COL216
Computer Architecture

Processor design -

A simple datapath

25th February, 2016

Outline of this lecture

Build the datapath step by step as follows

- Start with some instructions
- Include other instructions one by one
- Identify control signals
- Interconnect datapath and controller

Design of controller in the next class

Instruction subset for implementation

- Data processing (DP) instructions
  - add/sub, logical, test, move
- Data Transfer (DT) instructions
  - ldr, str, ldrb, strb
- Branch instructions
  - b, bl
- Multiply instruction
  - mul

Instruction codes

DP I = 0

4	1	1	1	4	1	4	4	5	2	1	4
cond	0	0	I	opc	S	Rn	Rd	s_amt	s_typ	0	Rm

DP I = 1

4	1	1	1	4	1	4	4	4	8
cond	0	0	I	opc	S	Rn	Rd	rot	Imm

mul A = 0

4	6	1	1	4	4	4	4	4
cond	0 0 0 0 0 0	A	S	Rn	Rd	Rs	1 0 0 1	Rm

DT I = 0 P = 1 W = 0

4	1	1	6	4	4	12
cond	0	1	I P U B W L	Rn	Rd	offset

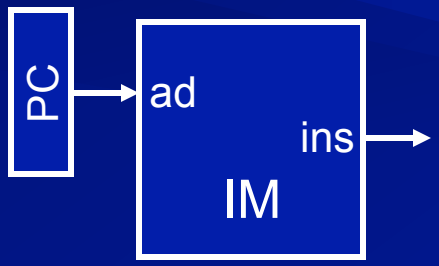
b bl

4	1	1	1	1	24
cond	1	0	1	L	offset

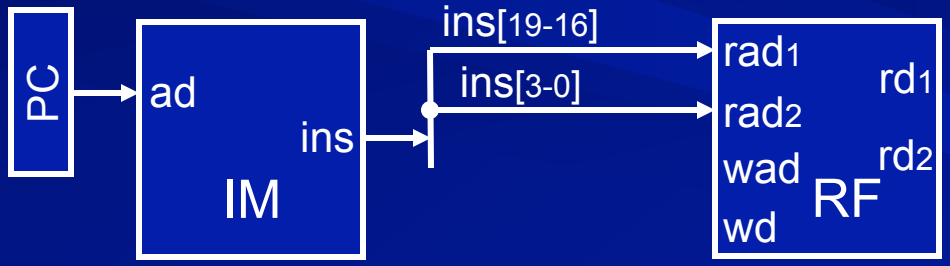
Actions for DP instructions

- fetch instruction
- access the register file
- pass operands to ALU
- pass result to register file
- increment PC

