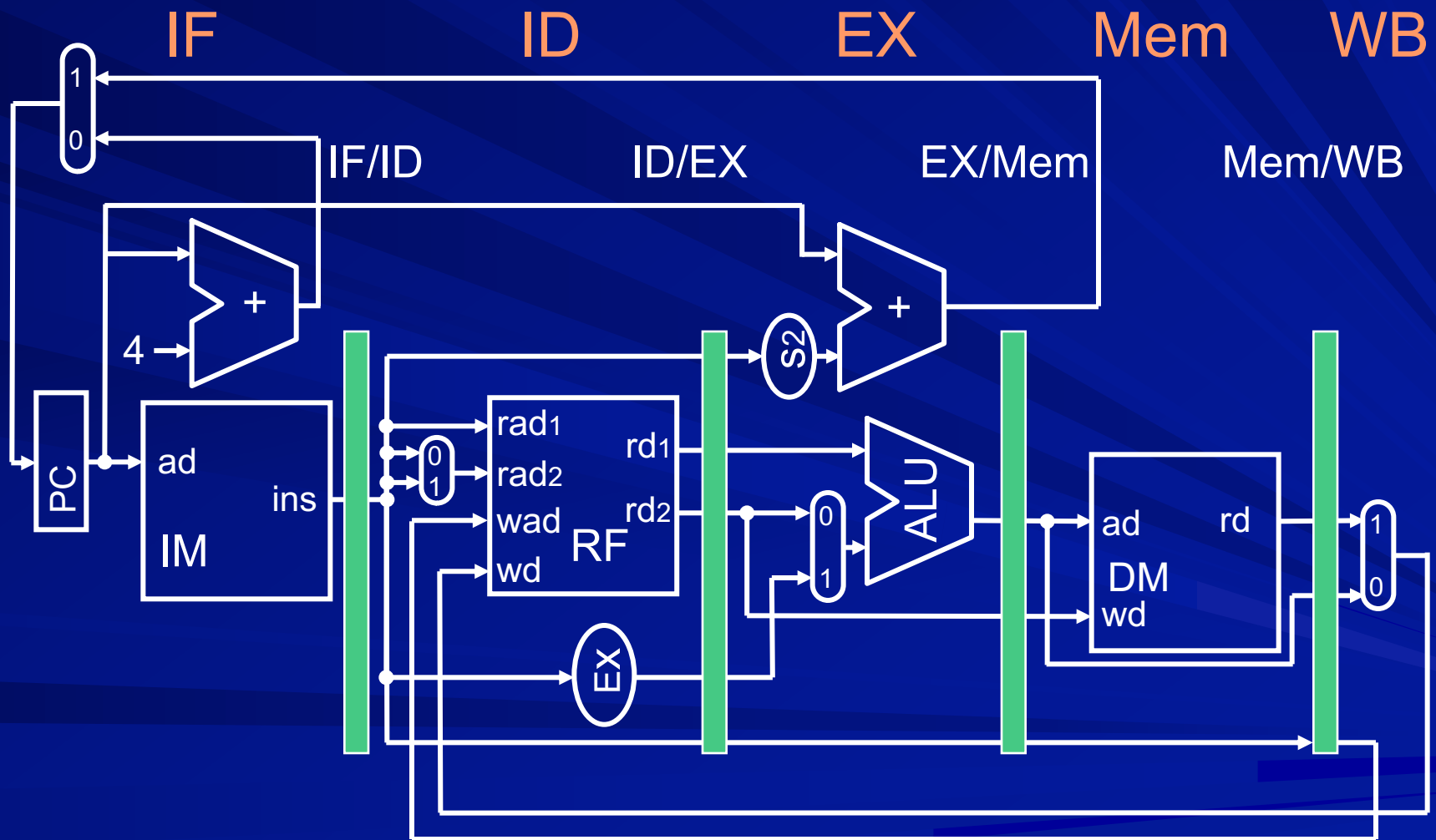


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Computer Architecture

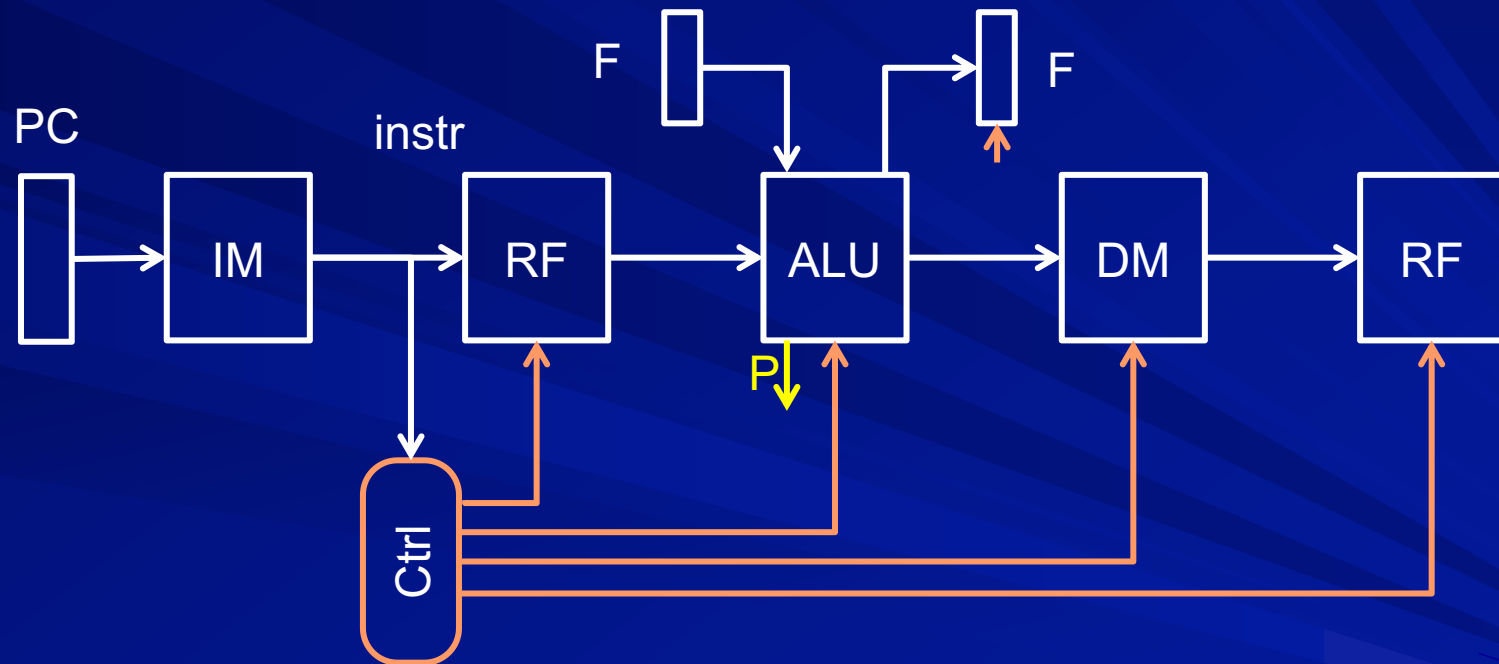
Pipelined Processor design –
Controller, Data forwarding
21st February 2022

