

CSCI 210: Computer Architecture

Lecture 31: Data Hazards

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Slides from Cynthia Taylor

Announcements

- Problem Set 10 due Sunday, January 2
- Lab 8 due Sunday, January 2
- Office Hours tomorrow 13:30–14:30

Data Hazards in ALU Instructions

- Consider this sequence:

```
sub $2, $1, $3
```

```
and $12, $2, $5
```

```
or $13, $6, $2
```

```
add $14, $2, $2
```

```
sw $15, 100($2)
```

- We can resolve hazards with forwarding
 - How do we detect when to forward?

Forwarding

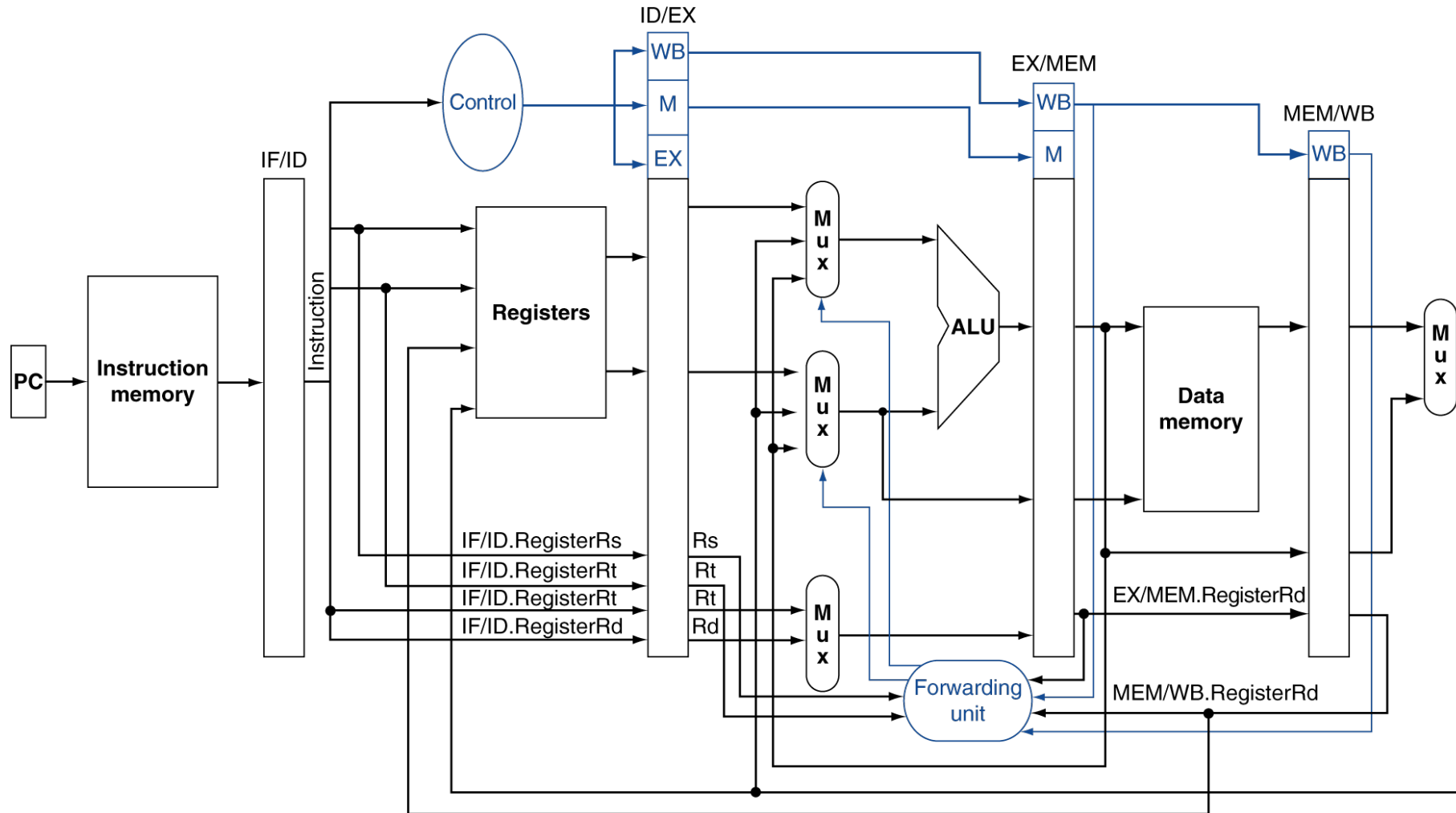
Datapath

- Connect the outputs of EX and MEM stages to both ALU inputs controlled by muxes

