**Control Hazards **

Yuxuan Tang Final RC Part 1

Branch Hazards

Branch outcome determined in MEM. There are three method to solve it.

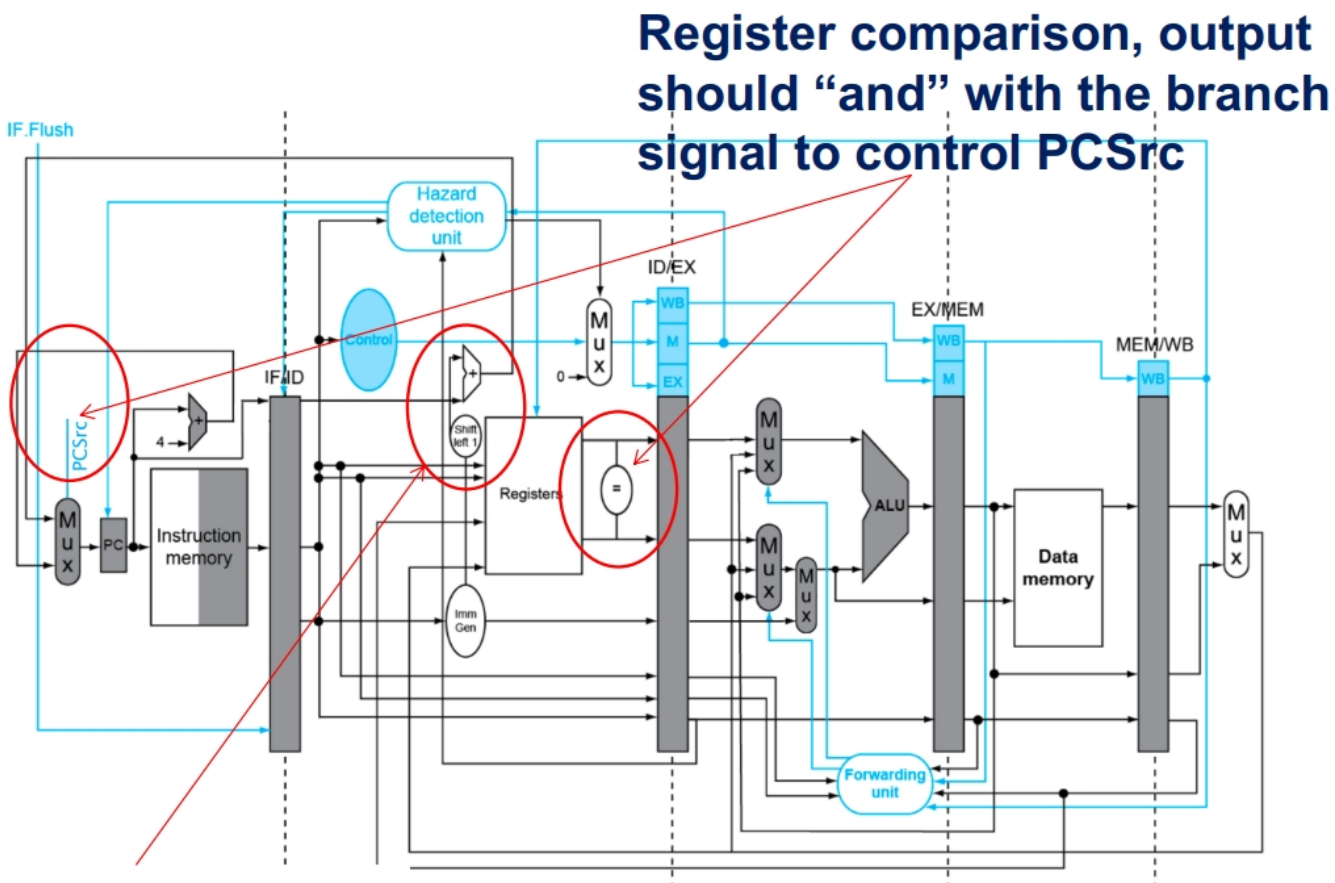
- Stall on branch
- Always assume branch not taken
- Branch prediction (instead of assumption)

1. Stall on branch

- Wait until branch outcome is determined (In MEM) before fetching the next instruction – 3 nops
- By moving hardware for determining branch outcome to the ID stage – 1 nop

Move Branch Judgement Logic

- Target address adder
- Register comparator
- Branch logic (the and gate)



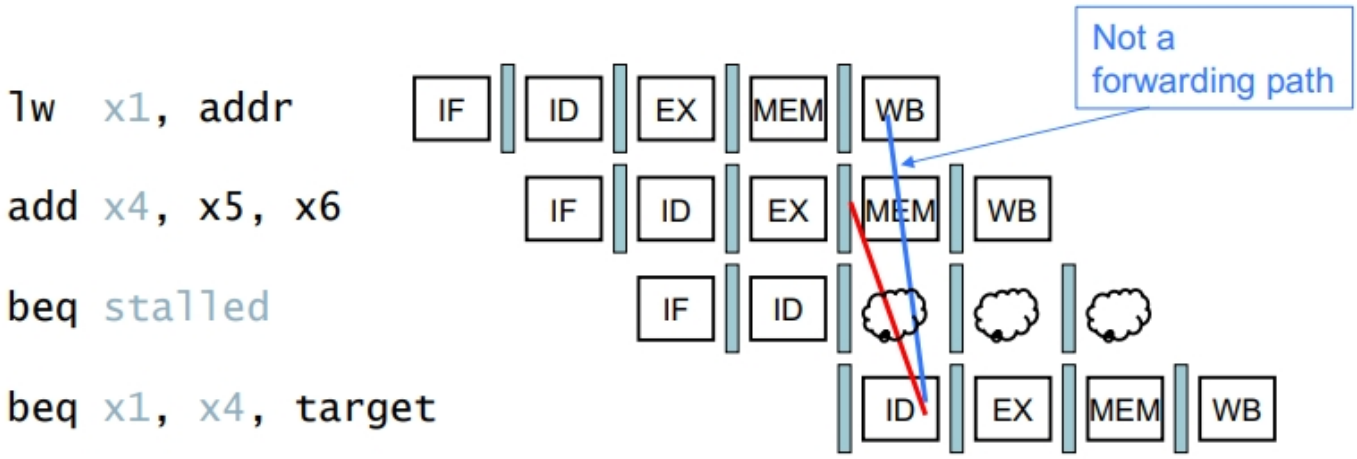
2. Always assume branch not taken

Always assume branch not taken. If we are wrong, penalty will be to flush one (previously, three) instructions.

- Flush an Instruction
  - Clear IF/ID pipeline register, by a new control signal `IF.Flush`
  - In IF stage.

New Data Hazards

- Forwarding paths are created between stage pipeline register and comparator inputs.
- Need 1 stall cycle even with forwarding.
- Need 2 stall after load instruction.



3. Branch prediction

- Static prediction
- Dynamic prediction
  - 1-Bit Predictor:
  - 2-Bit Predictor: