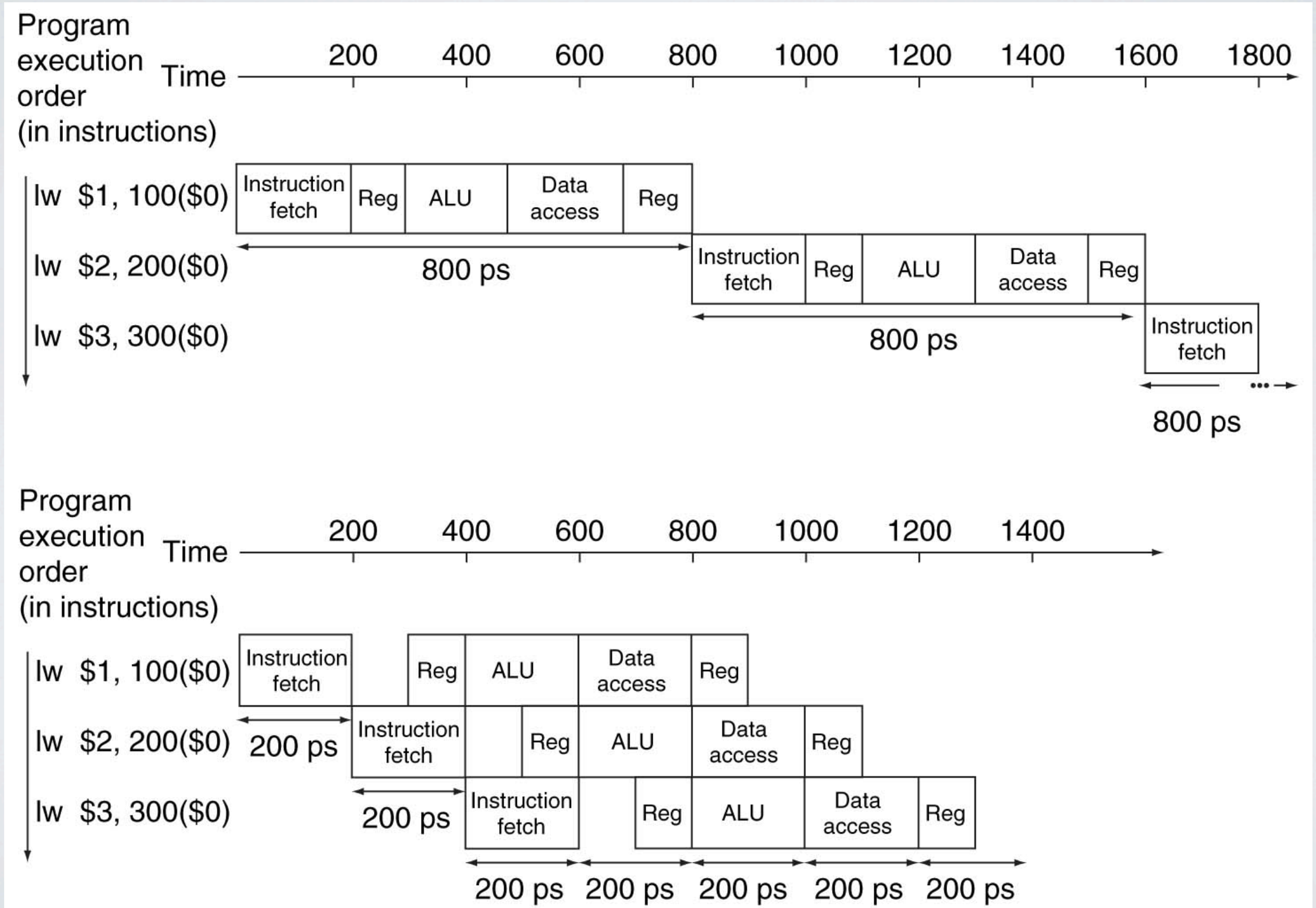
CSCI341

Lecture 34, Pipelined