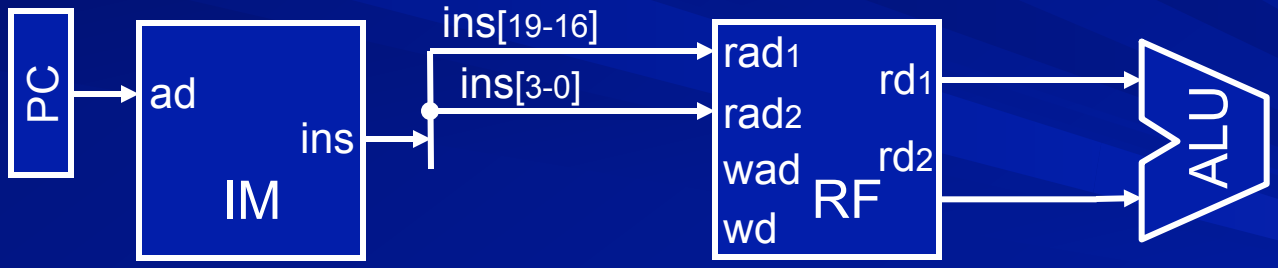
Fetching instruction



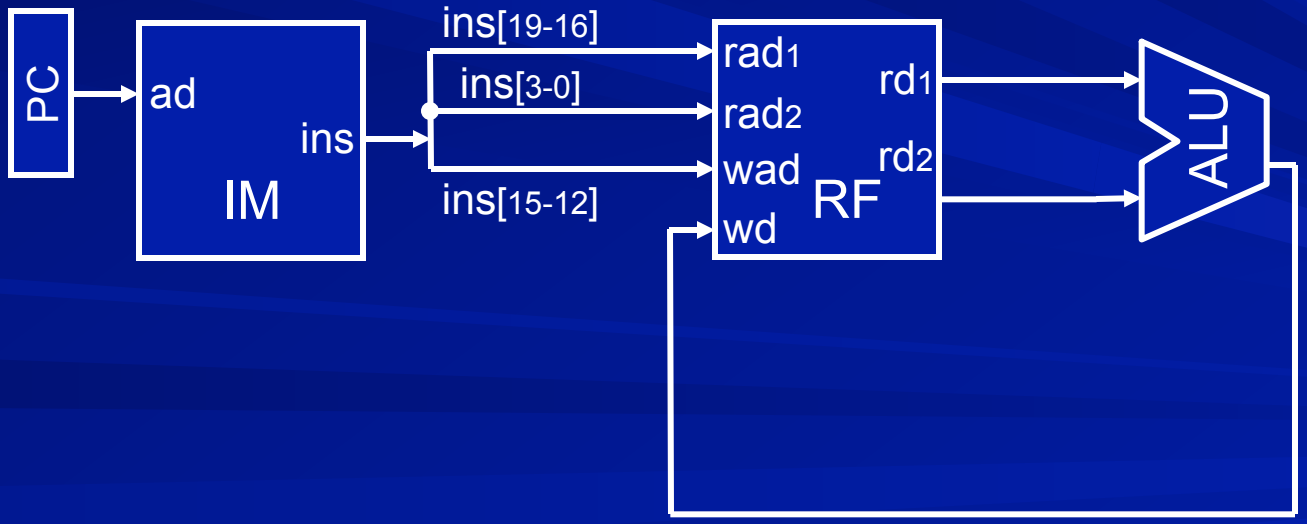
Accessing RF