5 Stage Pipeline

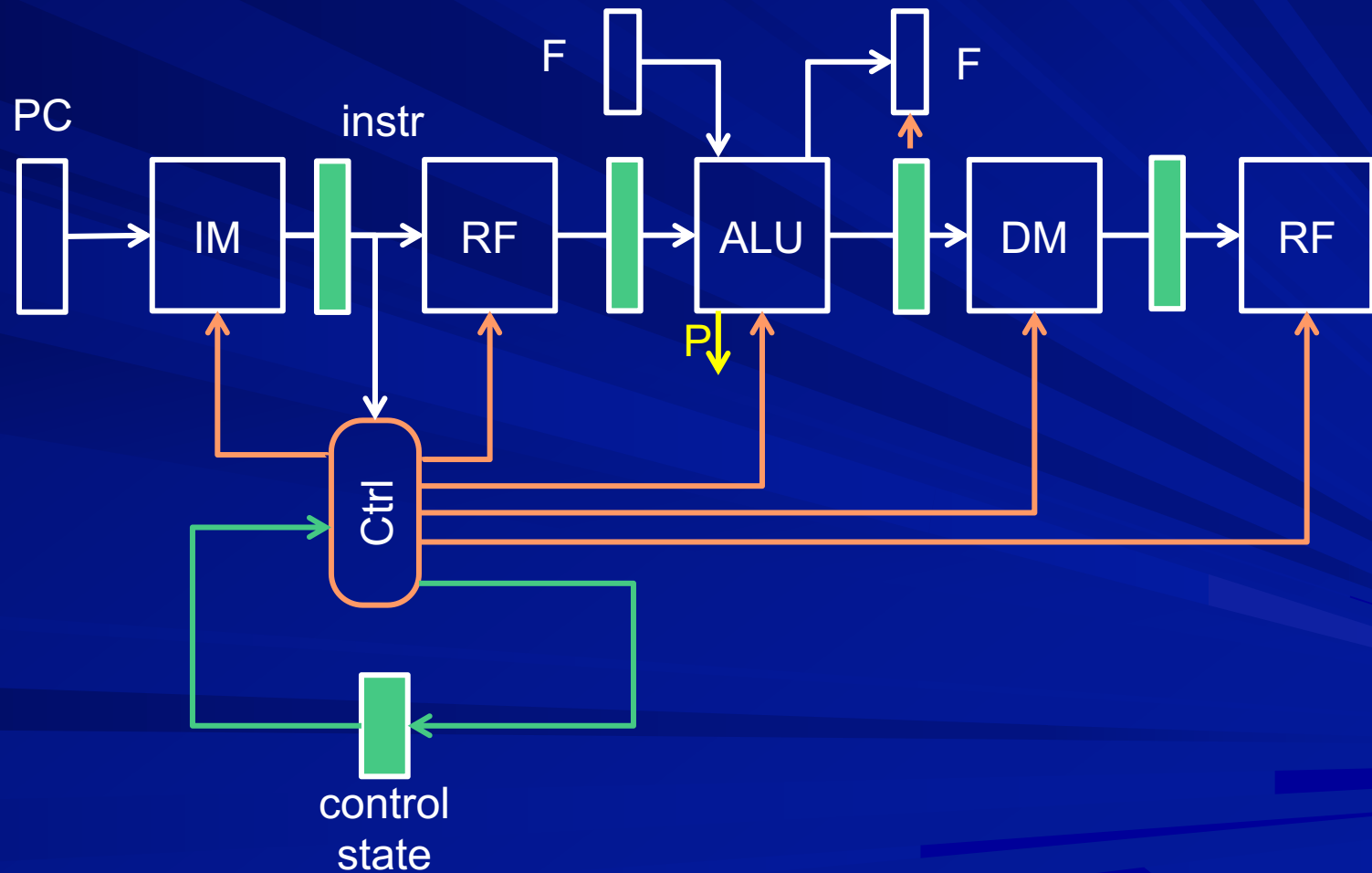


Controllers for different design styles

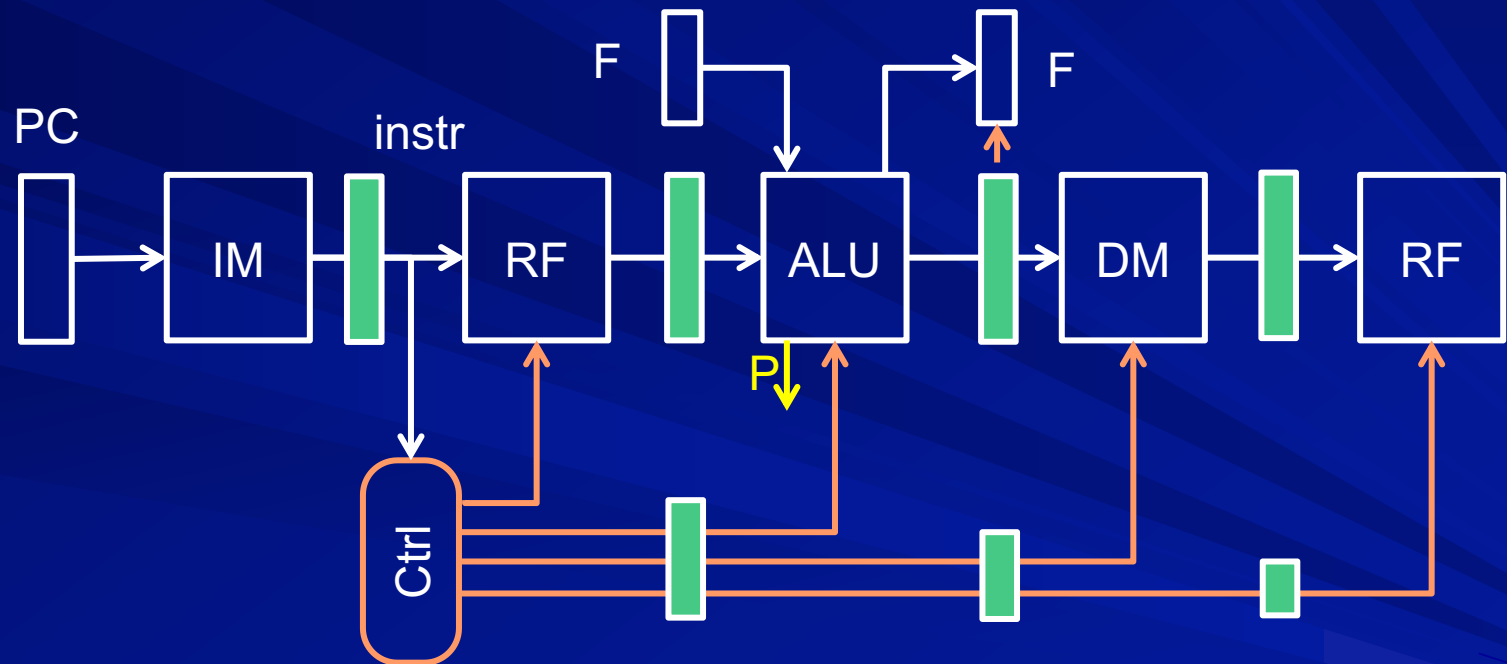
Controller for single cycle DP



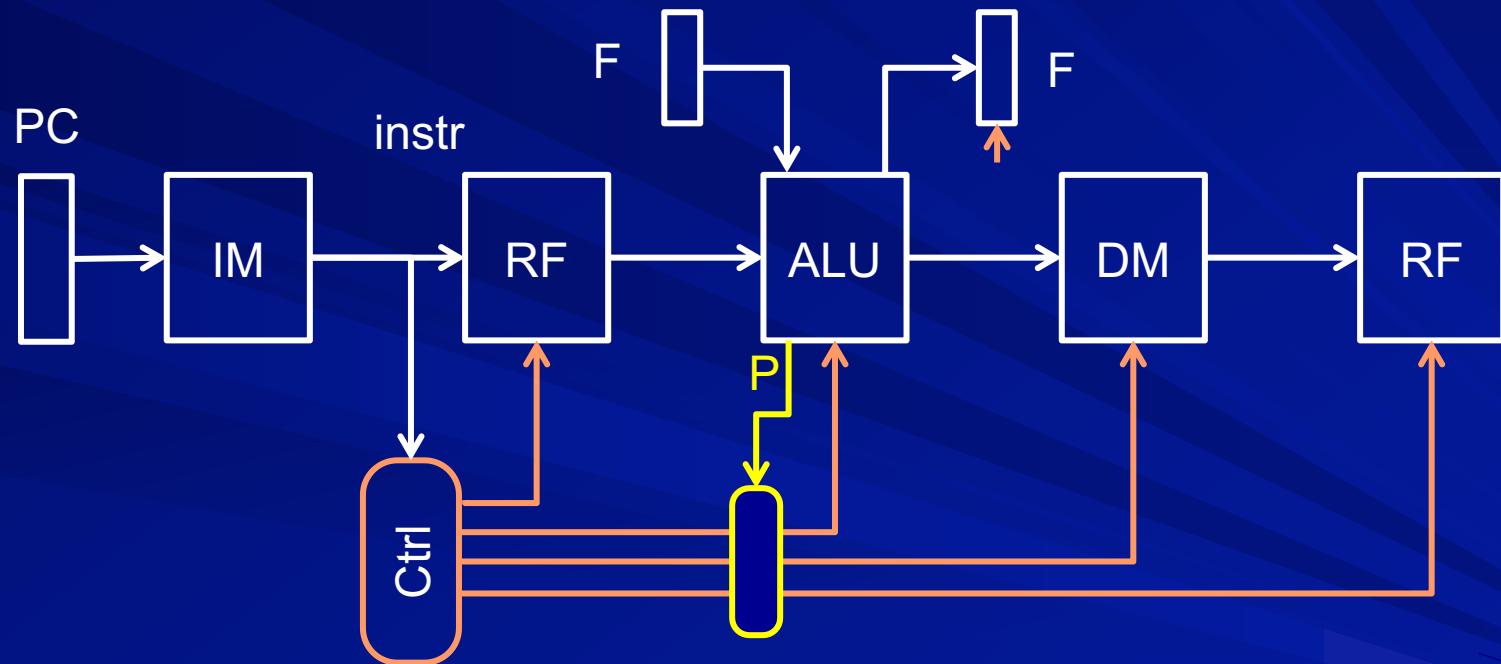
Controller for multi-cycle DP