Datapath

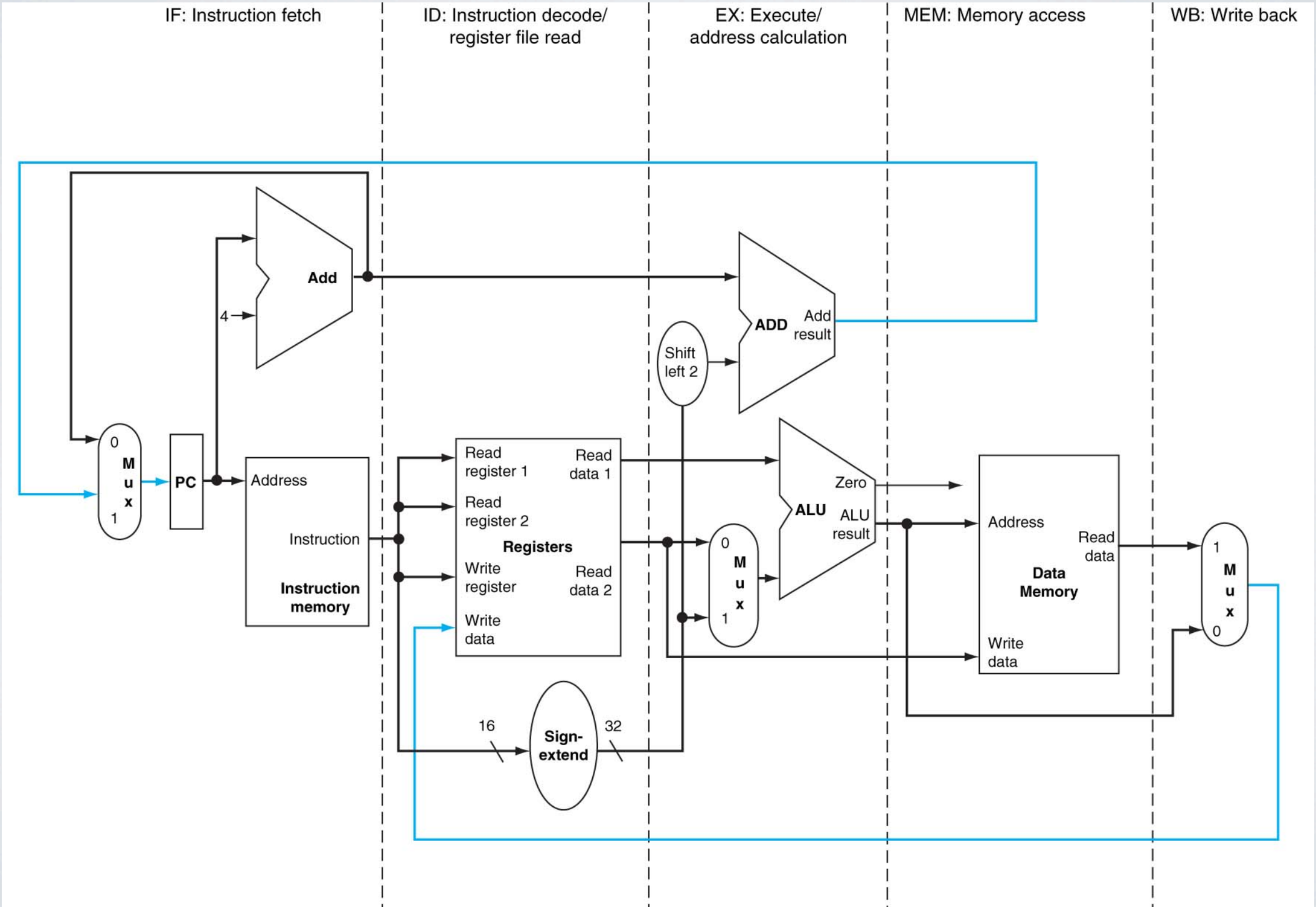
RECALL...