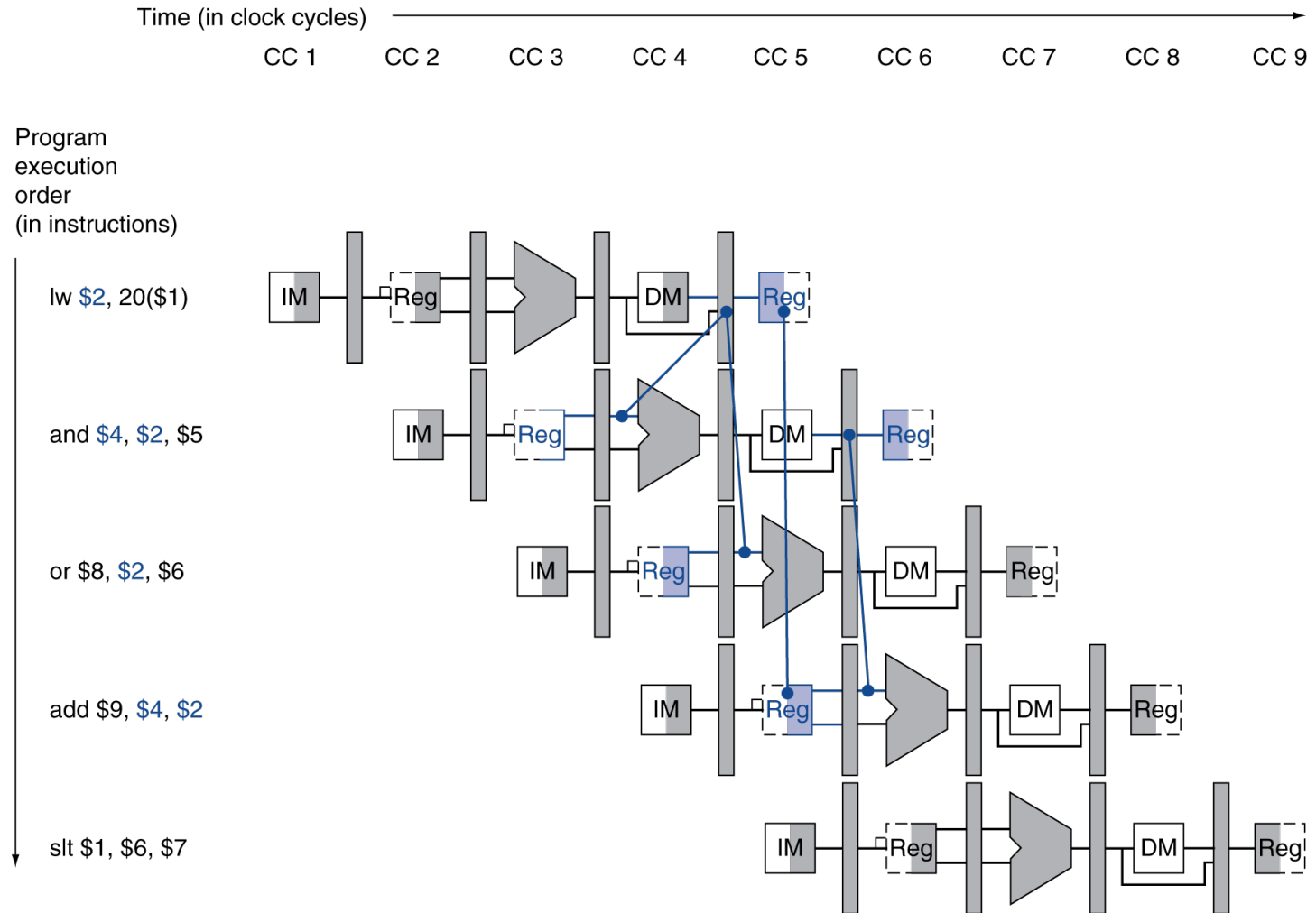
Control path

- Pass rs, rt, and rd register numbers through the pipeline registers
- Add a forwarding unit to control the muxes
 - Depends on RegWrite and rs/rt/rd from various stages