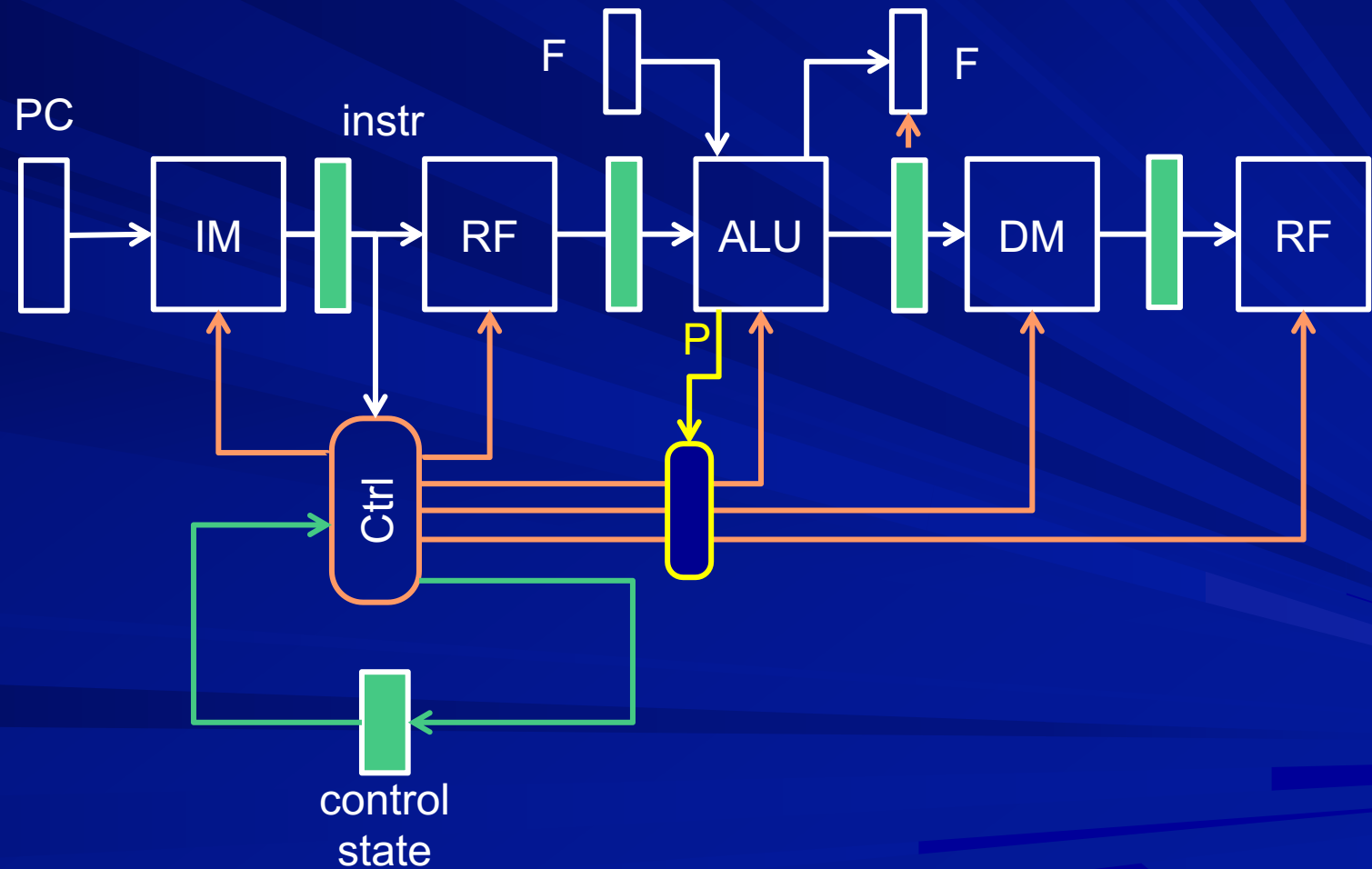
Controller for pipelined DP



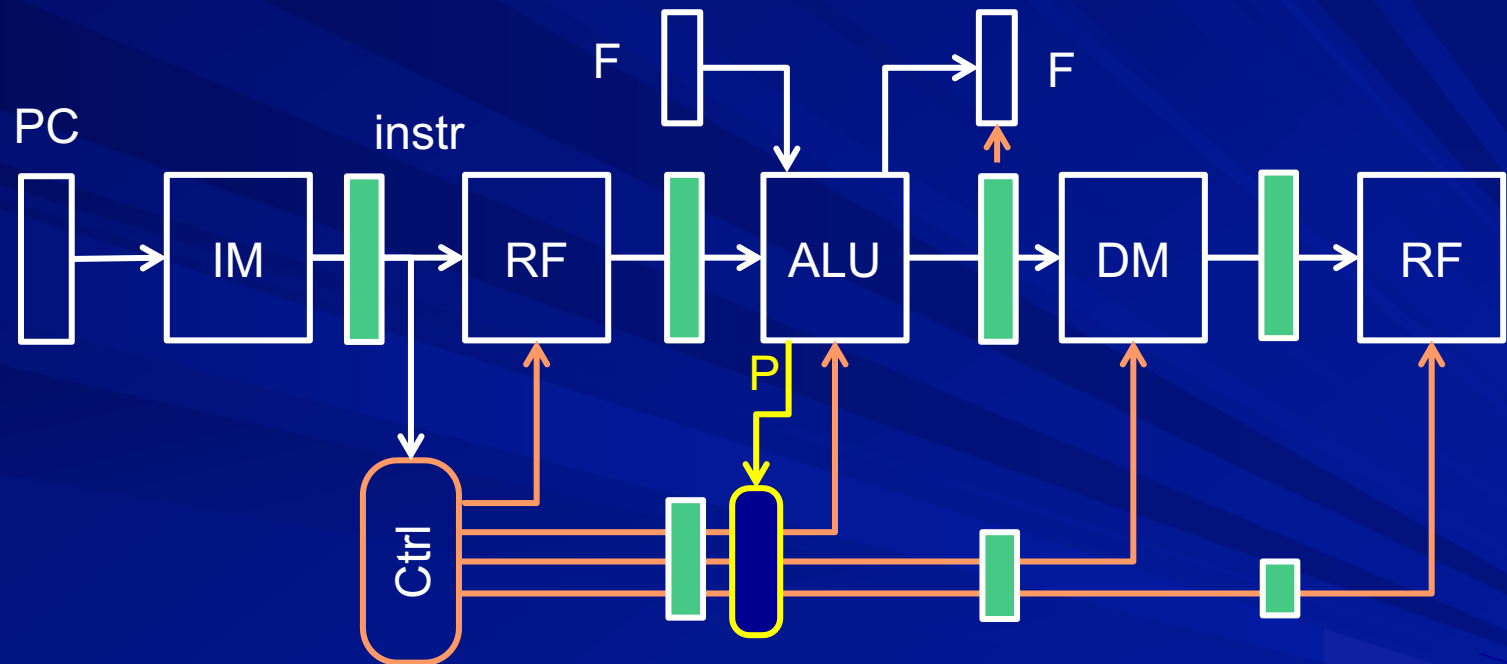
Controller for single cycle DP



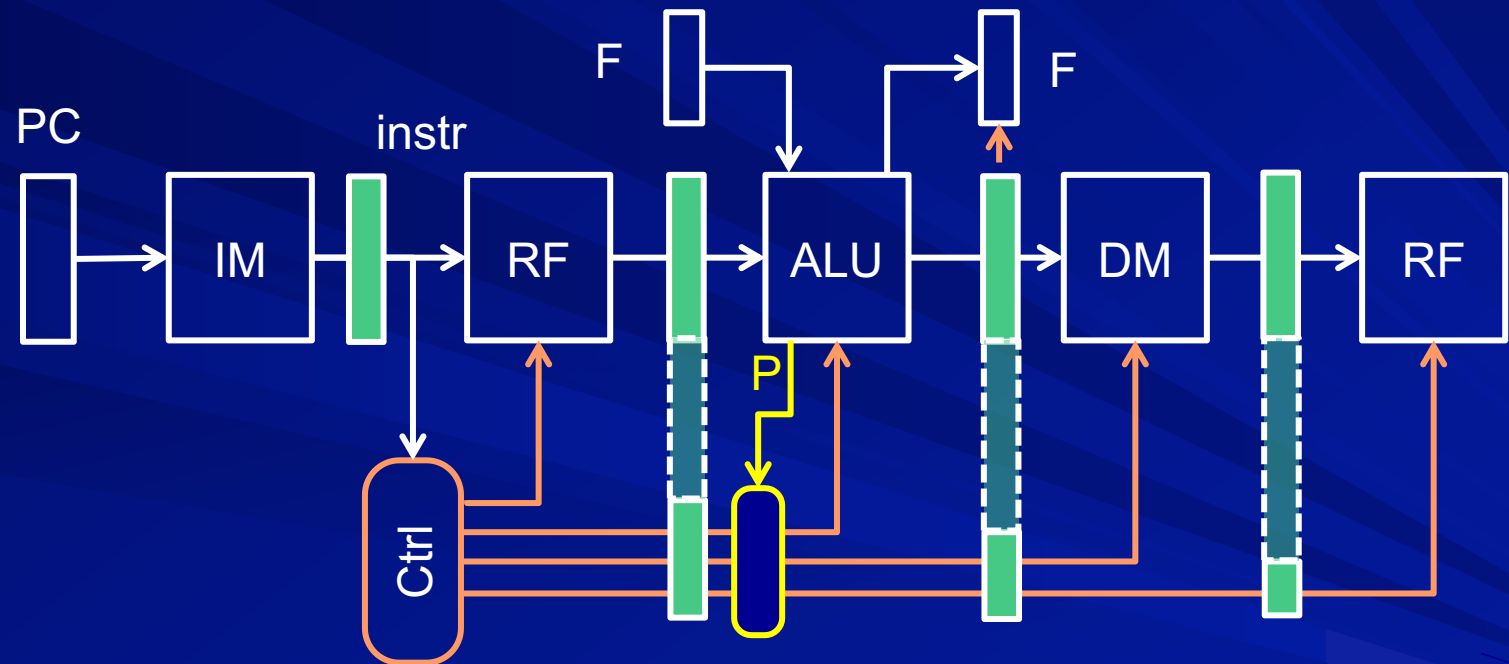
Controller for multi-cycle DP



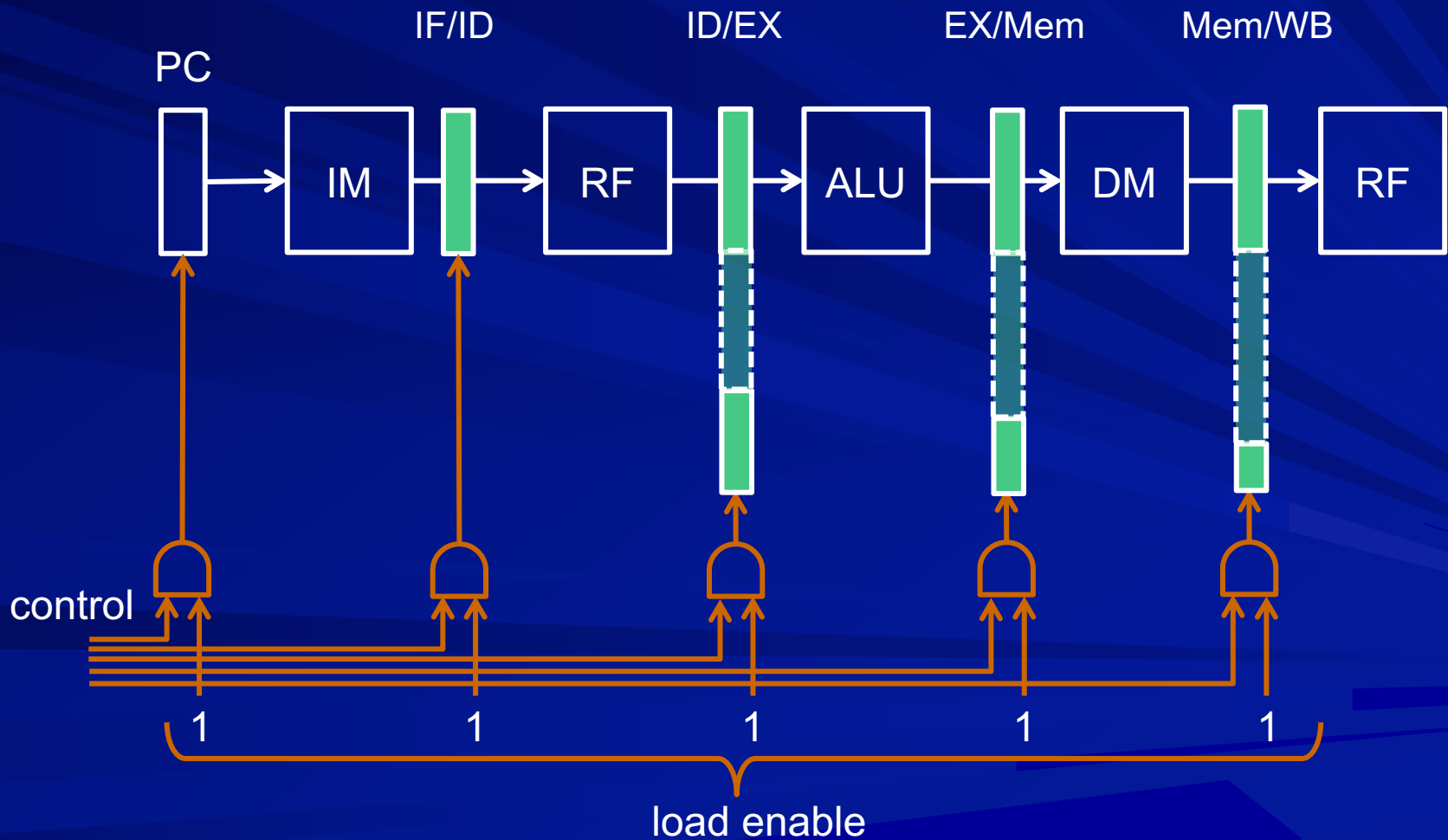
Controller for pipelined DP