Program execution order (in instructions)
Time
200
400
600
800
1000
1200
1400
1600
1800
lw $1, 100($0)
lw $2, 200($0)
lw $3, 300($0)
Instruction fetch
Reg
ALU
Data access
Reg
800 ps
800 ps
800 ps
Program execution order (in instructions)
Time
200
400
600
800
1000
1200
1400
lw $1, 100($0)
lw $2, 200($0)
lw $3, 300($0)
Instruction fetch
Reg
ALU
Data access
Reg
200 ps
200 ps
200 ps
200 ps
200 ps
200 ps
200 ps

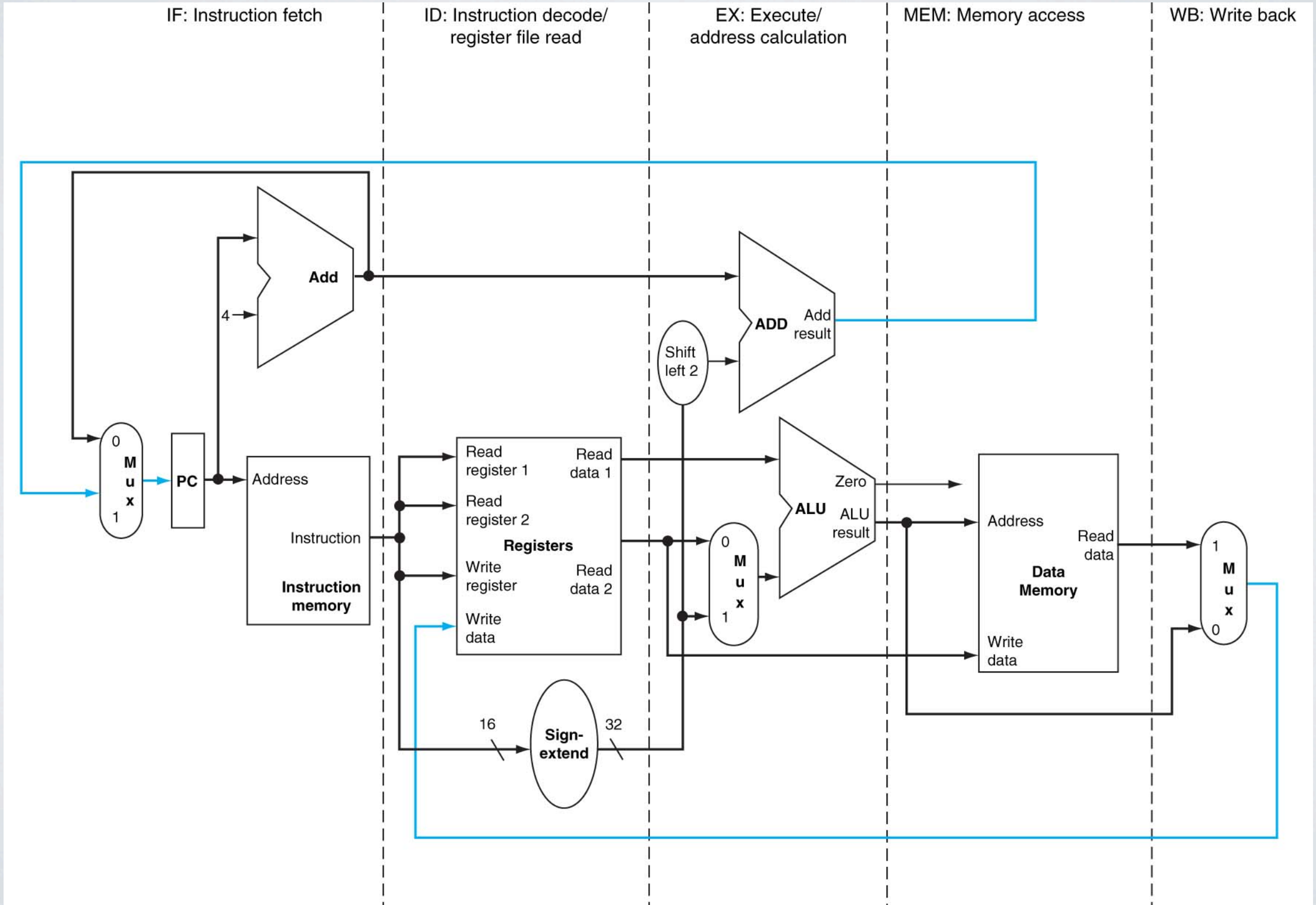
RECALL...