Datapath with Forwarding

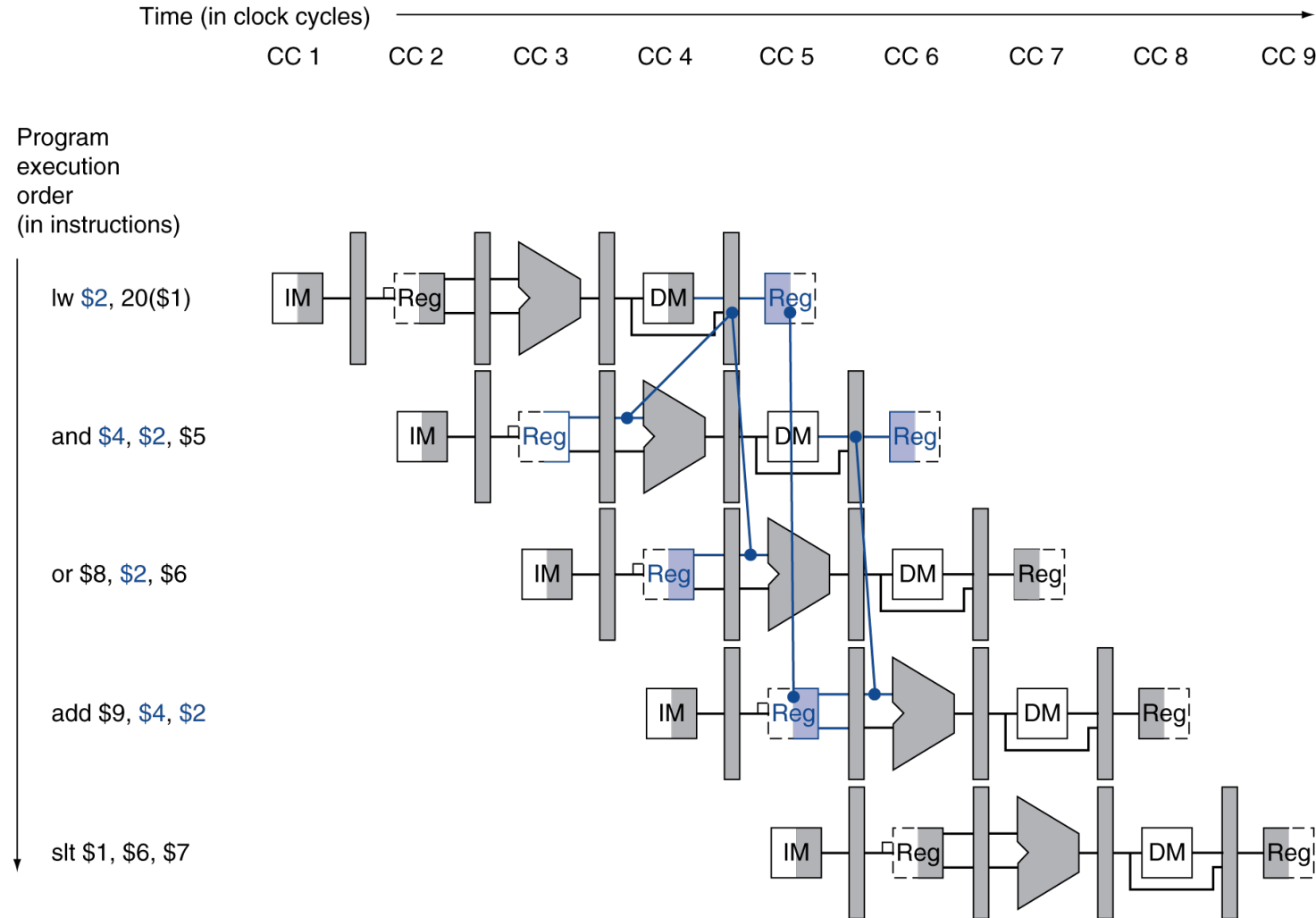


Load-Use Data Hazard

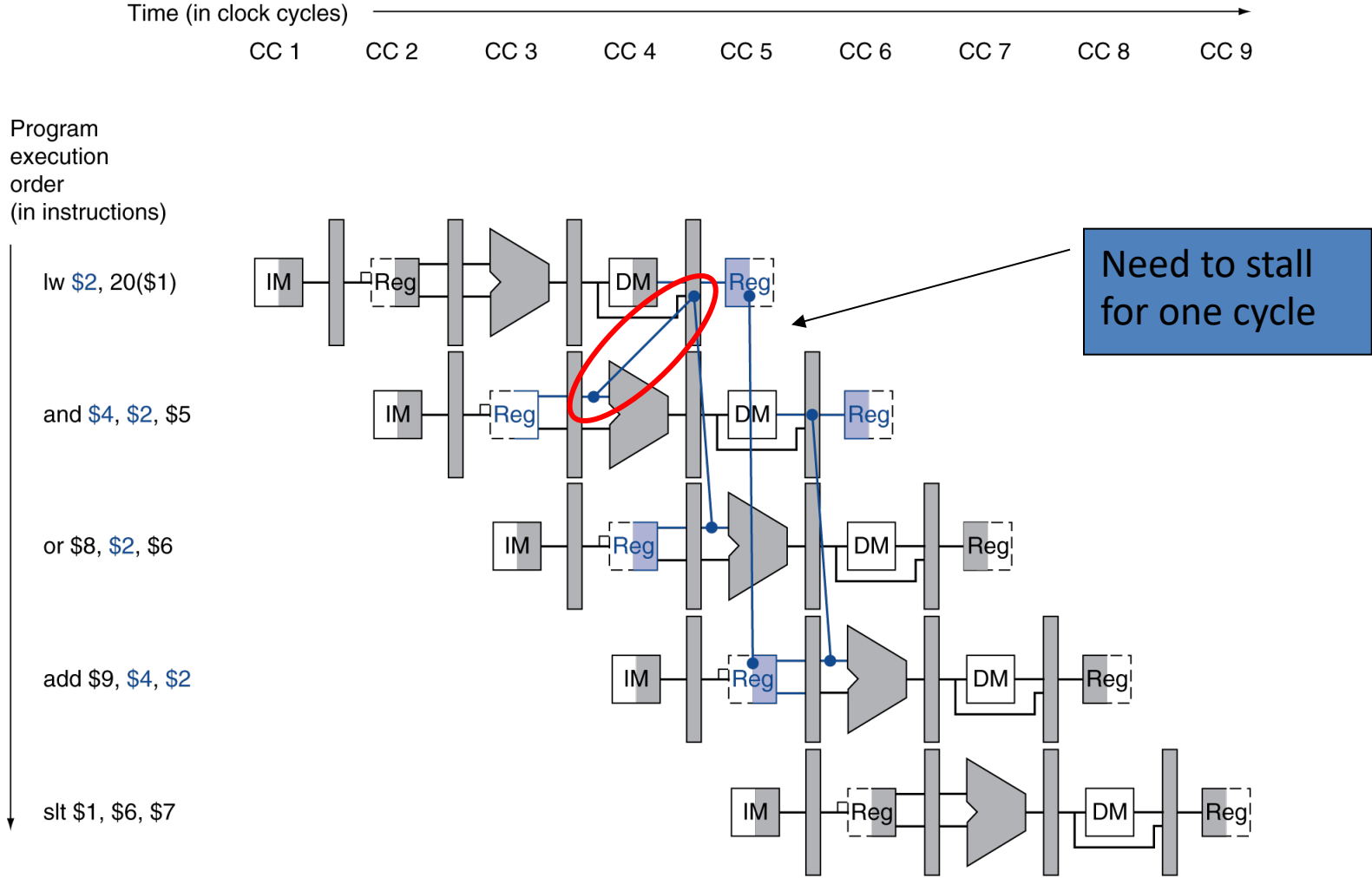


We can BEST solve these data hazards

- A. By stalling.
- B. By forwarding.
- C. By combining forwards and stalls.
- D. By doing something else.



