Lecture 21
June 25

Hazards

- If an instruction tries to access a register that will be modified by an instruction in the pipeline
    - This is a “data hazard”
    - Ex
        - 1. R2←10
        - 2. R2← R1+ R2
    - note: in the example architecture, the WB and DOF can be done in the same cycle
        - if there was an instruction between the ones above, no hazard
- a hazard can also occur when the programmer requests a conditional branch
    - ex
        - 1. BRZset
        - ADD
    - Instruction 2 would be inserted into the pipeline before 1 is finished
    - If the branch is taken, it shouldn’t be executed
    - A “control hazard”
- Possible solution 1: Do nothing
    - Make the programmer/compiler figure it out
    - No change in the circuits, just warn the programmer
    - Need to add a NOP (no operation) instruction
    - EX
        - 1. R1 ←10 R1 ← 10
        - 2. R2 ← R1 +R2 hazard NOP
        - 3. R1 ← R2 + 1 R2 ← R1 + R2
        - 4. no hazard → NOP
        - 5. R1 ← R2 +1
    - this requires the programmer/compiler to know a lot about the underlying architecture
    - makes it hard to program
    - no chance of backward compatibility with older code
- Possible solution 2: stall
    - Have the processor delay an instruction when necessary
    - When the processor notice a hazard it launches a “bubble”
        - I.e. keeps the instruction from moving down the pipe

- E.g.

Launches bubble

R1←10:	IF	DOF	EX	WB				
R2←R1+R2:		IF	DOF	O	O			
				DOF	EX	WB		
R1←R2+1:				IF	DOF	O	O	
						DOF	EX	WB

Notice hazard

- Designing a control unit to do this is tricky
  - Must check DR of instruction in the pipe
  - If they correspond to an operand in the pipe (current instruction), stall
  - To stall: in the next cycle, send the same instruction through the pipe
    - Don't increment PC or update IR
  - We must make sure the bubble has RW=MW=0
    - So it doesn't have any effect
  - For a control hazard, we don't want to always do the next instruction
    - More later

– Possible Solution 3: data forwarding (for data hazards only)
  - If the data is already in the pipeline somewhere use if from there
  - E.g.

R1←10:	IF	DOF	EX	WB	
R2←R1+R2		IF	DOF	EX	WB

Get the RI value from the function unit, not reg. file