- Structural Hazards
- Data Hazards
- Control Hazards

SINGLE-CYCLE DATAPATH



LEFT TO RIGHT

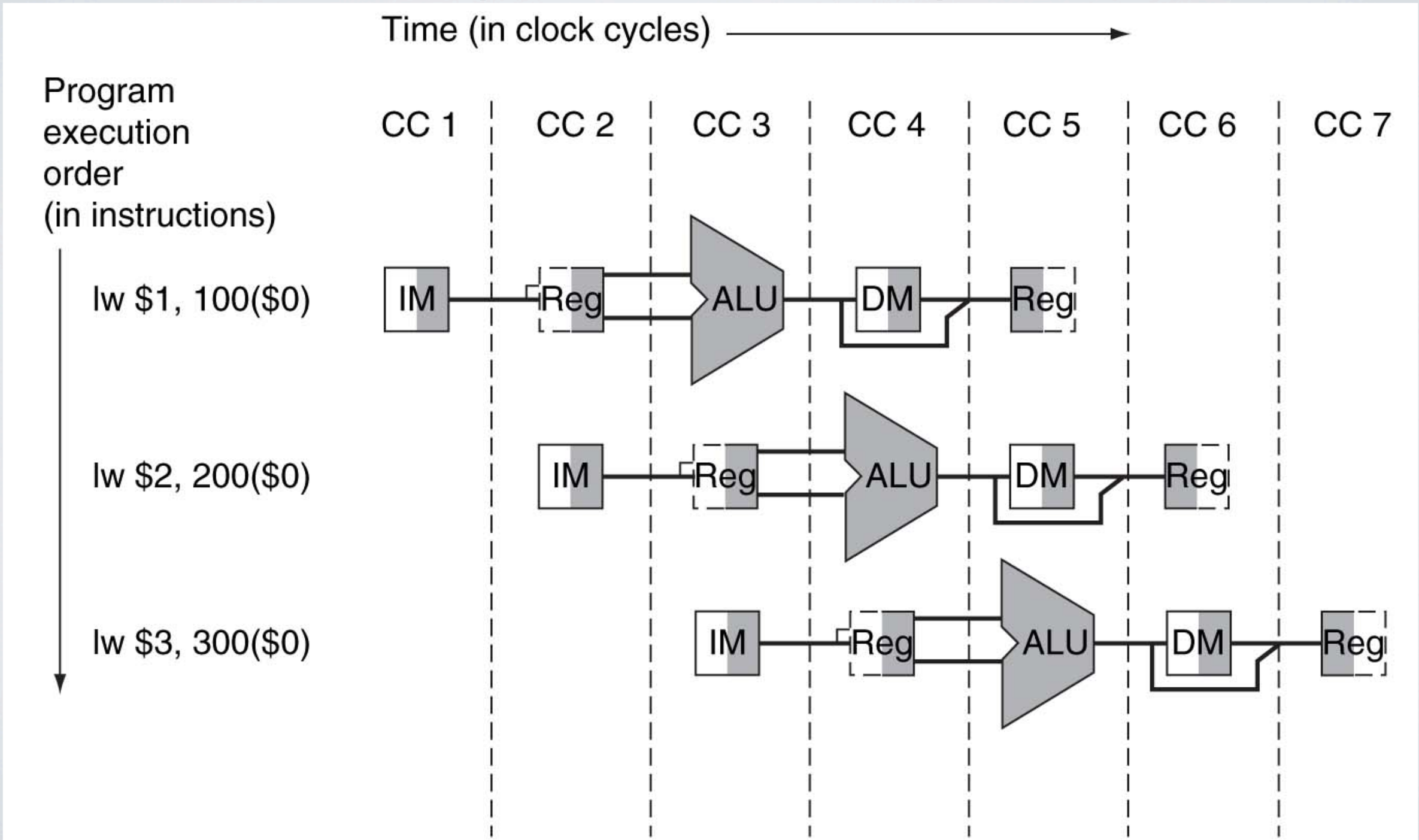


EXCEPT... LEFT-TO-RIGHT

- Writing back to the register file (what kind of hazard?)
- Selecting the value of PC (what kind of hazard?)

