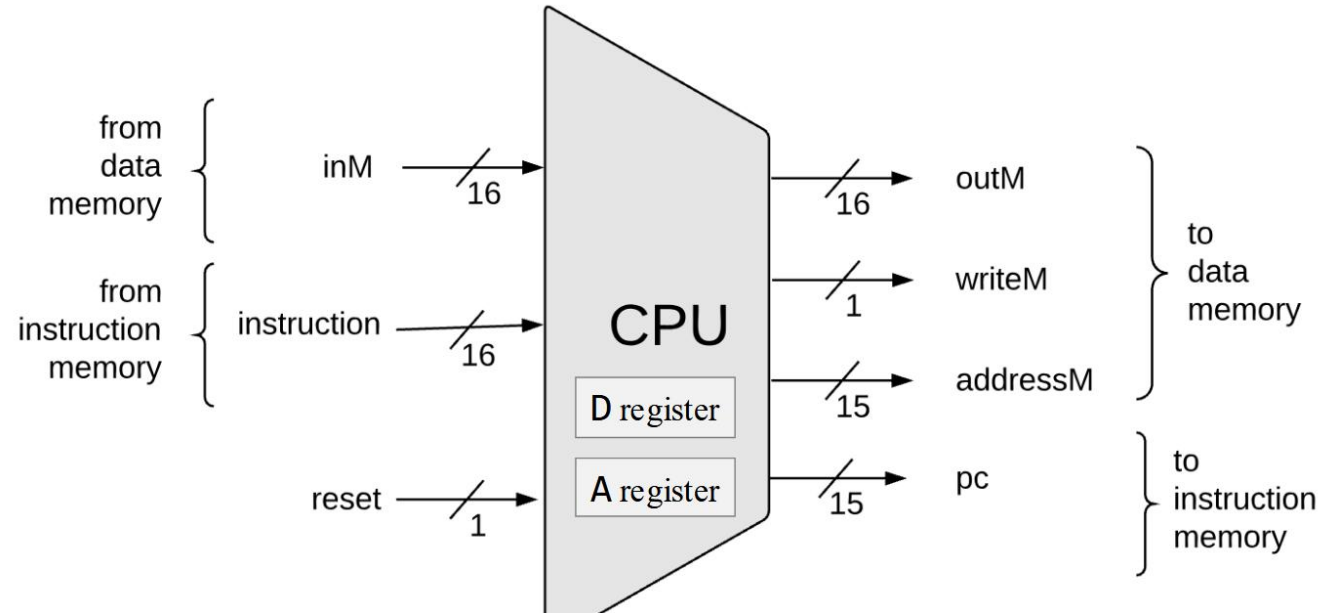
- D = 0x13
- A = 0x4
- PC = 0x3

Inputs:

- inM = 0x34
- instruction: D=M
- reset = 0

Outputs:

- outM =
- writeM =
- address =
- D =
- A =
- PC =



Exercise: CPU inputs/outputs

CPU State:

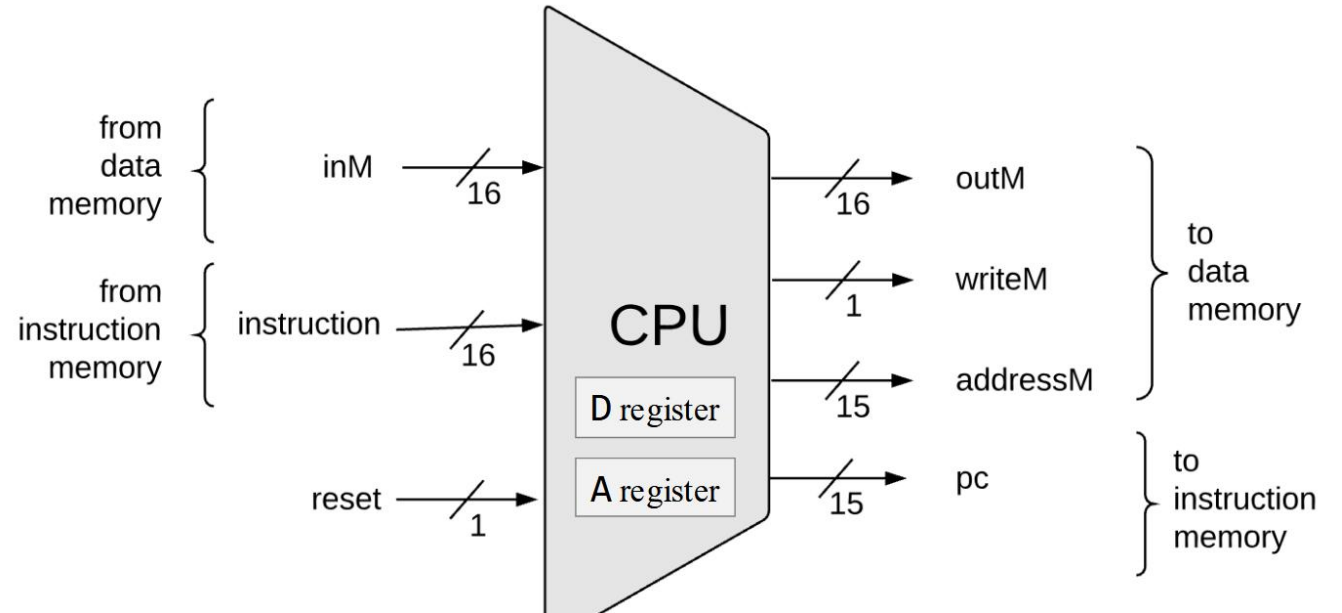
- $D = 0x13$
- $A = 0x4$
- $PC = 0x3$

Inputs:

- $inM = 0x34$
- instruction: $M=M+1$
- $reset = 0$

Outputs:

- $outM =$
- $writeM =$
- $address =$
- $D =$
- $A =$
- $PC =$



Exercise: CPU inputs/outputs

CPU State:

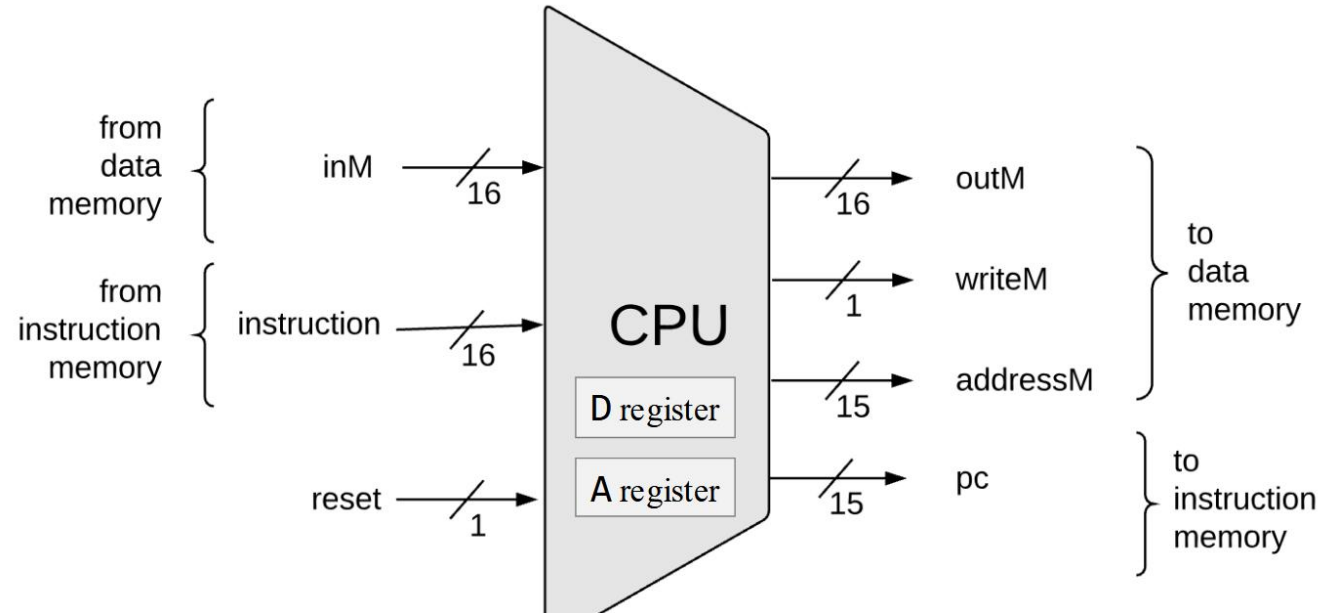
- D = 0x13
- A = 0x4
- PC = 0x3

Inputs:

