Complex Pipelines

Axel Feldmann

(slides adapted from prior 6.823 offerings)

Agenda

- Lab1 due today – please don't forget to **commit and push** your solutions!
- Recitations from today will reinforce lecture materials with:
  - Review slides
  - Going over problem sets
  - Going over prior quizzes
- Please ask questions!

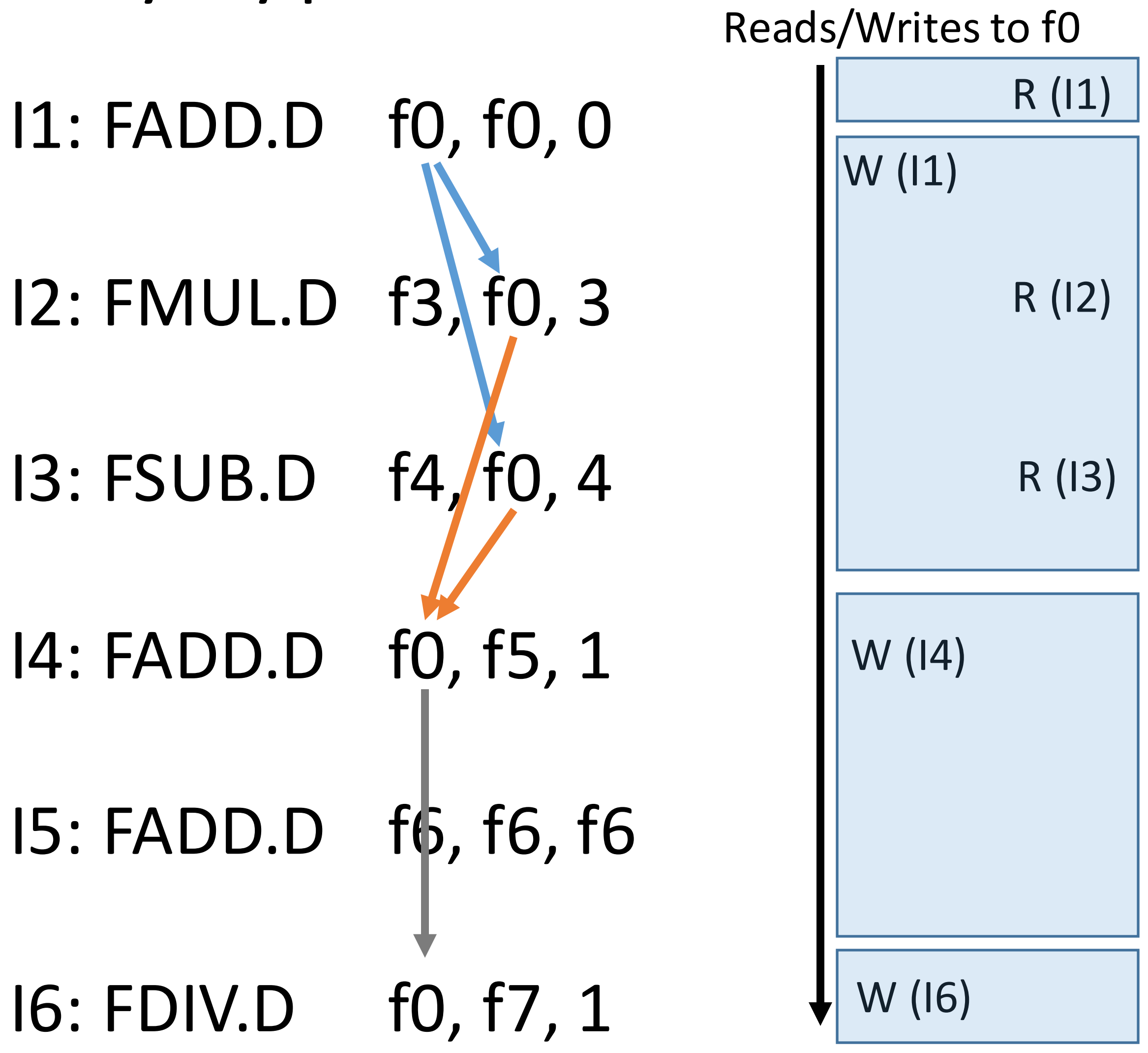
Dependence vs. hazard

- Dependence is a property of programs
- Whether a dependence results in a hazard is a property of pipeline organizations

Dependency types

- RAW
- WAR
- WAW

```
I1: FADD.D   f0, f0, 0
I2: FMUL.D   f3, f0, 3
I3: FSUB.D   f4, f0, 4
I4: FADD.D   f0, f5, 1
I5: FADD.D   f6, f6, f6
I6: FDIV.D   f0, f7, 1
```

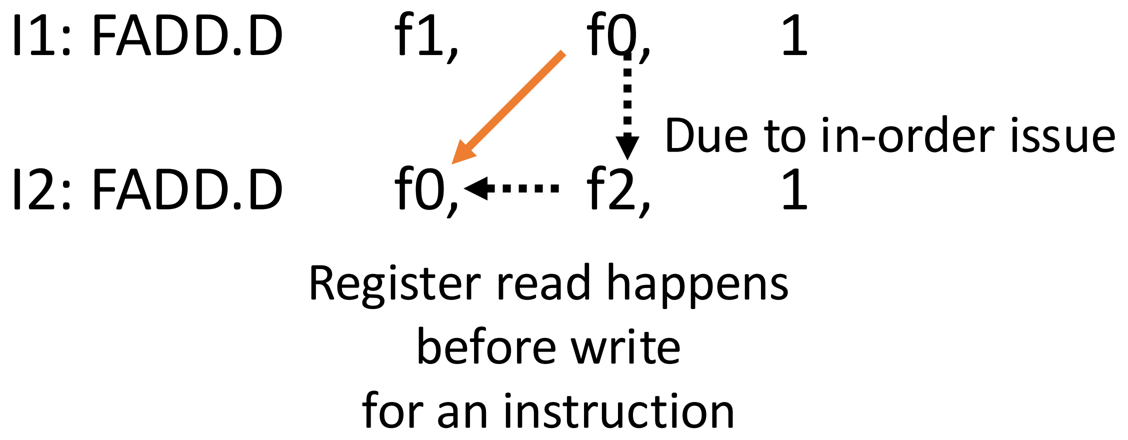


Scoreboard

- A data structure that detects hazards dynamically
- Applicable to both in-order and out-of-order issue
- Why do we need this?
  - Many execution units
  - Variable execution latency
  - Dynamic instruction scheduling

Scoreboard

- Can have many implementations!
- Example: In-order issue
  - WAR cannot happen (if value is latched to functional unit at issue)



```
I1: FADD.D    f1,    f0,    1
I2: FADD.D    f0,    f2,    1
```

  - Can be simplified as Busy[FU#] and WP[reg#] (if WAW resolved conservatively)

Scoreboard

- What strategy does it use to resolve RAW?
  - Stall
- How about bypass?
  - Expensive when there are many functional units!
  - Less beneficial where writeback stage is a small portion of the entire pipeline
  - Can still be incorporated to allow register read and write to happen in the same cycle

Questions?