

Pipeline architecture: example 1



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Example 1

Let consider the following MIPS64 architecture:

- Integer ALU: 1 clock cycle
- Data memory: 1 clock cycle
- Branch delay slot: 1 clock cycle
- Forwarding is enabled.

The following assembly program sums 10 integer (64 bits) numbers previously saved in memory.

; 10 integers addition

;-----

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN:	daddui R1,R0,10	;R1 <-- 10
	dadd R2,R0,R0	;R2 <-- 0 POINTER REG
	dadd R3,R0,R0	;R3 <-- 0 RESULT REG
LOOP:	ld R4,values(R2)	;GET A VALUE IN R4
	dadd R3,R3,R4	;R3 <-- R3 + R4
	daddi R2,R2,8	;R2 <-- R2 + 8 POINTER INCREMENT
	daddi R1,R1,-1	;R1 <-- R1 - 1 DECREMENT COUNTER
	bnez R1,LOOP	
	sd R3,result(R0)	;Result in MEM
	halt	;the end

Example 1 – [cont]

You are asked to compute the time (in clock cycles) required by the program to execute.

; 10 integers addition

;-----

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

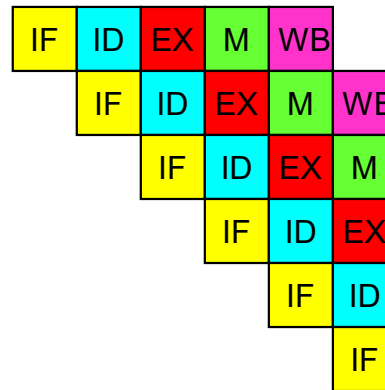
daddi R2,R2,8

daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

halt



; 10 integers addition

;-----

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

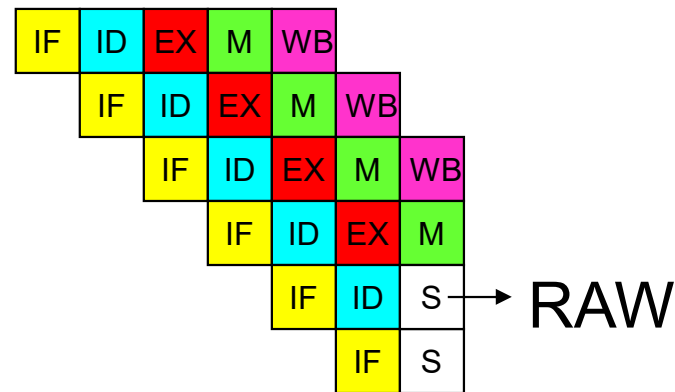
daddi R2,R2,8

daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

halt



values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

.text

dadd R2,R0,R0

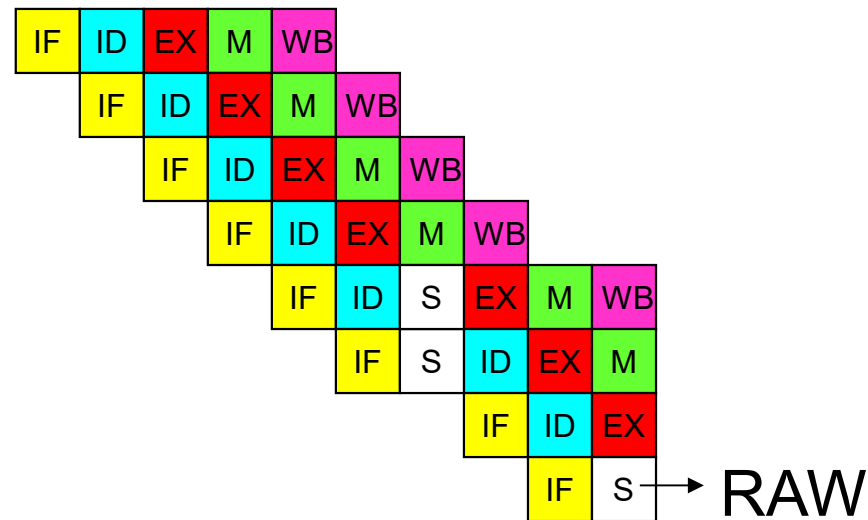
dadd R3,R3,R4

dadd R1,R1,-1

bnez R1,LOOP

```
sd R3,result(R0)
```

halt



; 10 integers addition

;-----

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

daddi R2,R2,8

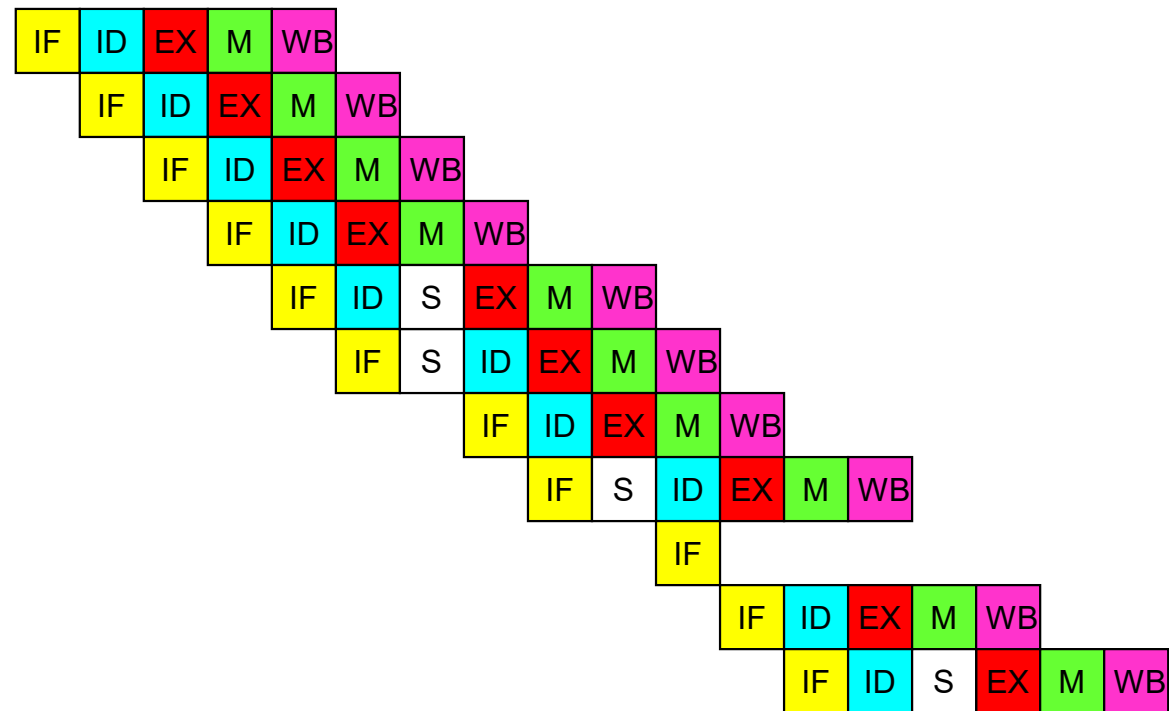
daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

LOOP: ld R4,values(R2)

dadd R3,R3,R4



; 10 integers addition

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.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

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.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

daddi R2,R2,8

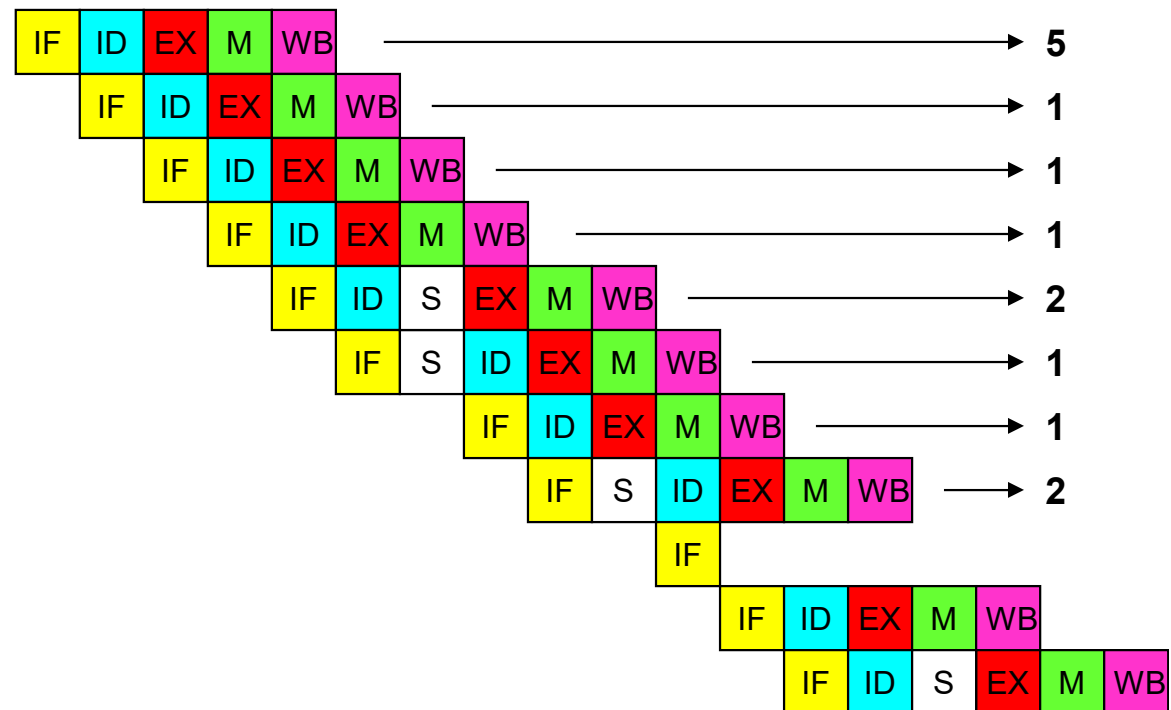
daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

