Lecture 8 slides

CE/CZ 3001:
Advanced Computer Architecture

(Module 4: Instruction Level Parallelism(ILP))

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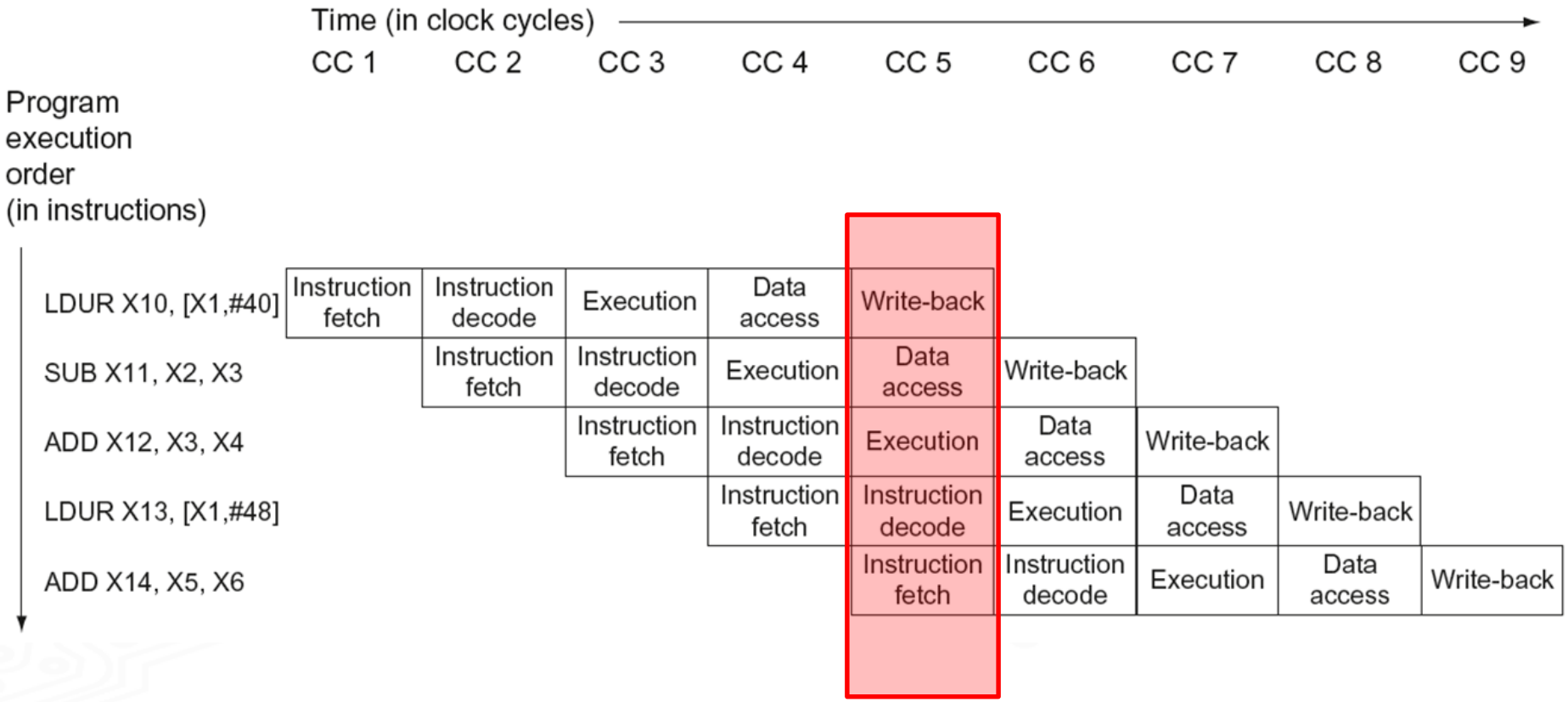
Summary of video

- Data-dependence
- How to handle data dependencies?
  - Detect and Wait
  - Data forwarding through register
  - Detect and forward
- In order and out of order execution
- Instruction reordering and renaming
- Loop unrolling