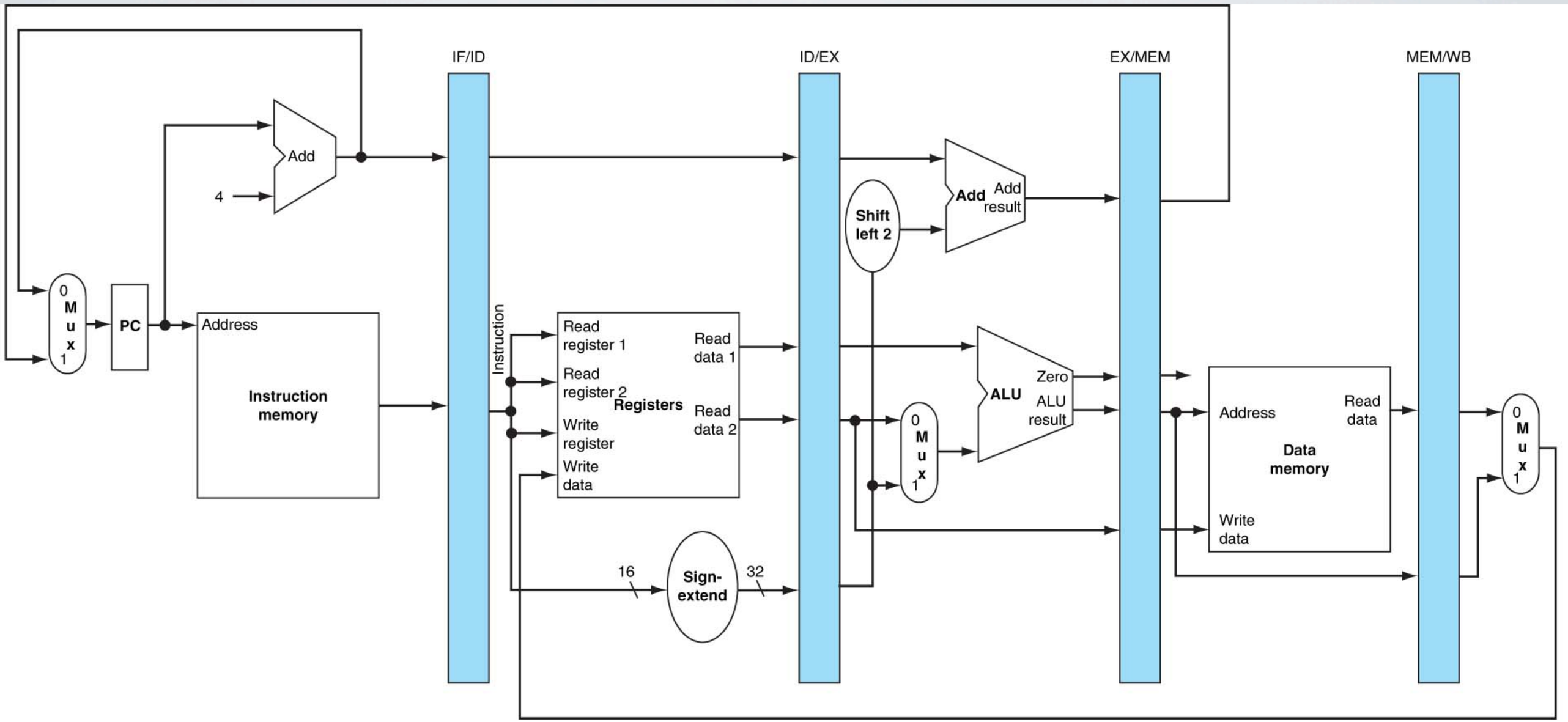
Note that data flowing R-to-L doesn't affect the *current* instruction.

PIPELINED EXECUTION (PRETEND)



PIPELINE REGISTERS

64 bits 128 bits 97 bits 64 bits



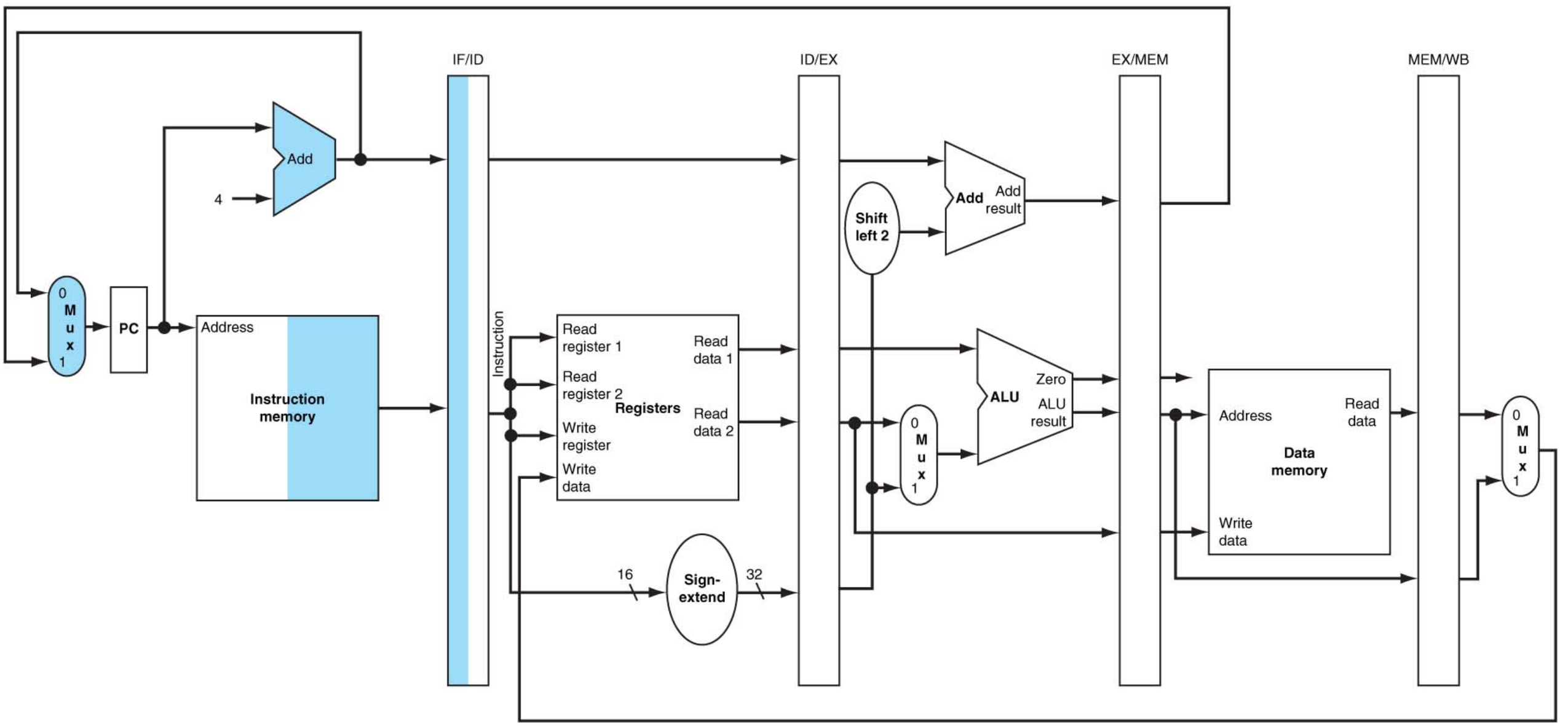
EXAMPLE

Five stages of a **`lw`** instruction.