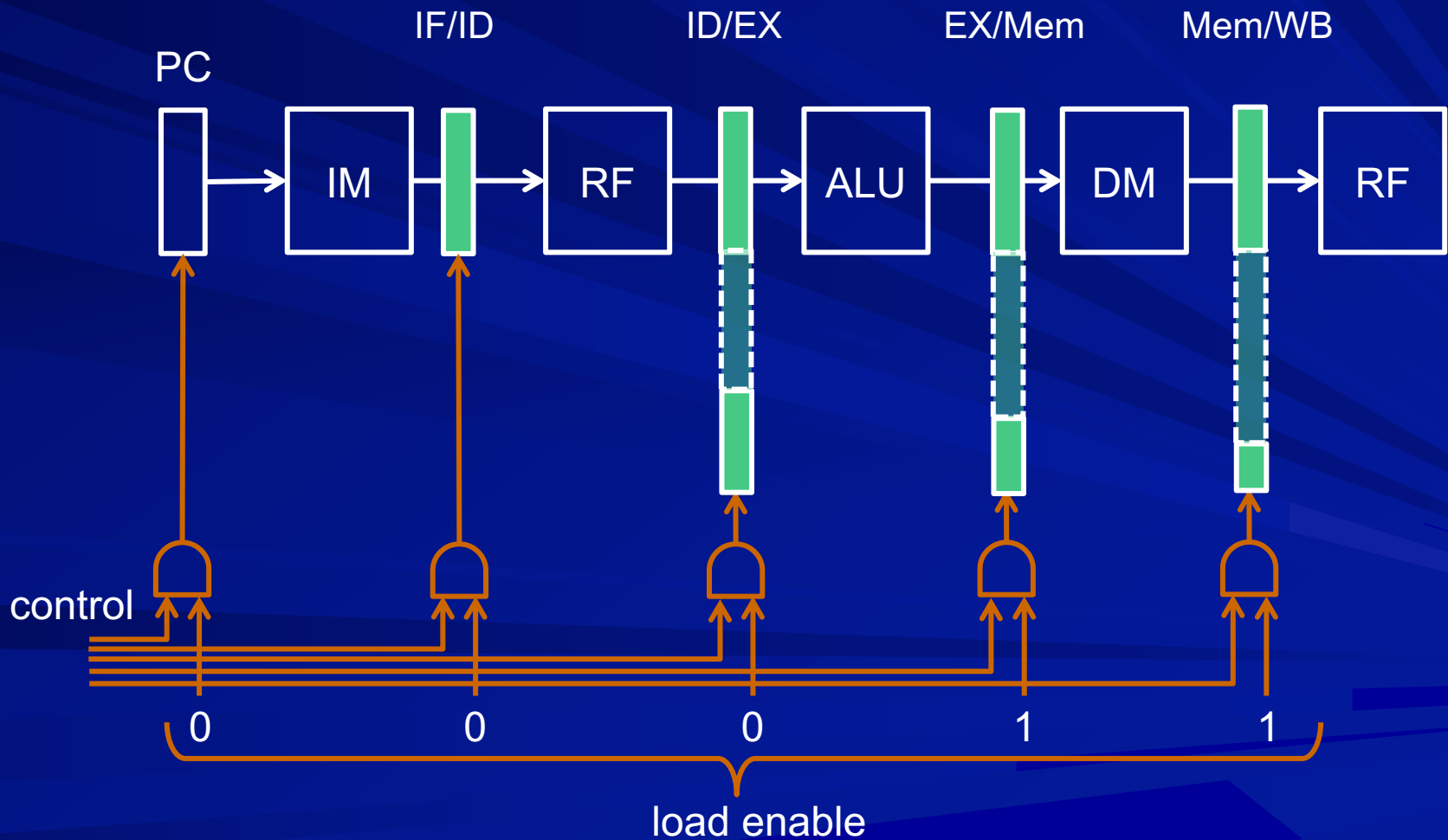
Extending inter-stage registers



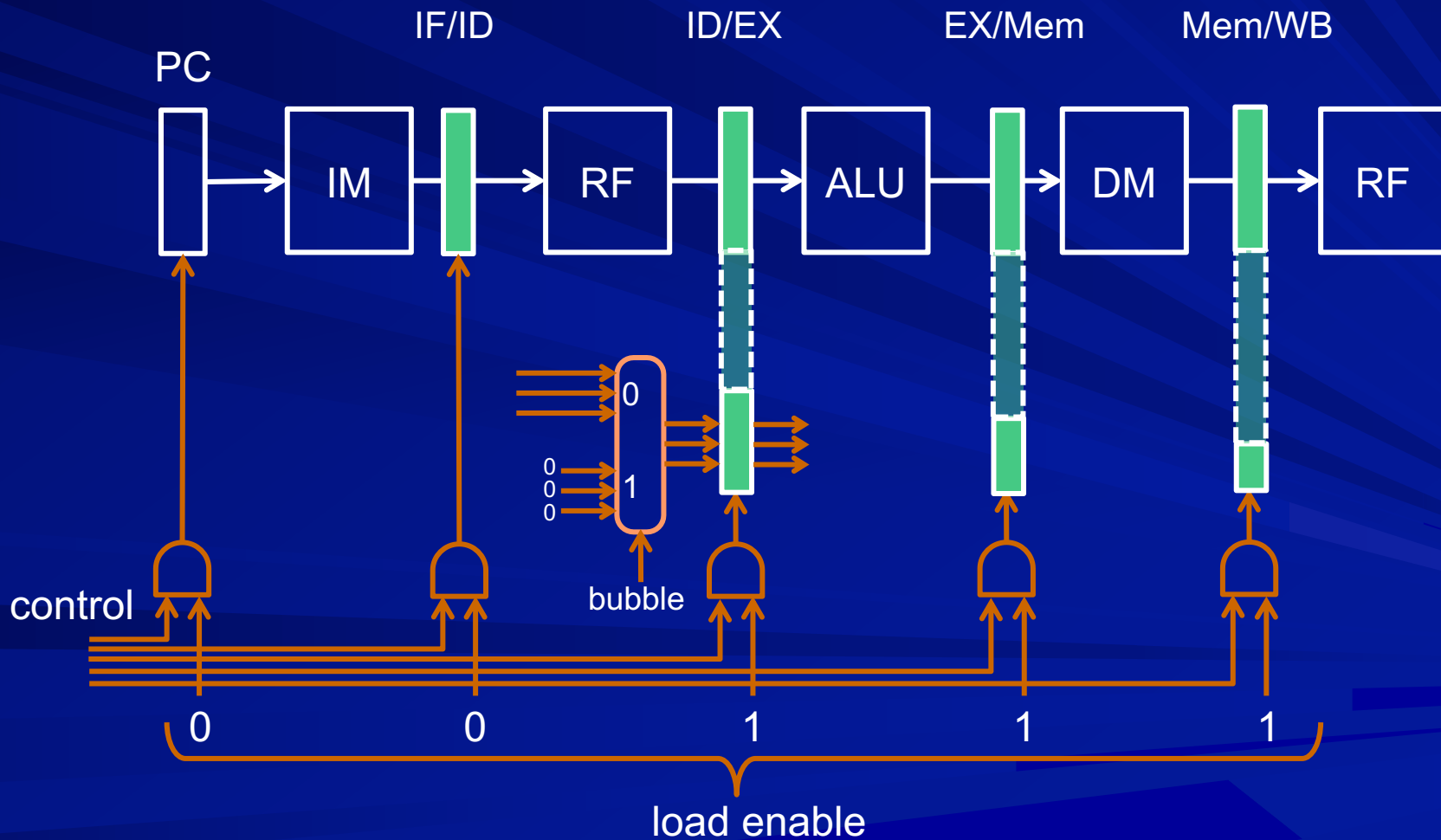
Controlling inter-stage registers



Stalling instructions



Inserting bubbles



Dependence check logic

Condition to be checked:

Operand of instruction in RF stage is a register in which instruction in ALU stage or DM stage is going to write

ID/EX.RW = 1 and

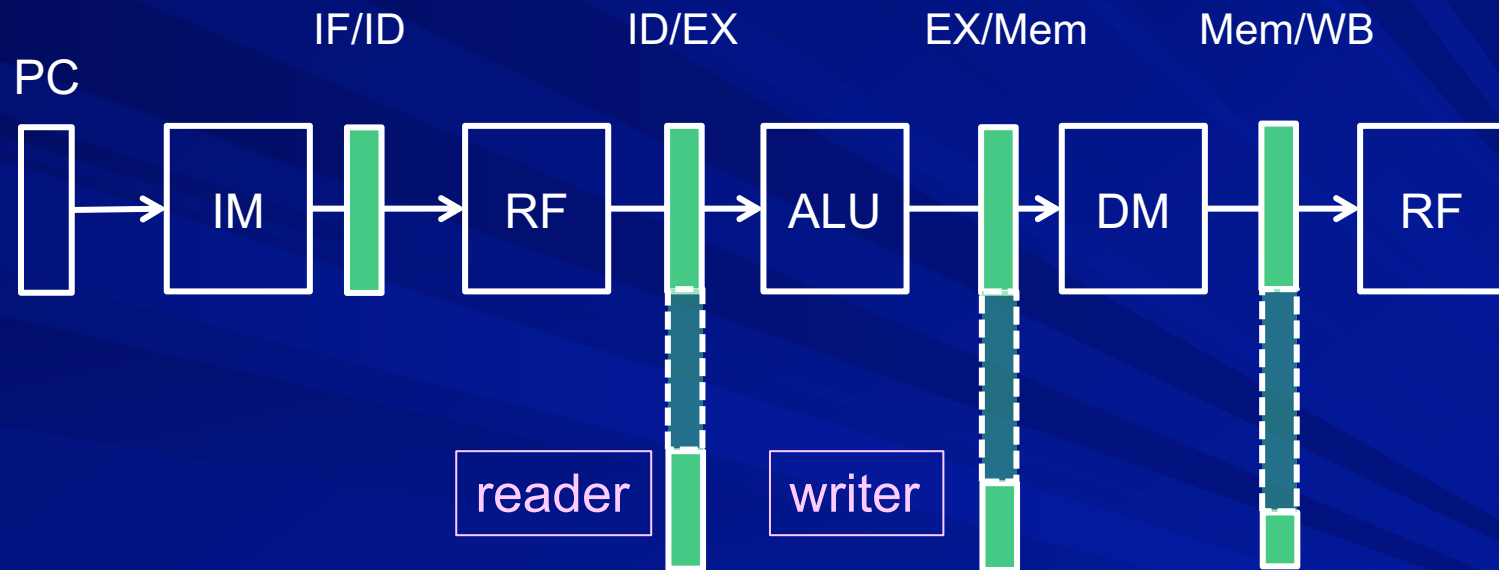
(IF/ID.Rn=ID/EX.Rd or IF/ID.Rm=ID/EX.Rd)

EX/Mem.RW = 1 and

(IF/ID.Rn=EX/Mem.Rd or IF/ID.Rm=EX/Mem.Rd)

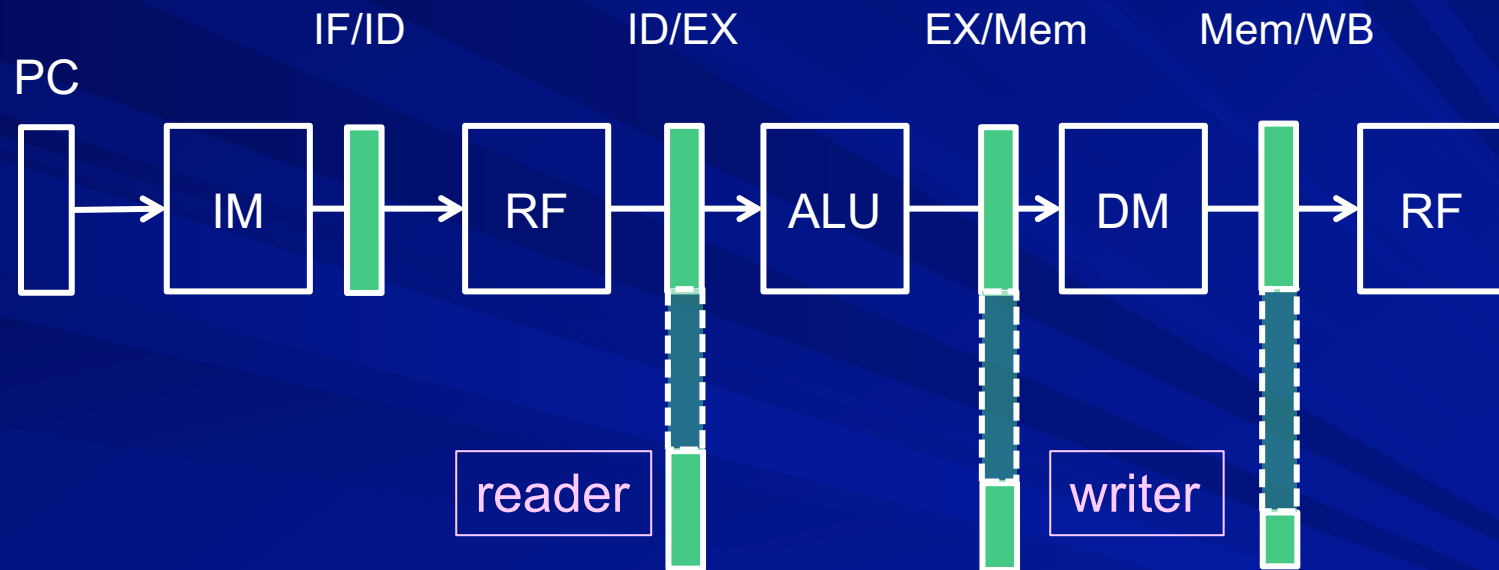
We need to ensure that instruction in RF stage actually reads Rn and/or Rm (not taken care here)

Dependence check



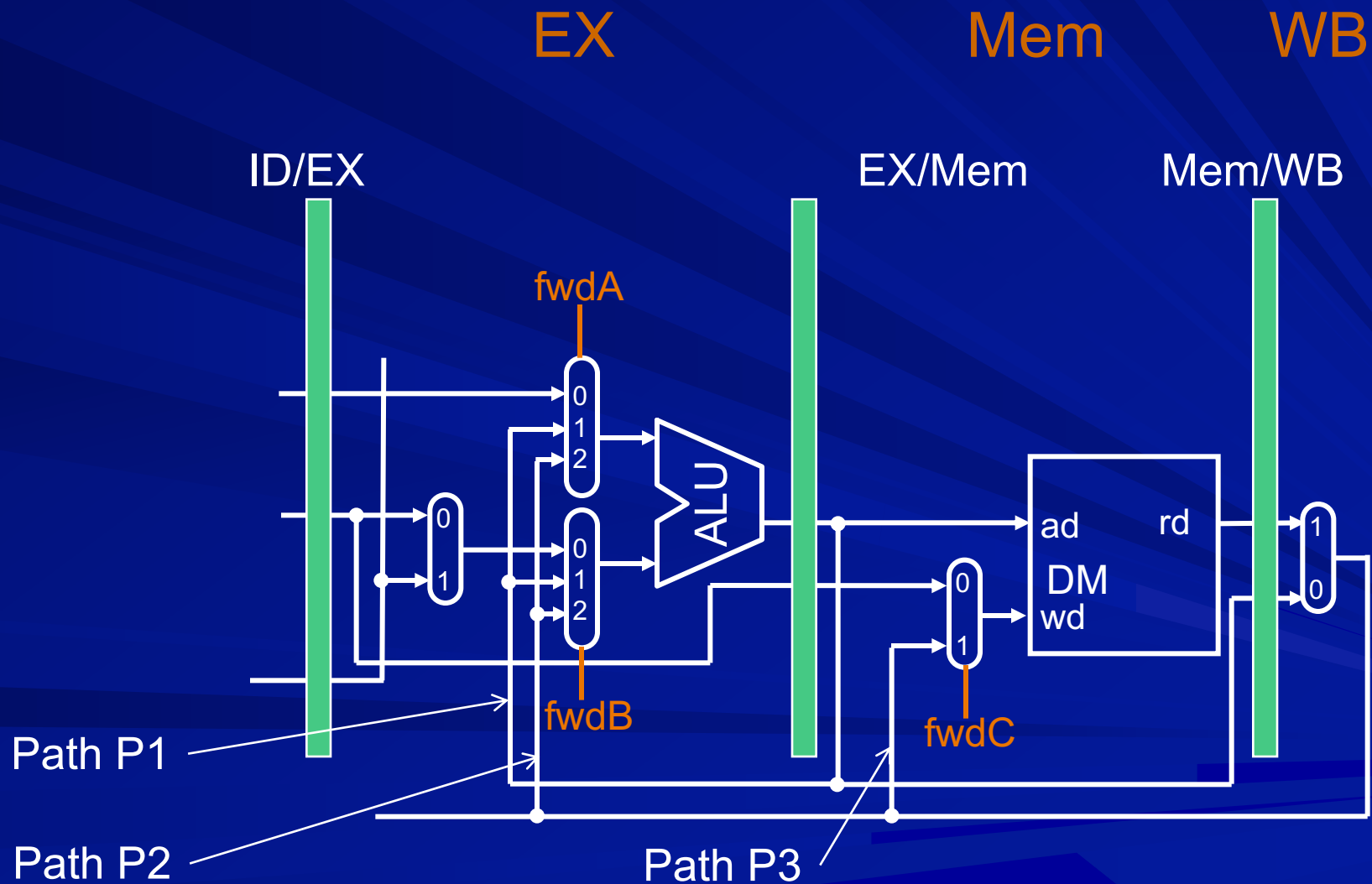
$ID/EX.RW = 1$ and
($IF/ID.Rn = ID/EX.Rd$ or
 $IF/ID.Rm = ID/EX.Rd$)

