

# Chapter 06: Instruction Pipelining and Parallel Processing

## Lesson 07:

### Overcoming Hazard by Result Forwarding (Bypassing)

# Objective

- Learn how the data dependency effect overcome by result forwarding

# Overcoming Hazard by Result Forwarding

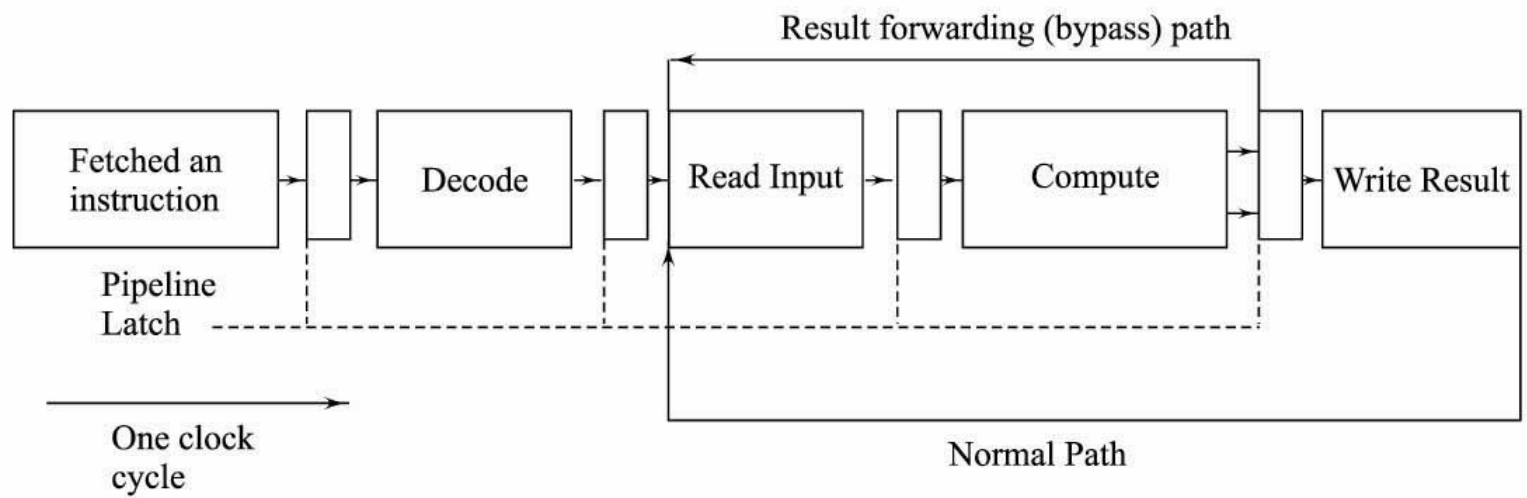
# Reducing Data dependency Effects

- In addition to the conventional write-back path at last stage of the instruction, connections are added that send the output of the execute stage directly to the input of the execute stage and to the register read stage

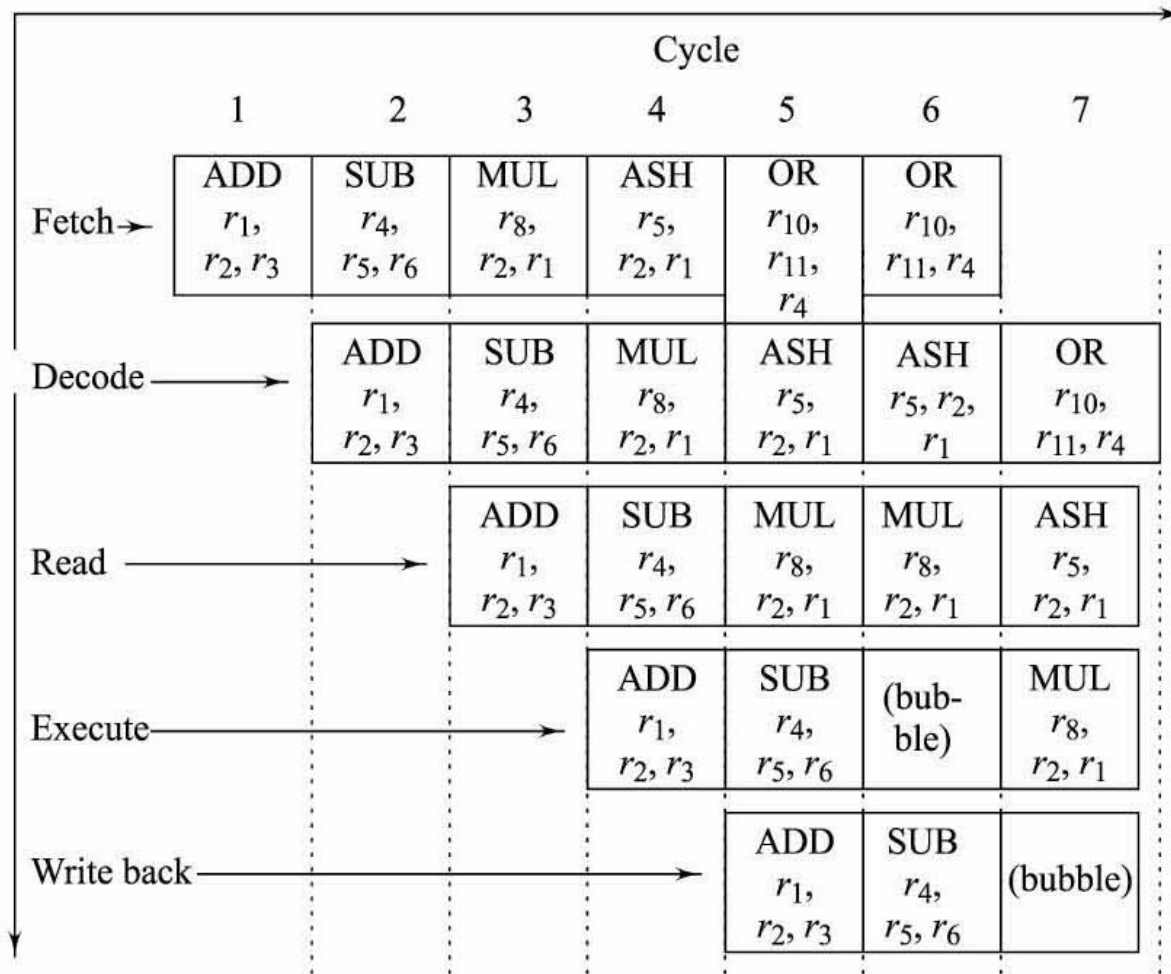
# Result Forwarding Mechanism

- Due to result forwarding from fourth stage (compute) to third stage (read), only two-cycle stall would suffice

# Forward paths for result forwarding (bypass) path



# Pipeline stall in cycle 6 between SUB and MUL



# ADD in Cycle 4 and SUB in Cycle 7

- The result of the ADD instruction computed in the execute stage of the pipeline in cycle 4
- But the SUB instruction is unable to issue until cycle 7 because the result of the ADD is not written into the register file until cycle 5, allowing the subtract to read it on cycle 6 only



# ADD in Cycle 4 and SUB in Cycle 7

- If the result of the ADD could be sent to the subtract instruction directly, without going through the register file, the subtract could issue on cycle 5 without any pipeline stalls

# Result forwarding (bypassing) in Virtually all pipelined processors

- Result forwards from the execute stage(s) directly to the instructions in the previous stages of the pipeline

# Result forwarding (bypassing)

- The instruction latency of non-branch instructions in a pipeline with bypassing is equal to the number of execute stages in the pipeline, because the output of an instruction is not computed until it completes the last execute stage, but an instruction's inputs are required when it enters the first execute stage

# Result forwarding (bypassing) in case of branch operation

- Bypassing does not usually improve the latency
- The results of branch instructions are not written into the register file

# Summary

# We learnt

- Result forwarding from last of the execution stages to previous reduces the dependency effects

End of Lesson 07 on  
**Overcoming Hazard by Result Forwarding  
(Bypassing)**