CPI of a pipeline without stalls

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CPI= No of clock cycles/instruction
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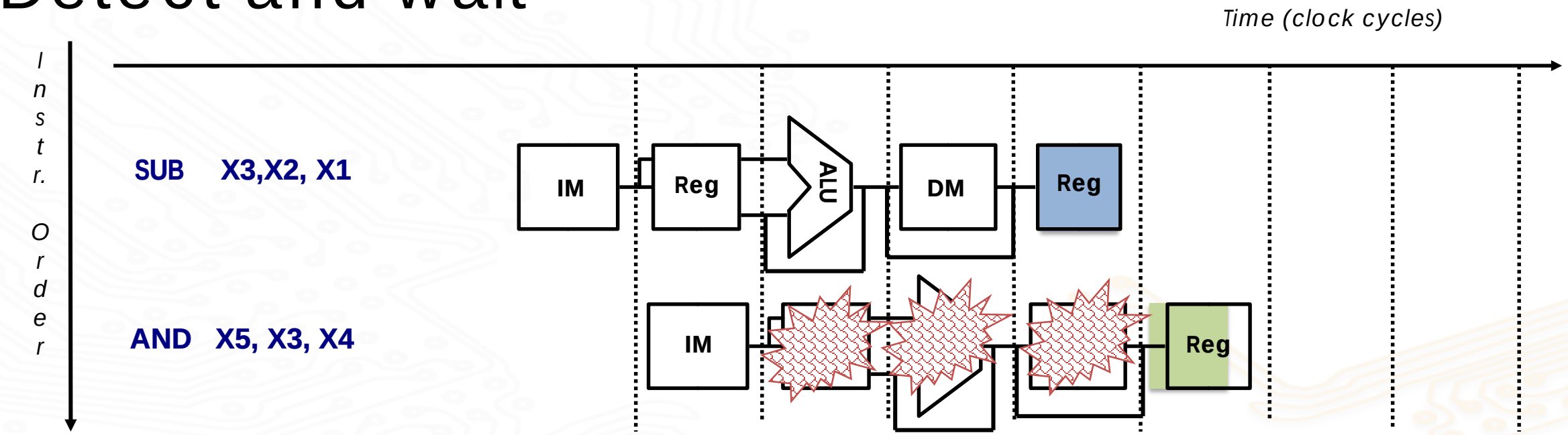
Steady state CPI = (No of instructions + no of stalls) / No of instructions

How to handle data dependencies

- Anti and output dependences are easier to handle
- True (Flow or RAW)dependences are more difficult to handle as they constitute true dependence on a value
  - Detect and wait until value is available in register file
    - Stall the program. (HARDWARE)
    - Compiler can also plug in the NOP instructions in between. (SOFTWARE)
  - Detect and forward / bypass data to dependent instruction