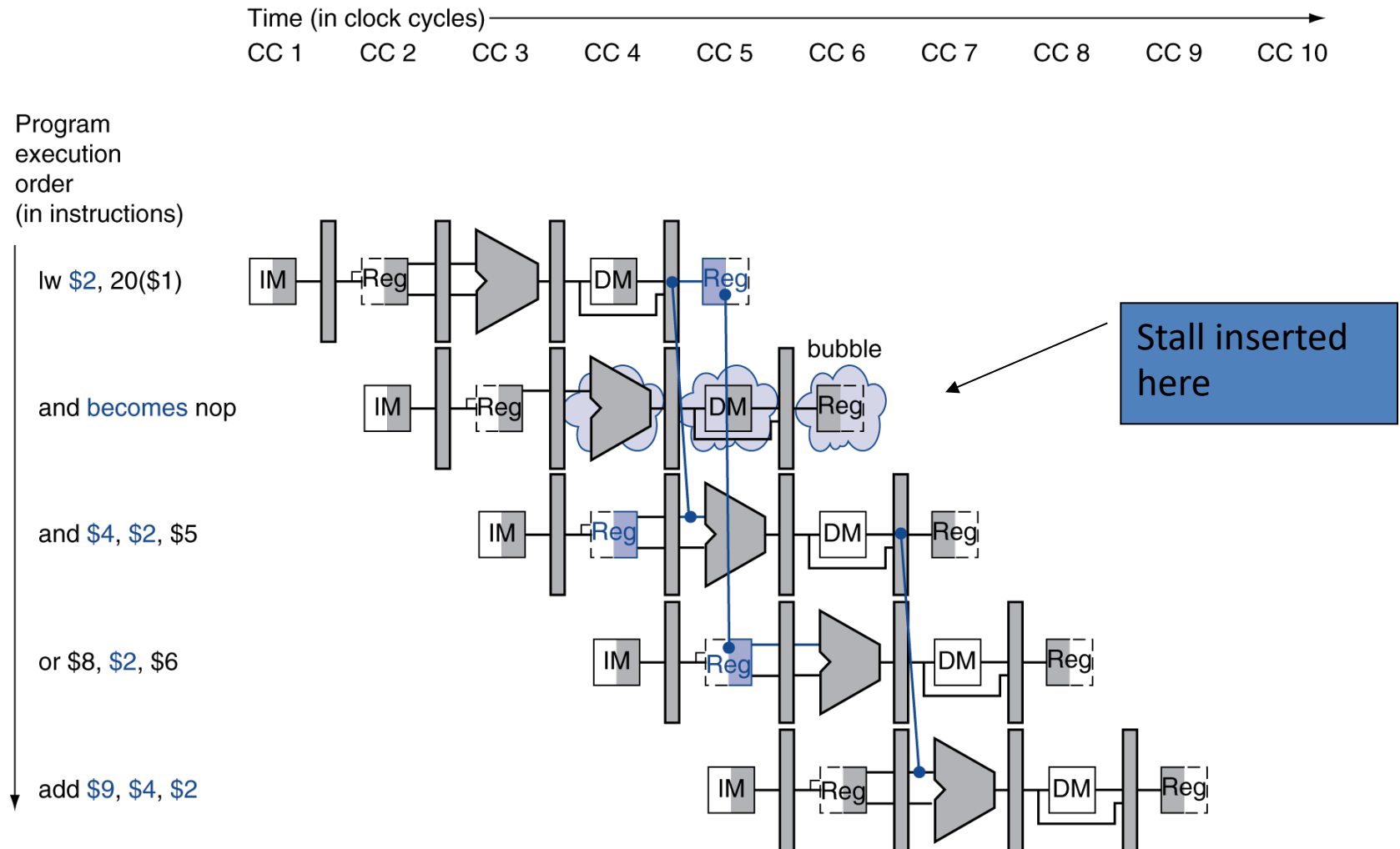
Load-Use Data Hazard



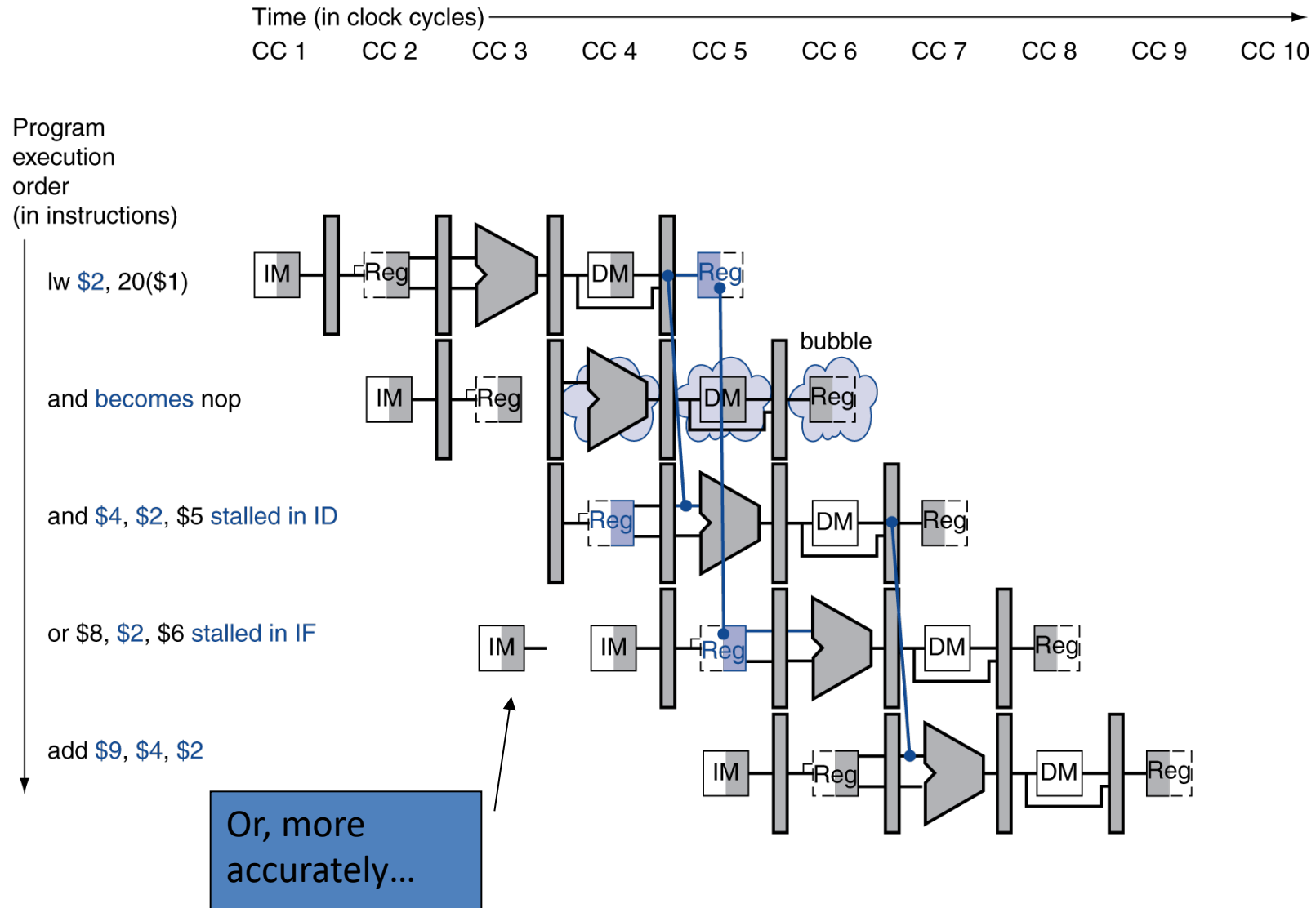
How to Stall the Pipeline

- Detect hazard in ID stage using Hazard detection unit
 - Check if instruction in EX stage is load with destination rs or rt
- Force control values in ID/EX register to 0
 - EX, MEM and WB do nop (no-operation)
- Prevent update of PC and IF/ID register
 - Instruction with dependency is decoded again
 - Following instruction is fetched again
 - 1-cycle stall allows MEM to read data for T_w
 - Can subsequently forward to EX stage