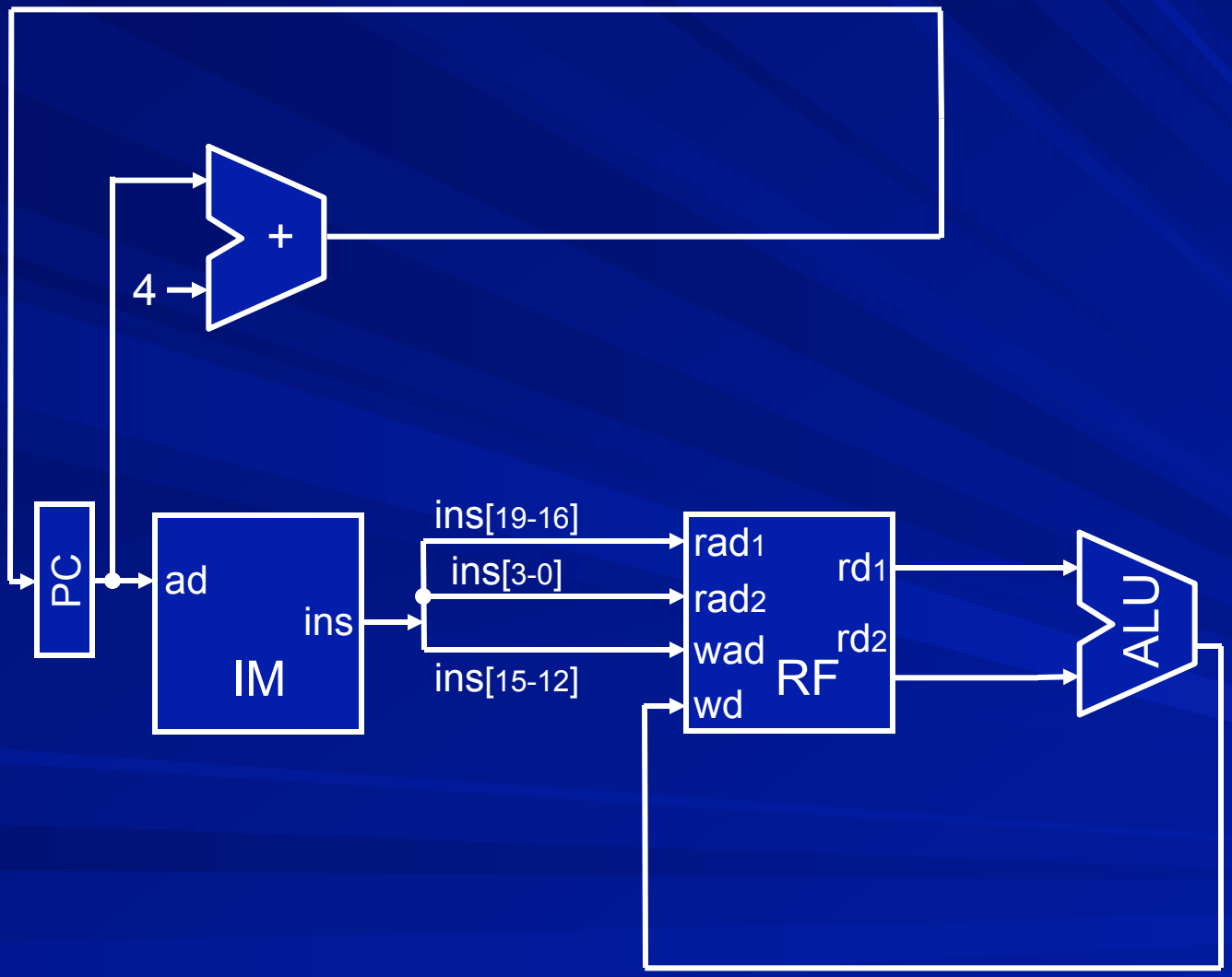
Passing operands to ALU



Passing the result to RF



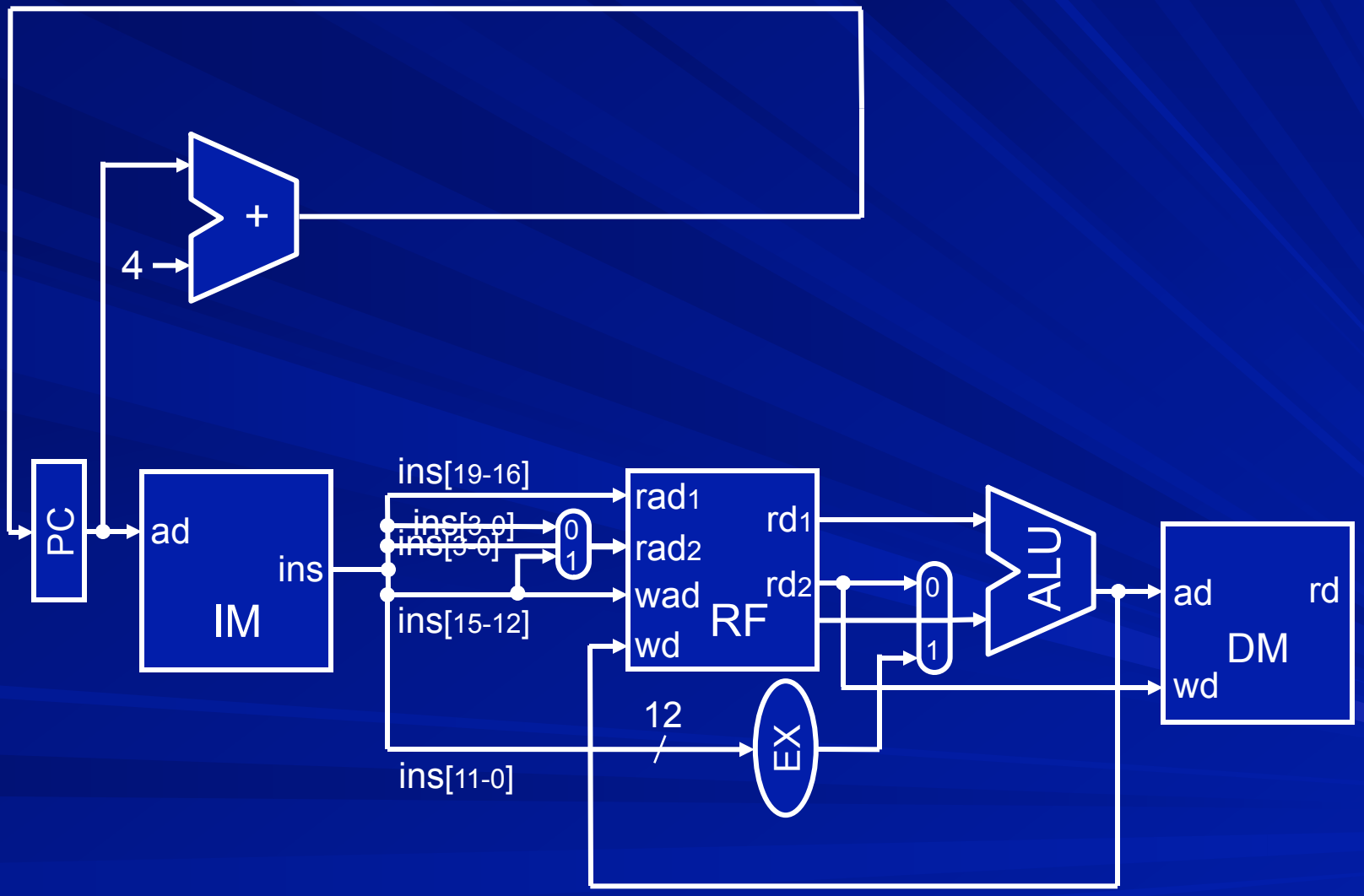
Incrementing PC



Actions for str instructions

- fetch instruction
- access the register file
- compute address in ALU
- write data into memory
- increment PC