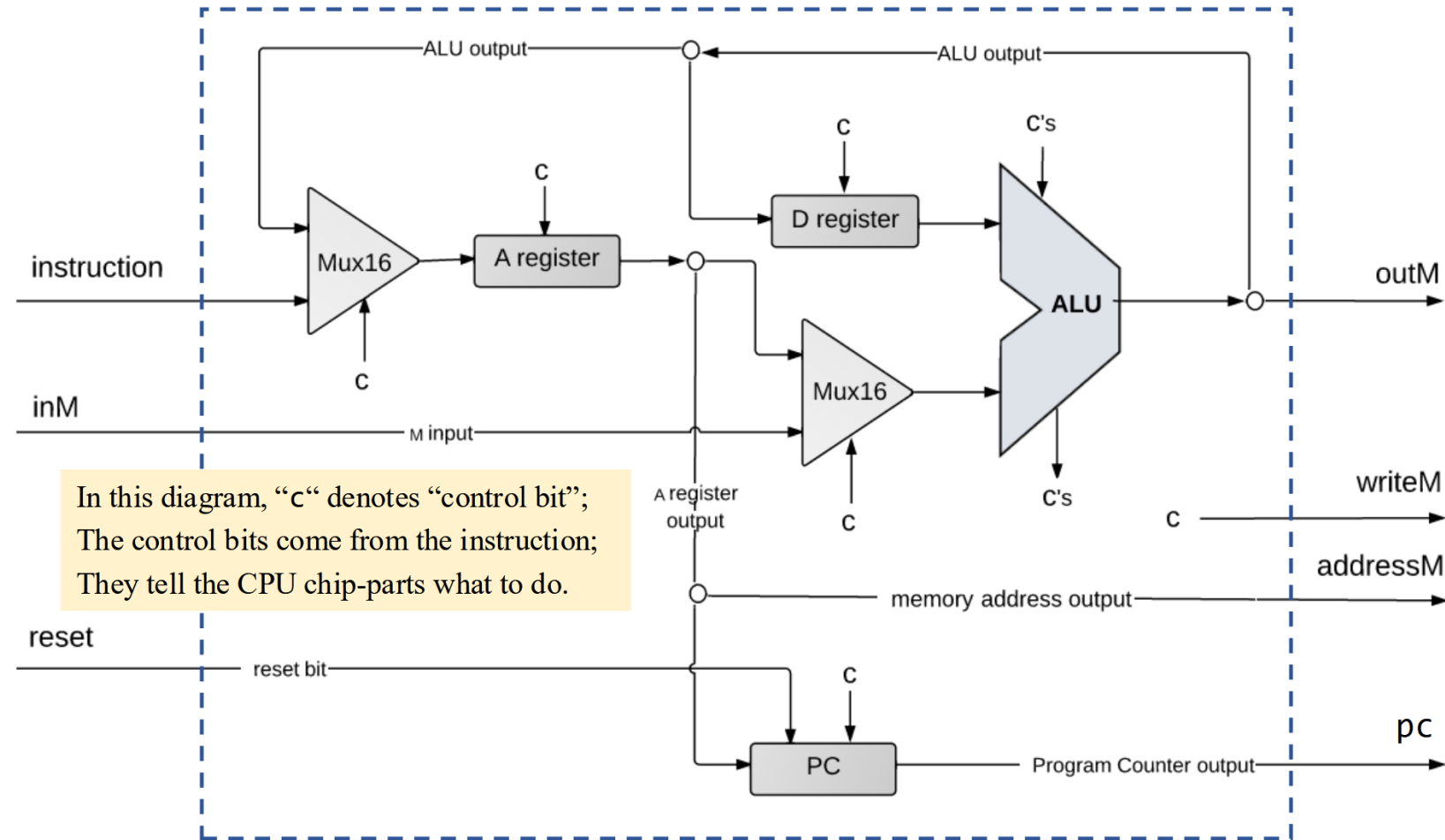
- inM = 0x34
- instruction: D=A
- reset = 0

Outputs:

- outM =
- writeM =
- address =
- D =
- A =
- PC =



Recall: Hack CPU architecture



Hack CPU architecture

Exercise: Show how the following instruction is converted to control signals for the CPU

0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	@9
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----

Exercise: Show how the following instruction is converted to control signals for the CPU

1	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

A=0

Exercise: Show how the following instruction is converted to control signals for the CPU

1	1	1	0	1	0	1	0	1	0	0	1	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

D=0

Exercise: Show how the following instruction is converted to control signals for the CPU

1	1	1	1	1	1	0	1	1	1	0	0	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Exercise: Show how the following instruction is converted to control signals for the CPU

1	1	1	0	1	0	1	0	1	0	0	0	0	1	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

0;JMP