Note:
shaded on the right: read
shaded on the left: write

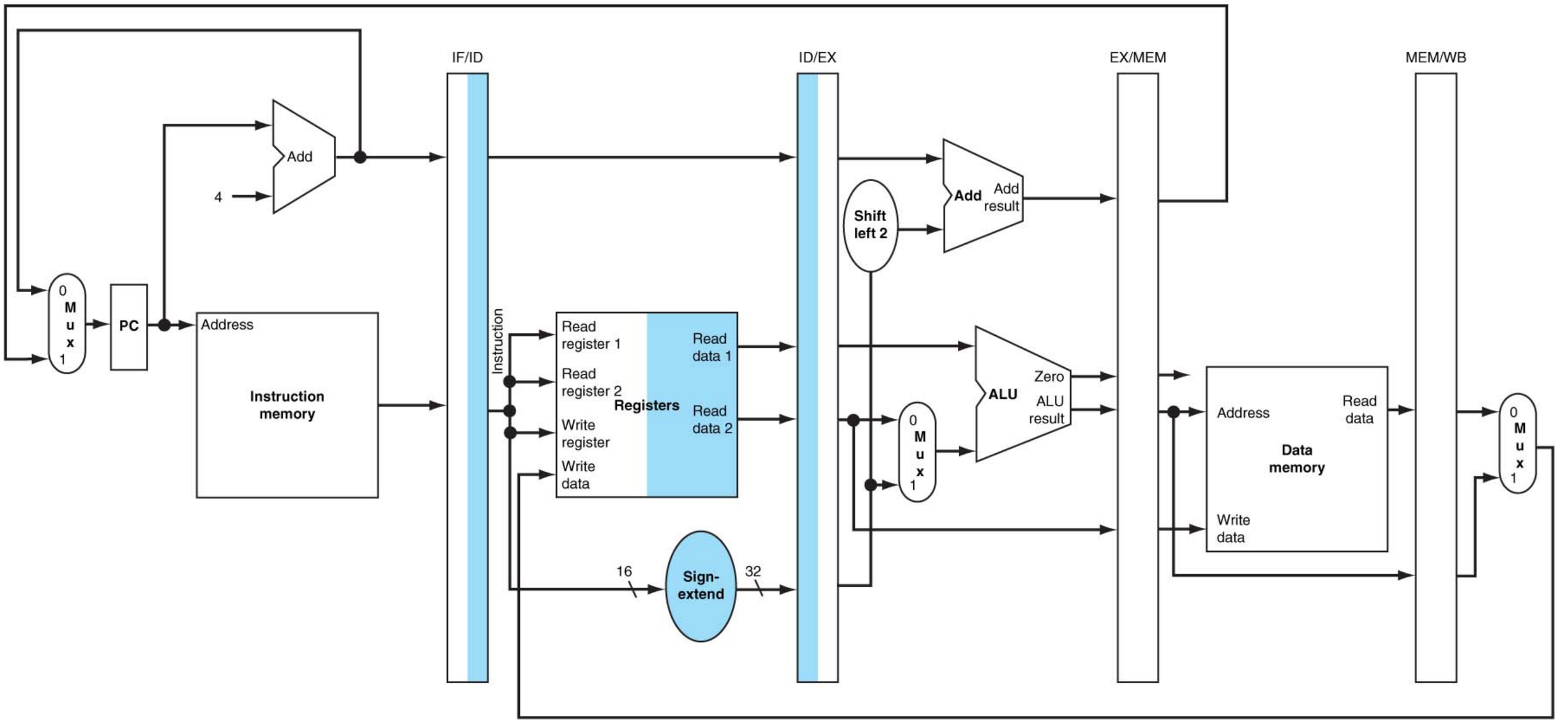
lw

Instruction fetch



lw

Instruction decode



lw

Execution

IF/ID

ID/EX

EX/MEM

MEM/WB

Add

4

M
u
x

0

1

PC

Address

Instruction memory

Instruction

Read register 1

Read register 2

Registers

Write register

Write data

Read data 1

Read data 2

Shift left 2

Add

Add result

ALU

Zero

ALU result

16

Sign-extend

32

Address

Read data

Data memory

Write data

lw

Memory

IF/ID

ID/EX

EX/MEM

MEM/WB

Add

4

0
M
u
x
1

PC

Address

Instruction memory

Instruction

Read register 1

Read register 2

Registers

Write register

Write data

Read data 1

Read data 2

16

Sign-extend

32

Shift left 2

Add

Add result

0
M
u
x
1

ALU

Zero

ALU result

Address

Data memory

Read data

Write data

0
M
u
x
1

lw

Write-back

IF/ID

ID/EX

EX/MEM

MEM/WB

Add

4

0
M
u
x
1

PC

Address

Instruction memory

Instruction

Read register 1

Read register 2

Registers

Write register

Write data

Read data 1

Read data 2

Shift left 2

Add

Add result

ALU

Zero

ALU result

0
M
u
x
1

Address

Read data

Data memory

Write data

0
M
u
x
1

16

Sign-extend

32

HOMEWORK

- Reading 29

I zombies.