Detect and wait



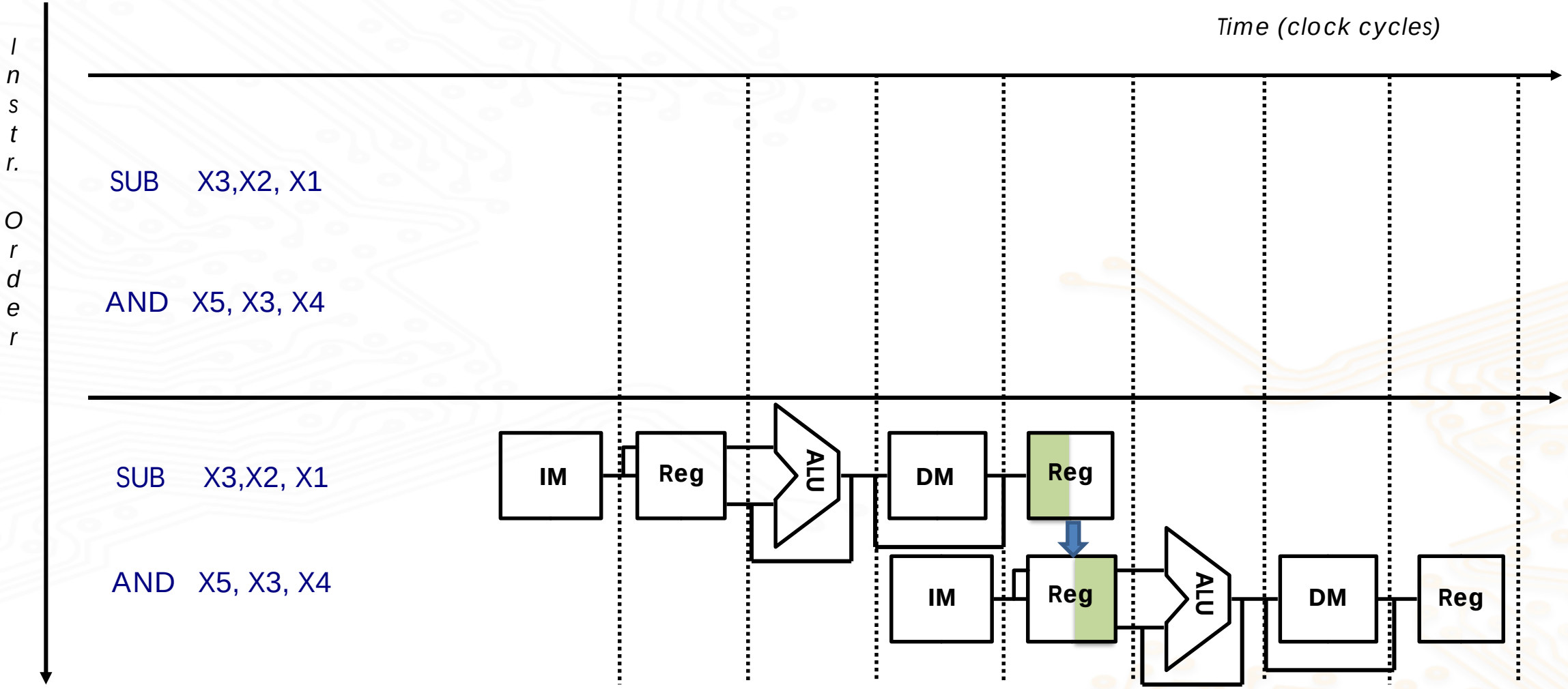
Hardware stall

Instr.	1	2	3	4	5	6	7	8	9
I1									
I2									

Software inserting NOPs

Instr.	1	2	3	4	5	6	7	8	9
I1									
I2									

Data Forwarding – through register

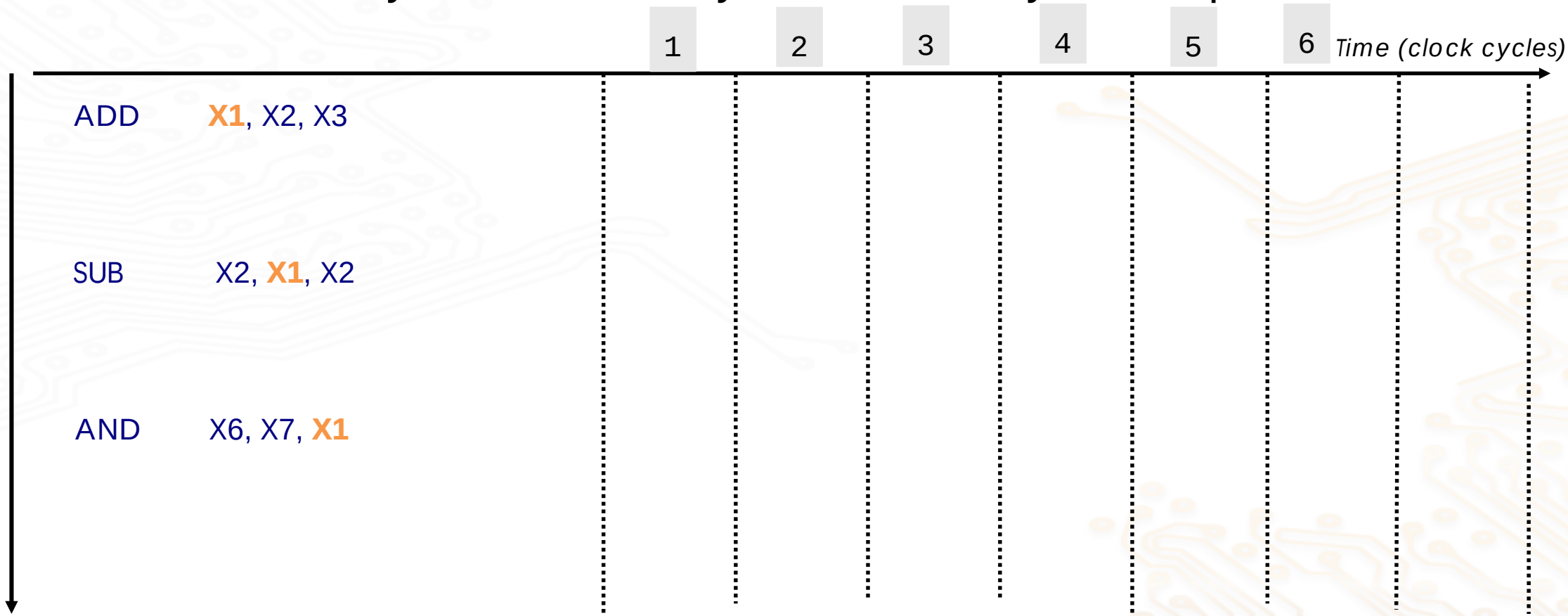


Solution: write and read in the same cycle

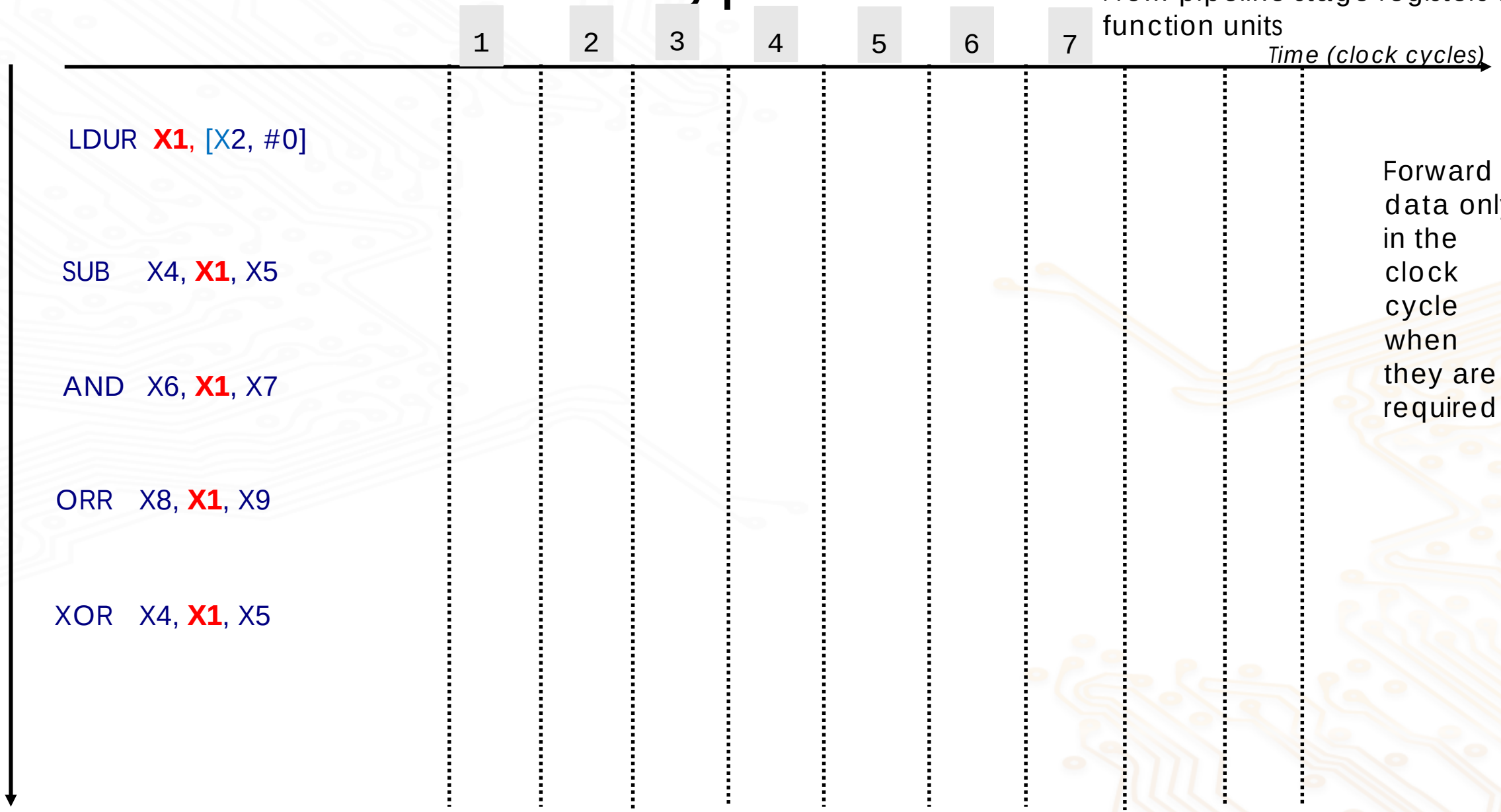
Most processors have this as it is easy to implement

Detect and Forward / bypass

- Data forwarding.
- From pipeline stage registers to function units
- Forward data only in the clock cycle when they are required



Detect and Forward / bypass



Data forwarding – example 2

I1: ADD X1, X2, X3

I2: LDUR X2, [X1, #0]

I3: AND X6, X7, X1

Without forwarding
(writeback and decode can happen simultaneously)

Clocks	1	2	3	4	5	6	7	8	9	10
I1	IF	ID	EX	M	WB					
I2		IF	S	S	ID	EX	M	WB		
I3					IF	ID	EX	M	WB	

With forwarding

Clock cycle	1	2	3	4	5	6	7
I1							
I2							
I3							

Steady state CPI = (No of instructions + no of stalls) / No of instructions
Steady state CPI (no forwarding) =
Steady state CPI (forwarding) =

Lab 2 (Quiz)

- 15 min open book quiz
- Fill in the blanks, T/F and MCQ
- Max 5 questions
- Rest details in the announcement.