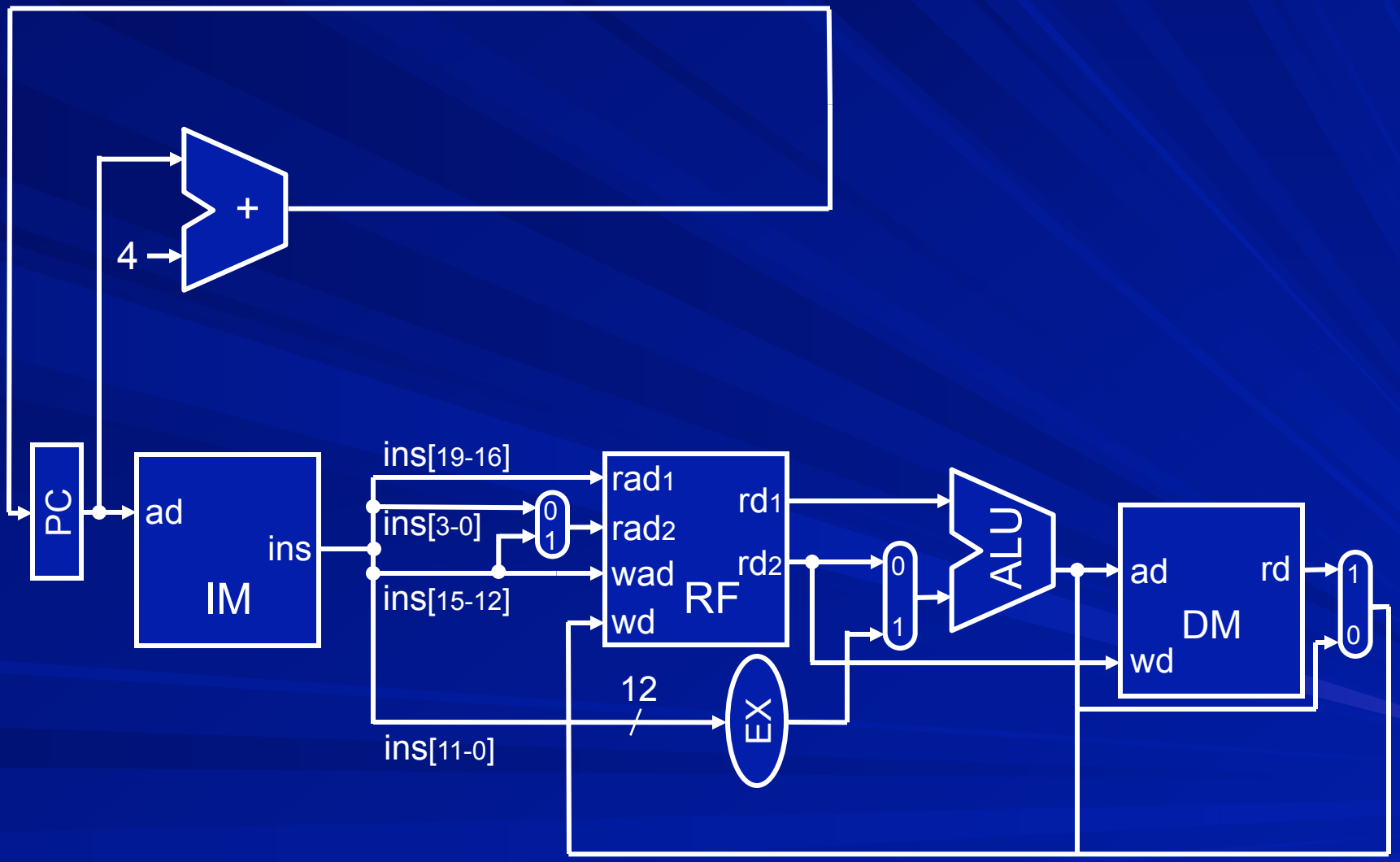
Adding “str” instruction



Actions for ldr instructions

- fetch instruction
- access the register file
- compute address in ALU
- read data from memory
- put data in register file
- increment PC

