

Mechanism of Forwarding Unit

- the forwarding unit takes the following values as input
 - Read Register 1 from ID/EX register
 - Read Register 2 from ID/EX register
 - Write Register from EX/MEM register
 - registerWrite signal from EX/MEM register
 - Write Register from MEM/WB register
 - registerWrite signal from MEM/WB register

where,

Read Register 1 holds the value indicating the first source register
Read Register 2 holds the value indicating the second source register
Write Register holds the value indication the destination register
registerWrite signal from the control unit, indicates the instruction requires to
 update the value of Write Register

- if the read register from ID/EX is the zero register, the corresponding register data is not forwarded. Therefore ALU gets data provided by the register unit.
- If the read register from ID/EX is equal to the write register of the EX/MEM register and the registerWrite signal is set, data is forwarded from EX/MEM unit to the corresponding register.
- If the read register from ID/EX is equal to the write register of the MEM/WB register and the registerWrite signal is set, data is forwarded from MEM/WB unit to the corresponding register.
- If a certain register fulfills the aforementioned conditions for both EX/MEM and MEM/WB units, data is forwarded from EX/MEM unit.
- In all other cases data is not forwarded. Therefore ALU gets data provided by the register unit.
- the forwarding unit generates 2 signals ForwardA and ForwardB, each of two bits length, according to the following table.

Table 1: explanation of Forwarding unit MUX control outputs

MUX control	source	Explanation
ForwardA = 00	ID/EX	the first ALU operand (A) comes from the register file
ForwardA = 10	EX/MEM	the first ALU operand (A) is forwarded from prior ALU result
ForwardA = 01	MEM/WB	the first ALU operand (A) is forwarded from two clock pulse prior ALU result
ForwardB = 00	ID/EX	the first ALU operand (B) comes from the register file
ForwardB = 10	EX/MEM	the first ALU operand (B) is forwarded from prior ALU result
ForwardB = 01	MEM/WB	the first ALU operand (B) is forwarded from two clock pulse prior ALU result

The required truth tables and functions for generating ForwardA and ForwardB signals are as follows:

Table 2.1: table for determining if data is required to be forwarded from EX/MEM unit

EX/MEM.destination == ID/EX.source	EX/MEM.regWrite	ID/EX.source == 0	Xsource
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 2.2: table for determining if data is required to be forwarded from MEM/WB unit

MEM/WB.destination == ID/EX.source	MEM/WB.regWrite	ID/EX.source == 0	Msource
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 2.3: table for determining MUX control, ForwardA

XA	MA	ForwardA1	ForwardA0
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	0

Table 2.4: table for determining MUX control, ForwardB

XB	MB	ForwardB1	ForwardB0
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	0

Functions:

$X_{source} = (EX/MEM.destination == ID/EX.source) \cdot (EX/MEM.regWrite) \cdot (ID/EX.source == 0)$

$M_{source} = (MEM/WB.destination == ID/EX.source) \cdot (MEM/WB.regWrite) \cdot (ID/EX.source == 0)$

$Forward0 = X'M$

$Forward1 = X$