Dependence check

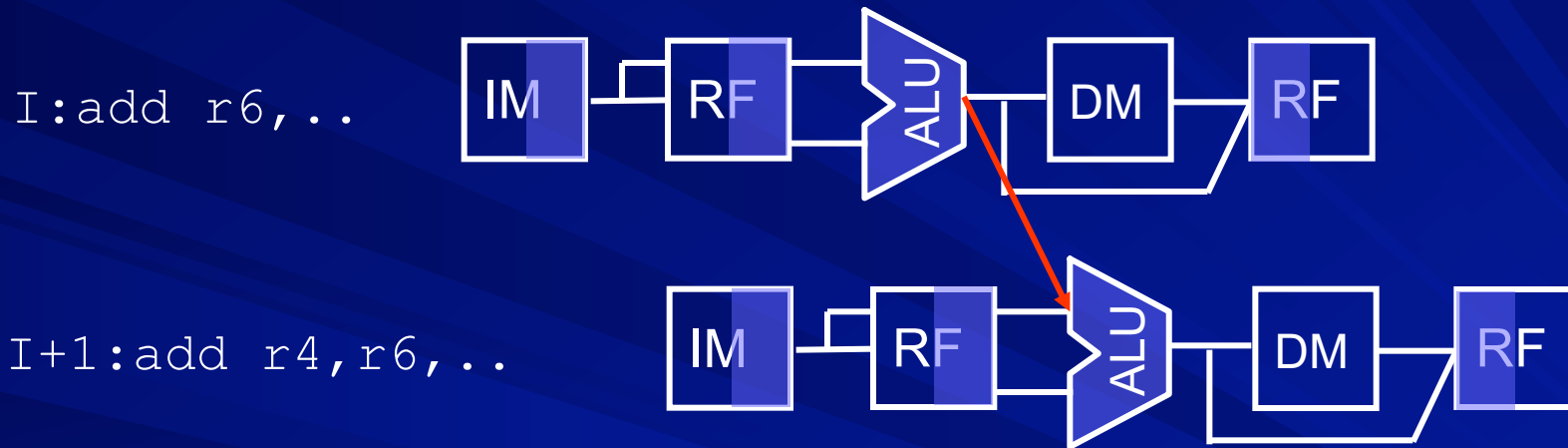


$EX/Mem.RW = 1$ and
($IF/ID.Rn = EX/Mem.Rd$ or
 $IF/ID.Rm = EX/Mem.Rd$)

Data forwarding paths



Data forwarding path P1



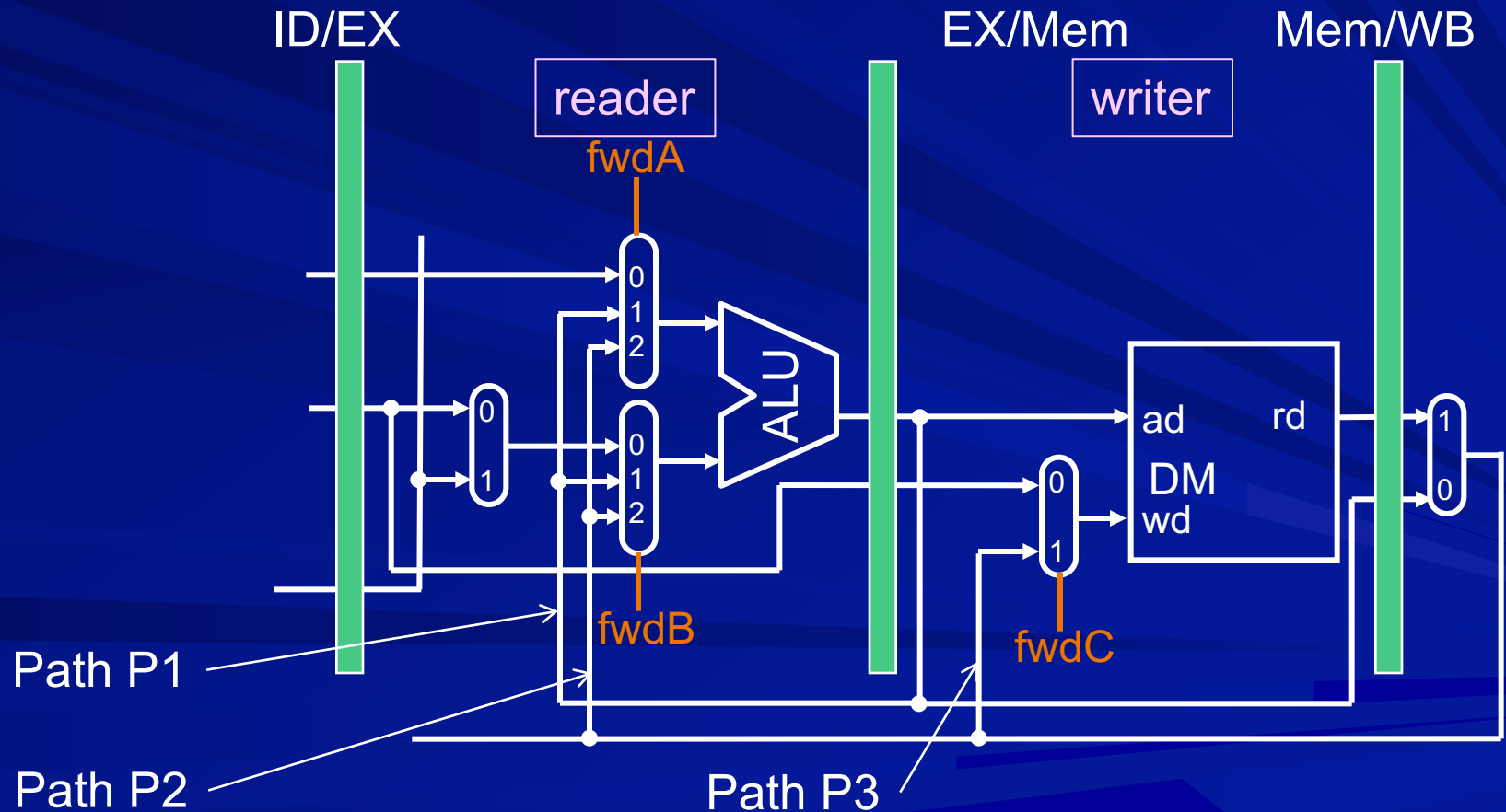
Control for forwarding path P1

$\text{fwdA} = 1$ if
 $\text{EX/Mem.RW} = 1$ and
 $\text{EX/Mem.Rd} = \text{ID/EX.Rn}$