Adding “ldr” instruction

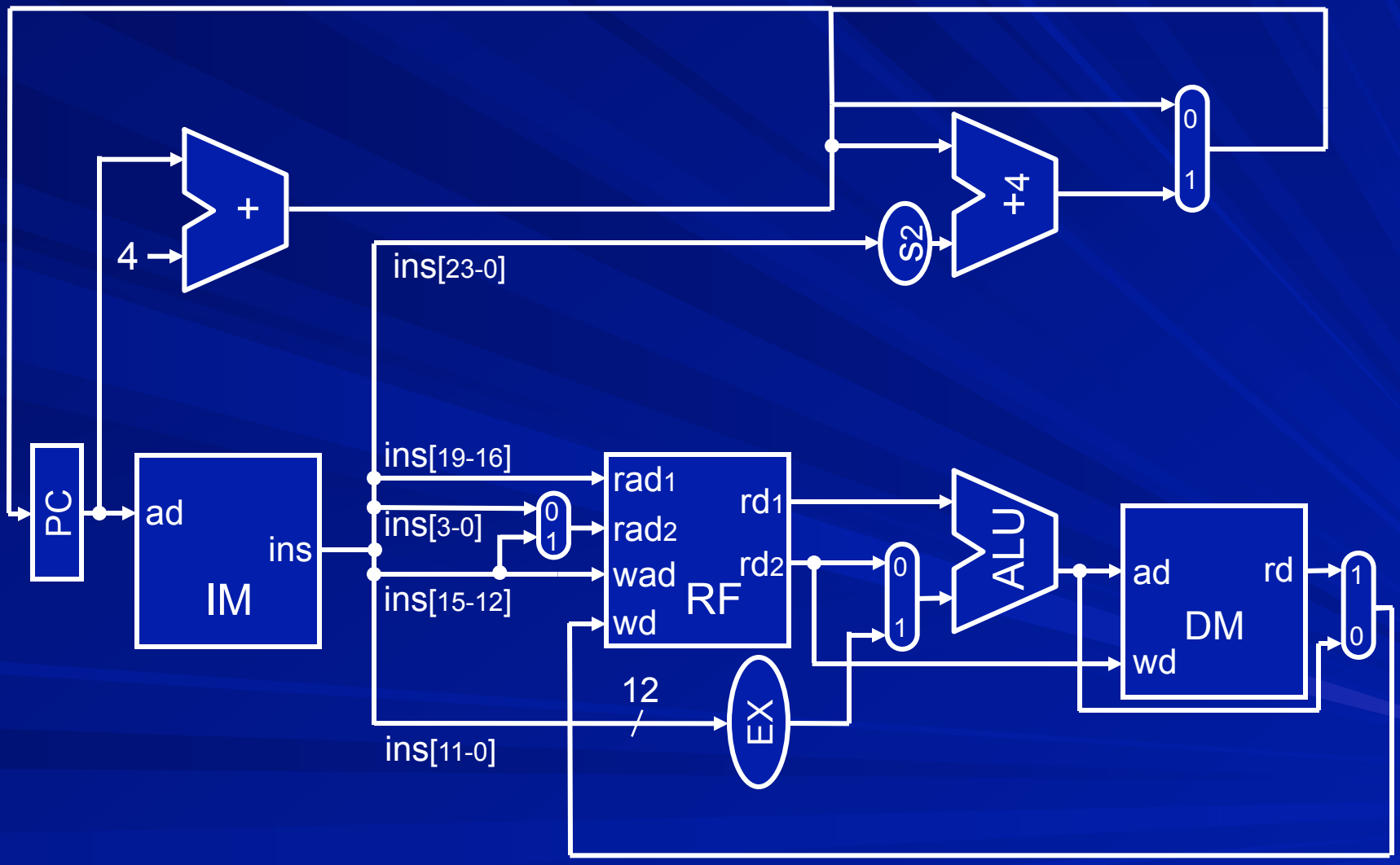


Actions for branch instruction

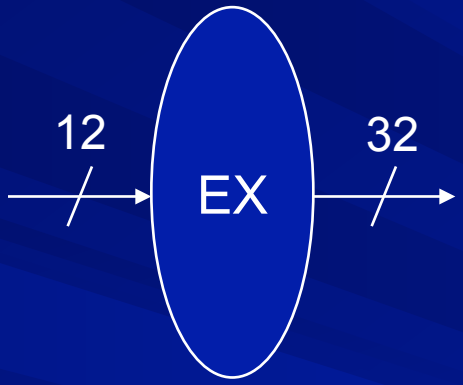
- fetch instruction

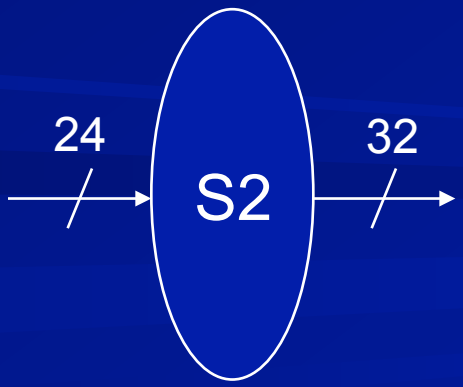
- compute target address
- transfer address to pc

