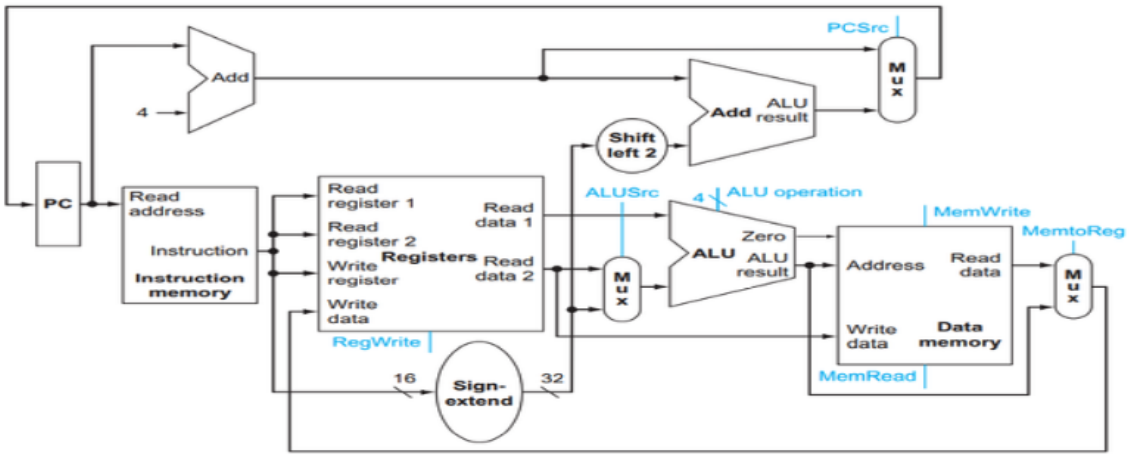
Computer Architecture (ENE1004)

▼ Lec 10

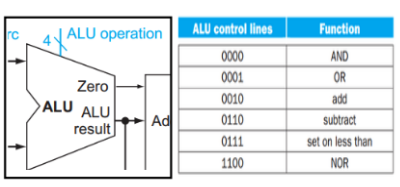
Lec 10: The Processor 3

A Single Datapath for Fetching (가져오기) + R + Load/Store + Branch

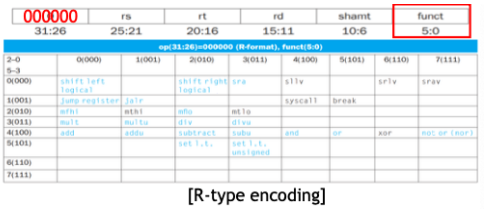


- (I) For fetching instructions, we need PC, Instruction memory, Adder
- (II) For R-type instructions, we need Register file and ALU
- (III) For load/store instructions, we need Register file, ALU, Sign extension unit, Data memory
- (IV) For branch instructions, we need Register file, ALU, Sign extension unit, Shift left 2 unit, Adder

ALU Control Unit (ALU 제어 장치)