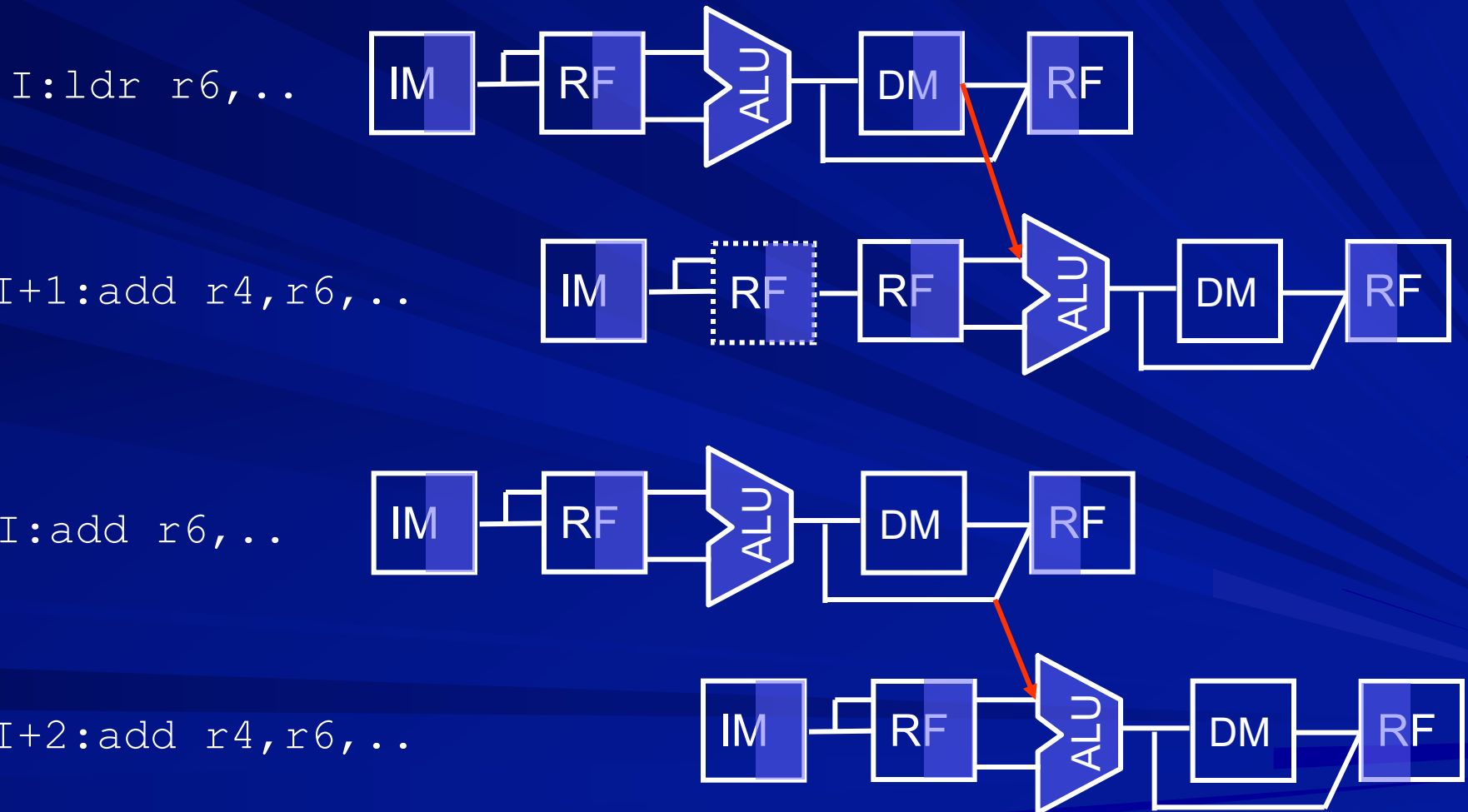
EX

Mem

WB



Data forwarding path P2



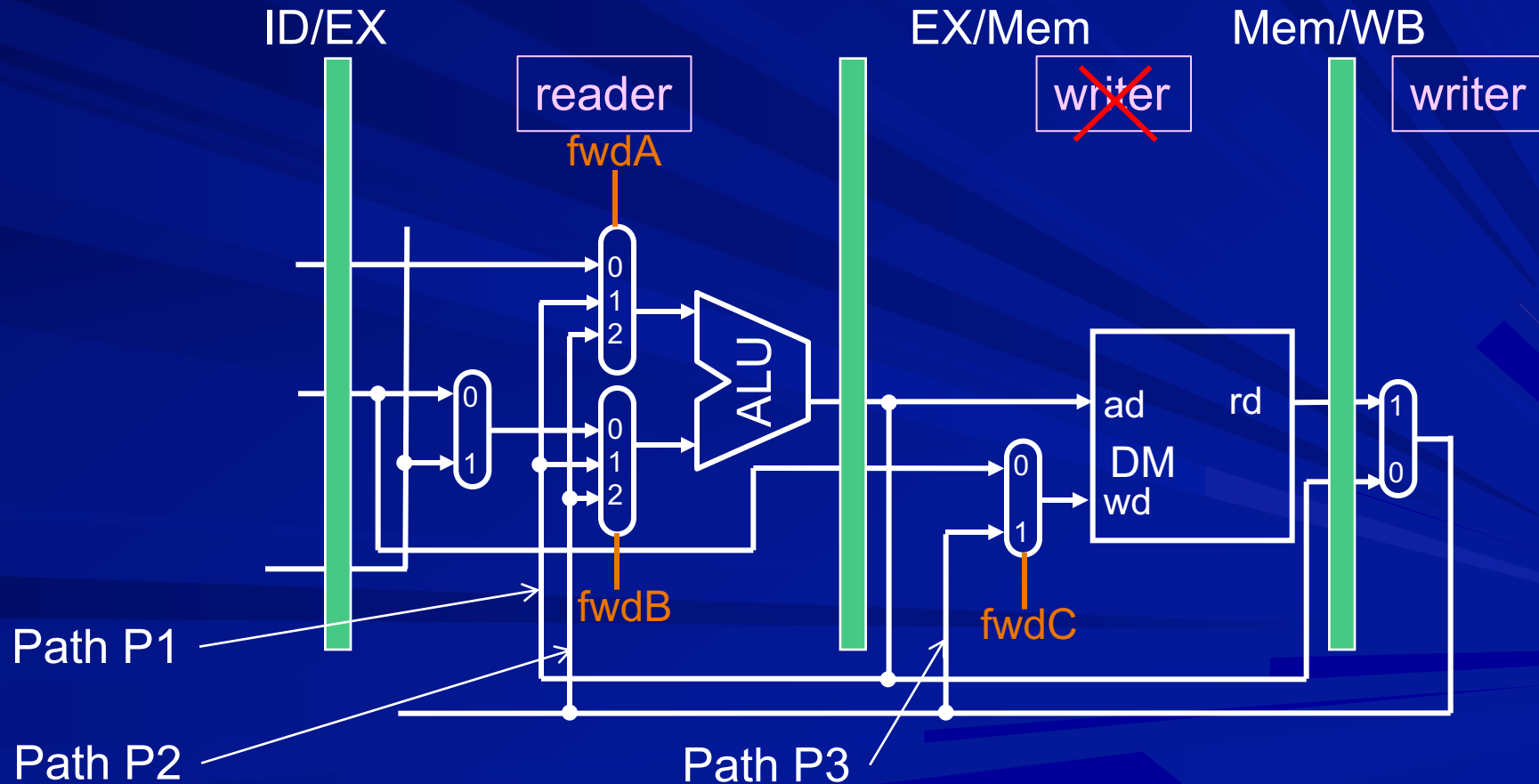
Control for forwarding path P2

$\text{fwdA} = 2$ if
 $\text{Mem/WB.RW} = 1$ and
 $\text{EX/Mem.Rd} \neq \text{ID/EX.Rn}$ and
 $\text{Mem/WB.Rd} = \text{ID/EX.Rn}$