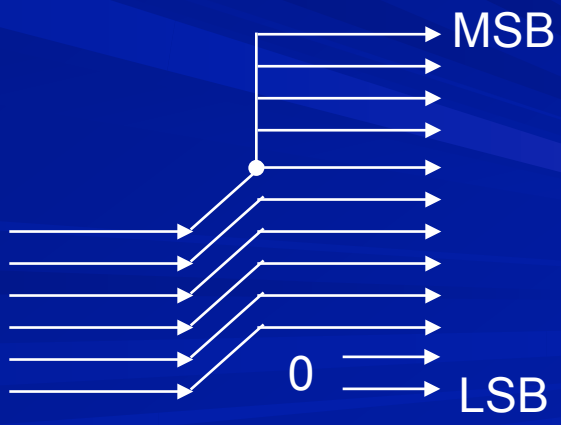
Adding “b” instruction



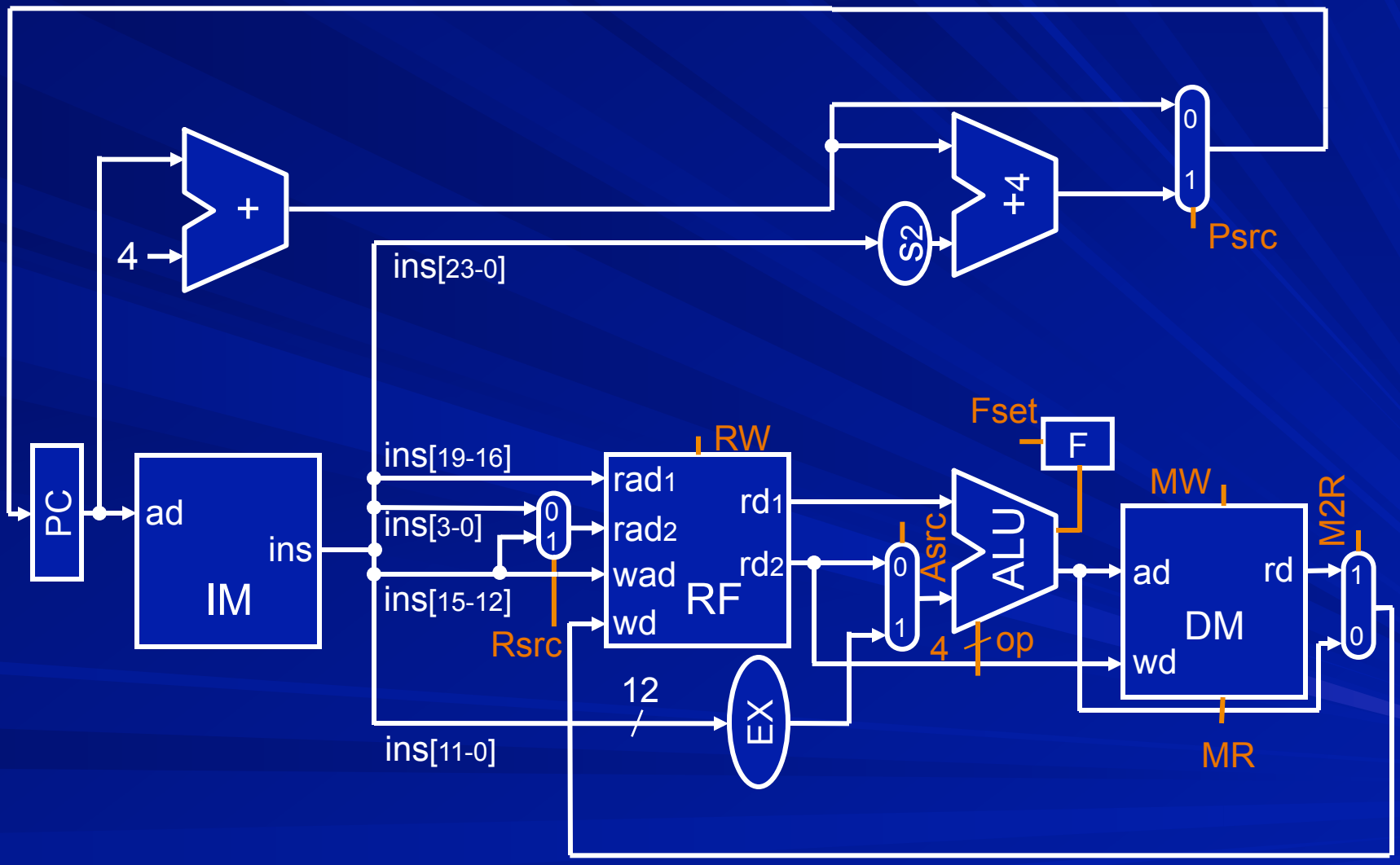
Extending offsets



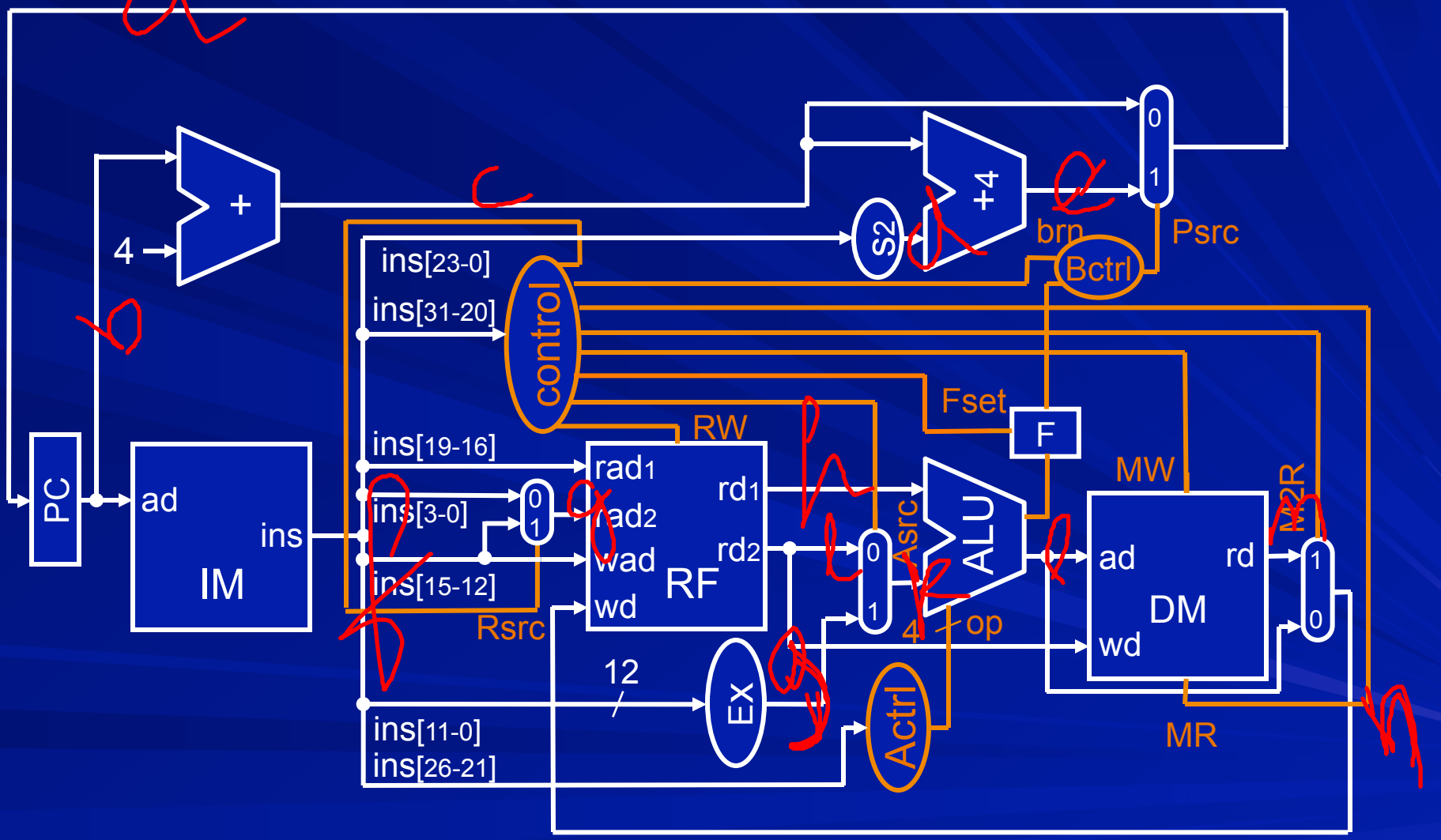




Control Signals



Datapath + Control



Summary

Processor designed for a small ARM subset

- Step by step approach
- Started with DP instructions
- Added DT, then added branch
- Identified control signals and connected to a controller (black box).