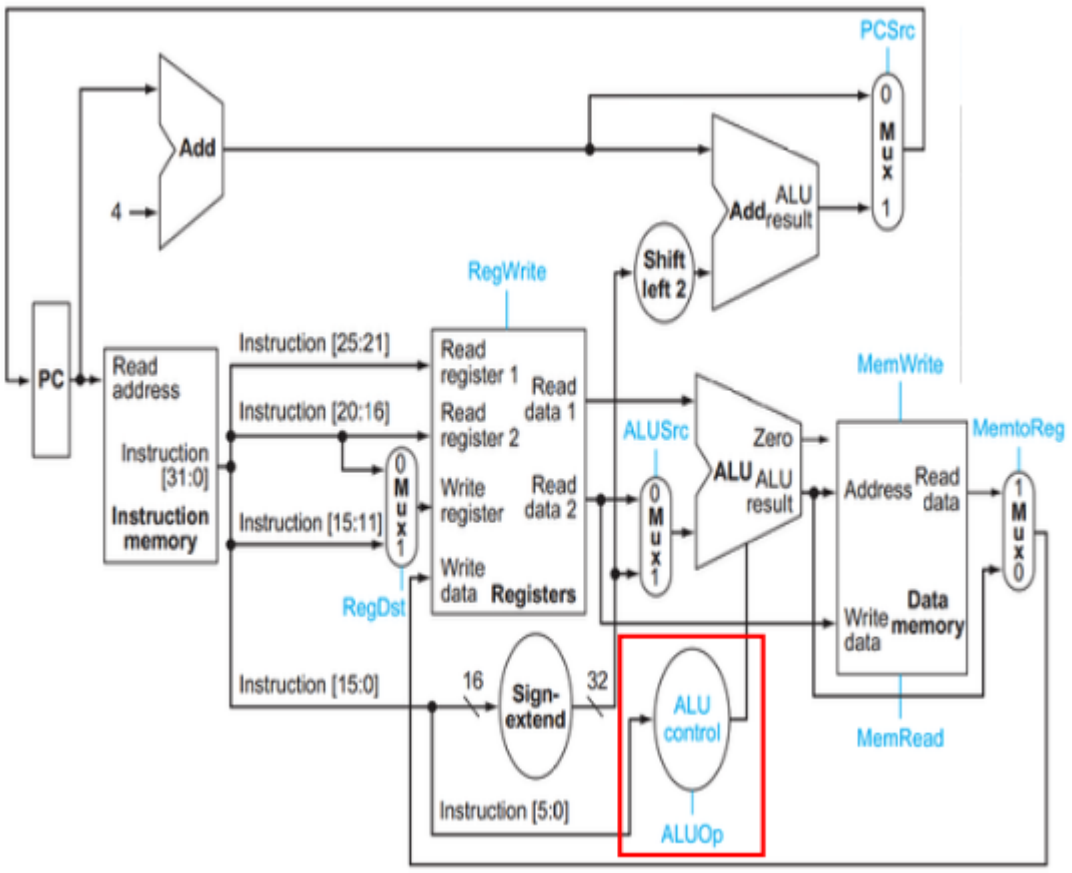


ALU control lines	Function
0000	AND
0001	OR
0010	add
0110	subtract
0111	set on less than
1100	NOR



[R-type encoding]

- ALU performs one of these functions (ALU는 다음 기능 중 하나를 수행한다.)
    - Load/store instructions use “addition” to compute the memory address (로드/저장 명령어는 “덧셈”을 사용하여 메모리 주소를 계산한다.)
    - Branch-equal instruction uses “subtraction” to compare two register values (Branch-equal(Beq) 명령어는 “빼기”를 시용하여 두 레지스터 값을 비교한다.)
    - R-type instructions selects “actions”, depending on the value of the 6-bit funct field (R 타입 명령어는 6비트 함수 필드의 값에 따라 “action”을 선택한다.)
- We need a “control unit” that determines what function ALU performs in datapath (데이터 경로에서 ALU가 어떤 기능을 수행할 지 결정하는 “제어 장치”가 필요 하다.)
    - Input (2 bits) – which type is this instruction, load/store, branch-equal, or R-type? (입력 2비트: 이 명령어는 로드/저장, Branch equal 또는 R 타입 중 어떤 타입인가? 를 결정)
    - Input (6 bits) – what is the value of the funct filed if it is R-type? (입력 6비트: R 타입인 경우, 인출된 함수의 값은 무엇인가?를 결정)
    - Output (4 bits) – what function the ALU performs? (출력 4비트: ALU가 어떤 기능을 수행하는가?를 결정)