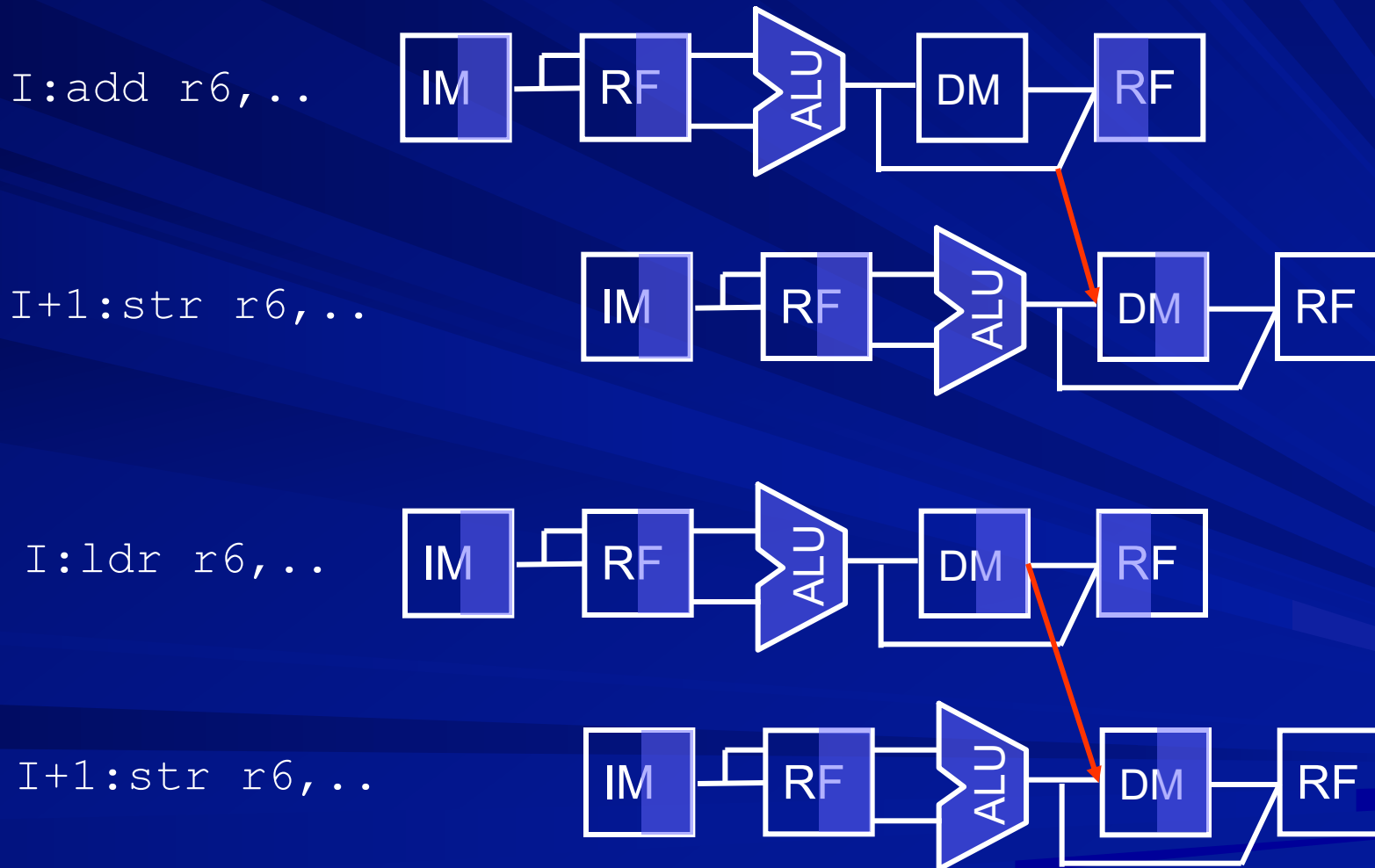
EX

Mem

WB



Data forwarding path P3



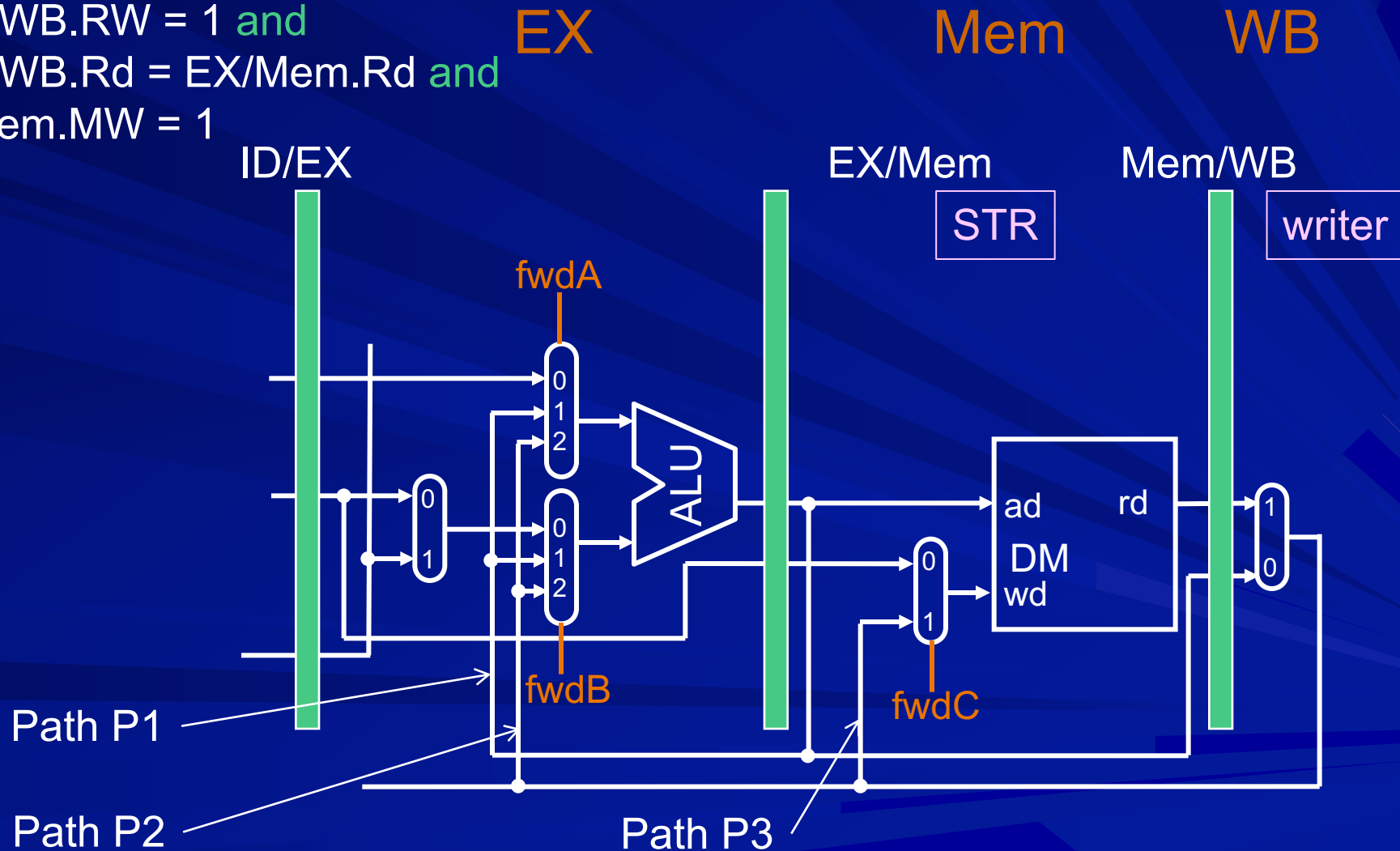
Control for forwarding path P3

$\text{fwdC} = 1$ if

$\text{Mem/WB.RW} = 1$ and

$\text{Mem/WB.Rd} = \text{EX/Mem.Rd}$ and

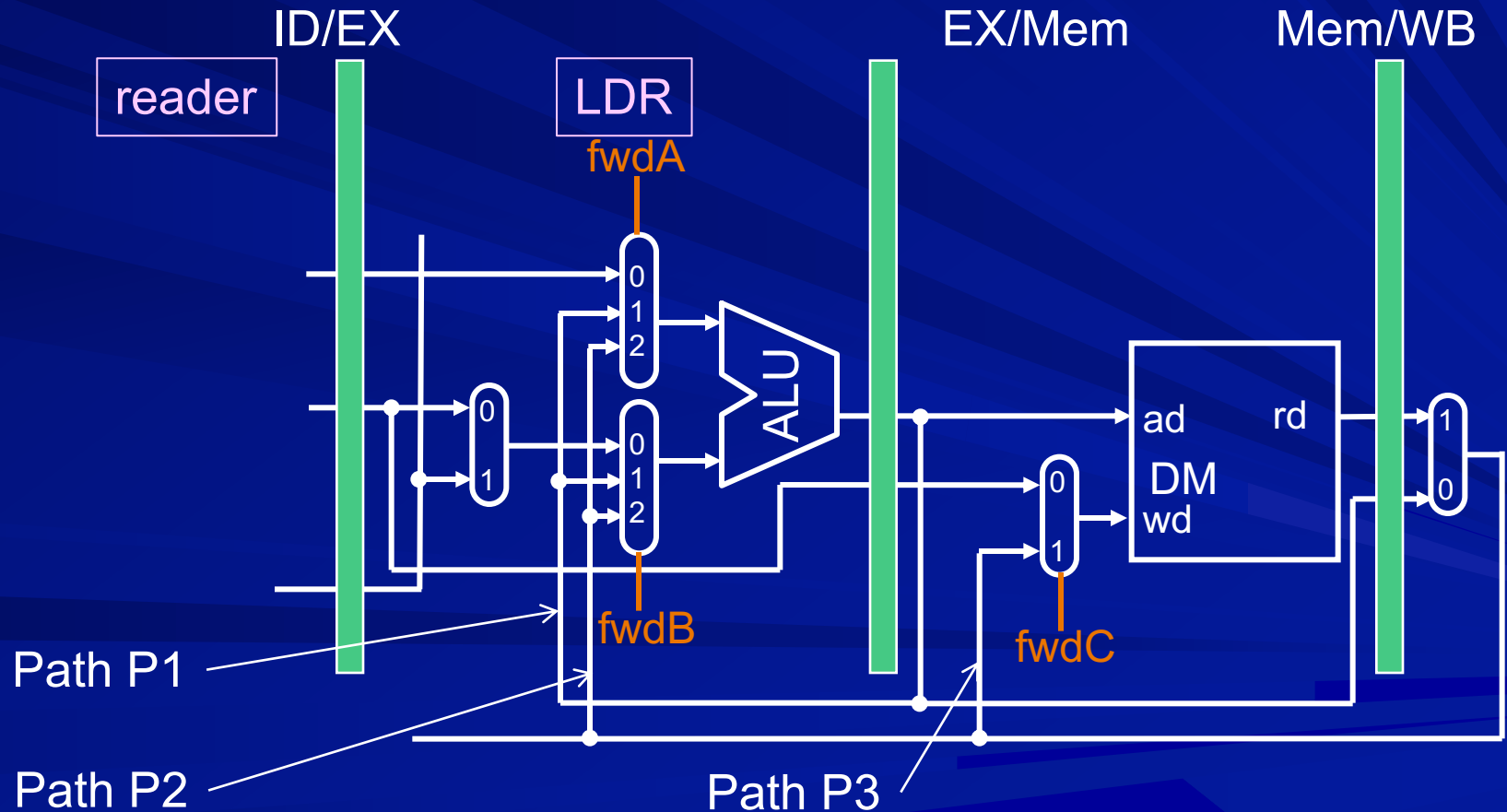
$\text{EX/Mem.MW} = 1$



Stalling with data forwarding

ID/EX.MR and
(IF/ID.Rn=ID/EX.Rd or
IF/ID.Rm=ID/EX.Rd)

EX Mem WB



The background is a solid dark blue color. It features a series of lighter blue diagonal lines that originate from the top right corner and fan out towards the bottom left, creating a sense of motion or depth. The lines vary in thickness and brightness, with some appearing as sharp, bright streaks and others as softer, more diffuse bands. The overall effect is a dynamic, abstract pattern that complements the central text.

Thanks