Stall/Bubble in the Pipeline

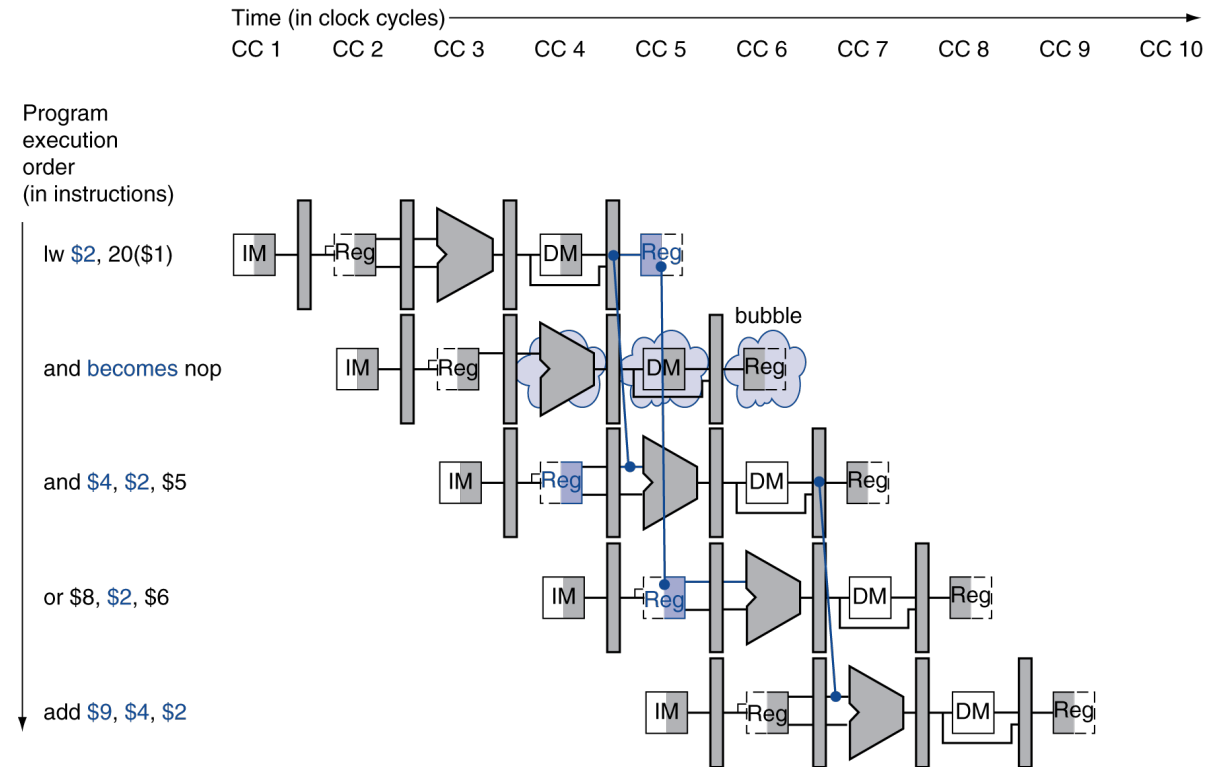


Stall/Bubble in the Pipeline

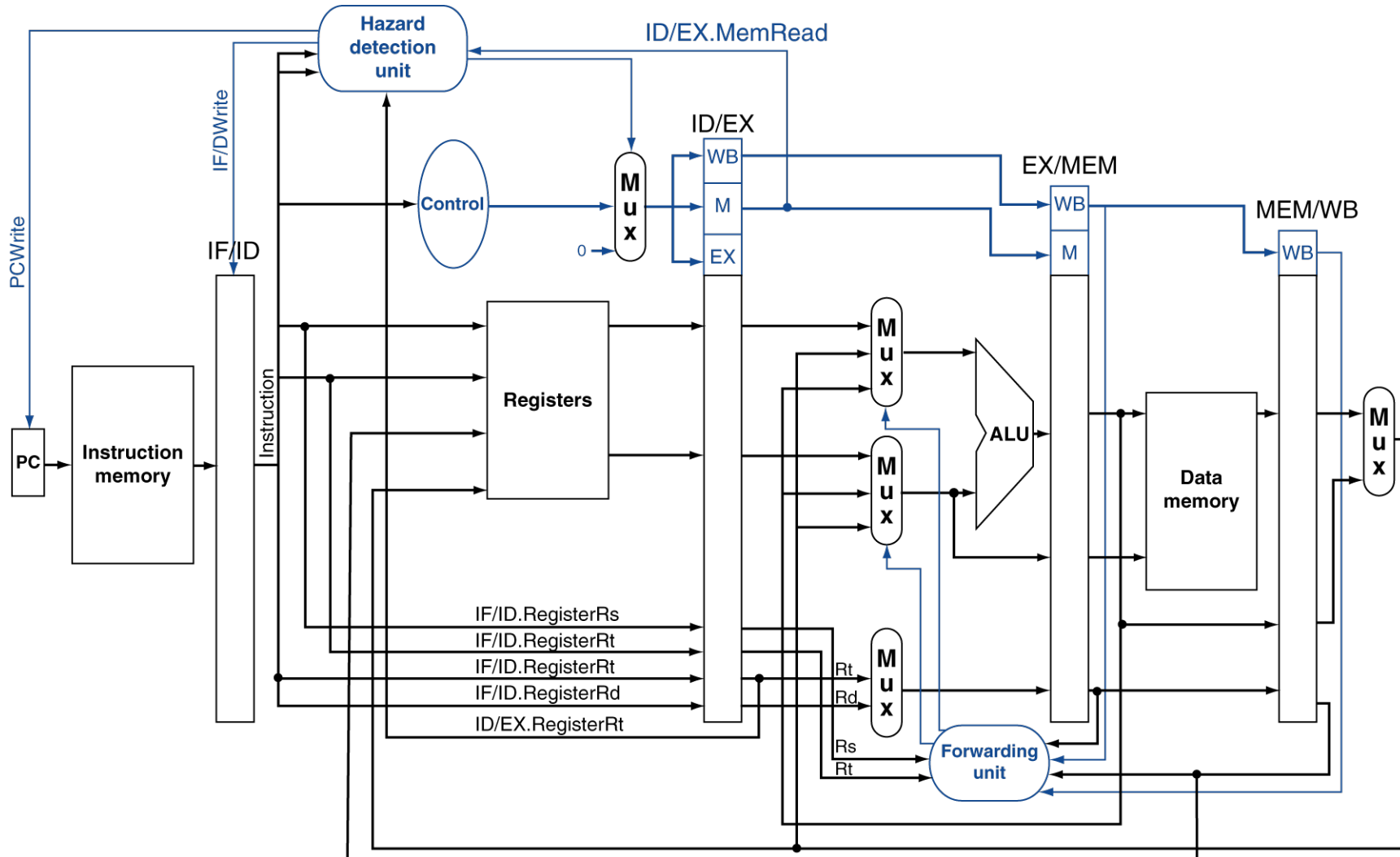


After we add the stall

- A. Everything works with our existing forwarding
- B. We need to forward between the register files to solve the 2nd hazard
- C. We need to do something else



Datapath with Hazard Detection



Reading

- Next lecture: Control Hazards
 - Section 5.9
- Problem Set 10 due Friday
- Lab 8 due Monday