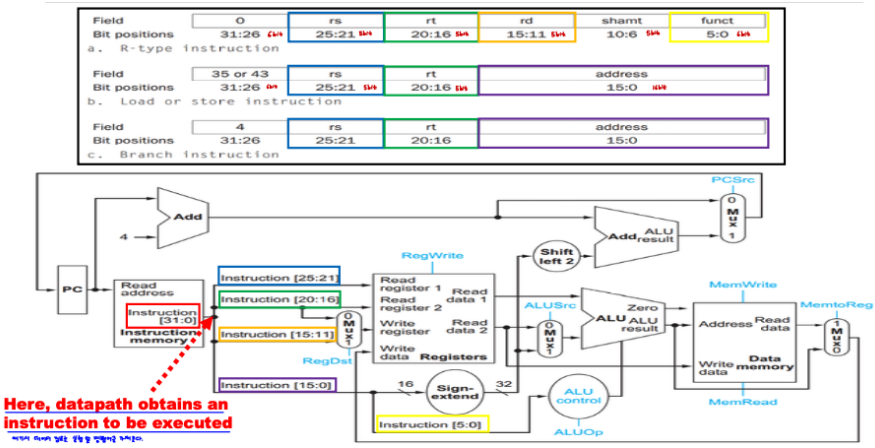
Input(2-bit) Input(6-bit) Output(4-bit)

Instruction opcode	ALUOp	Instruction operation	Funct field	Desired ALU action	ALU control input
LW	00	load word	XXXXXX	add	0010
SW	00	store word	XXXXXX	add	0010
Branch equal	01	branch equal	XXXXXX	subtract	0110
R-type	10	add	100000	add	0010
R-type	10	subtract	100010	subtract	0110
R-type	10	AND	100100	AND	0000
R-type	10	OR	100101	OR	0001
R-type	10	set on less than	101010	set on less than	0111

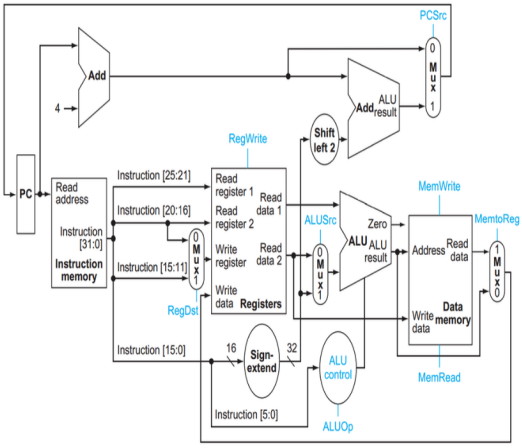
- ALUOp is determined by instruction types
  - 00 for load/store instructions (00: 로드/저장 명령어)
  - 01 for branch-equal instruction (01: branch-equal 명령어)
  - 10 for R-type instructions (10: R-type 명령어)
- Funct field is extracted from instruction (함수 필드는 명령어에서 추출된다.)
- Based on ALUOp and Instruction[5:0], ALU control unit determines the action to be performed by the ALU (ALUOp 및 Instruction[5:0]에 따라

ALU control 유닛이 수행할 동작을 결정한다.)

Datapath for Formats of Instructions (명령어 형식에 대한 데이터 경로)



Seven Control Signals + 2-bit ALUOp (7개의 제어 신호 + 2비트 ALUOp)



Signal name	A value of 0 Effect when deasserted	A value of 1 Effect when asserted
RegDst	The register destination number for the Write register comes from the rt field (bits 20:16).	The register destination number for the Write register comes from the rd field (bits 15:11).
RegWrite	None.	The register on the Write register input is written with the value on the Write data input.
ALUSrc	The second ALU operand comes from the second register file output (Read data 2).	The second ALU operand is the sign-extended, lower 16 bits of the instruction.
PCSrc	The PC is replaced by the output of the adder that computes the value of PC + 4.	The PC is replaced by the output of the adder that computes the branch target.
MemRead	None.	Data memory contents designated by the address input are put on the Read data output.
MemWrite	None.	Data memory contents designated by the address input are replaced by the value on the Write data input.
MemtoReg	The value fed to the register Write data input comes from the ALU.	The value fed to the register Write data input comes from the data memory.

- The values of the seven signals + ALUOp signal are determined by the given instruction type (7개의 신호 + ALUOp 신호의 값은 주어진 명령어 유형에 따라 결정된다.)
- Depending on the instruction type, a control unit that determines all the values is required (명령어 유형에 따라 모든 값을 결정하는 제어 장치가 필요하다.)