LOOP: ld R4,values(R2)

dadd R3,R3,R4



; 10 integers addition

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values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

daddi R2,R2,8

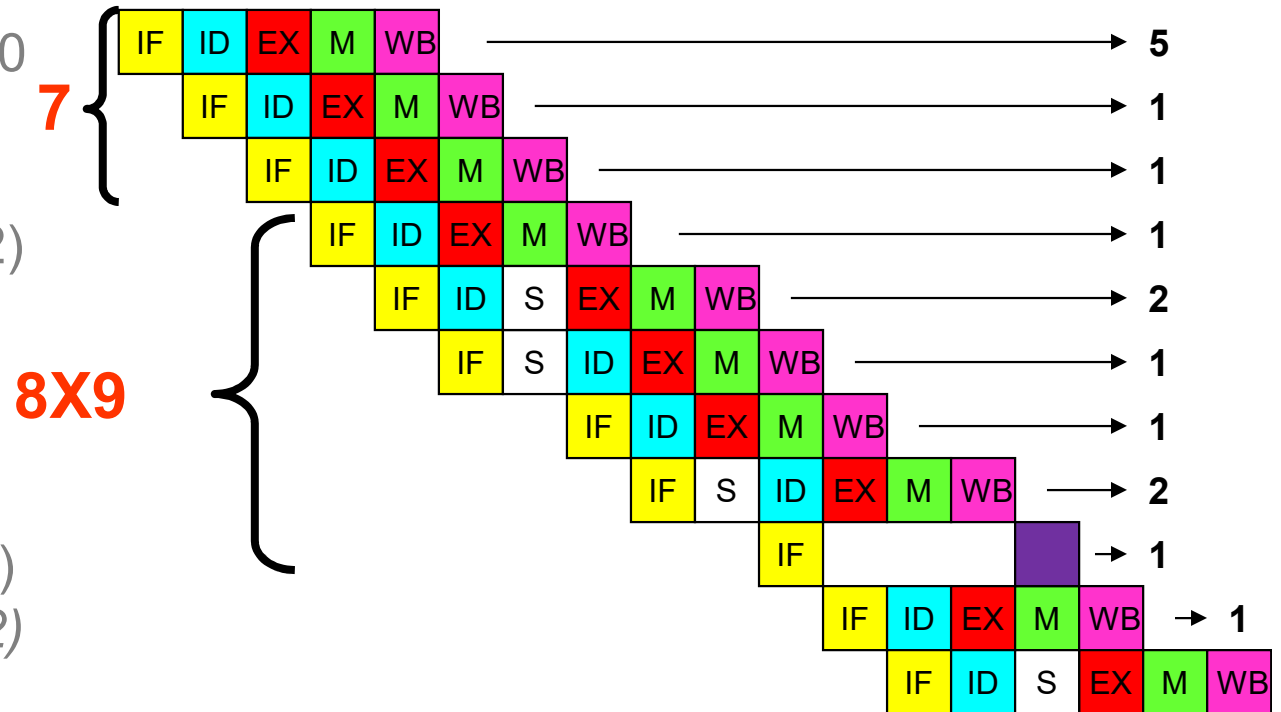
daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

LOOP: ld R4,values(R2)

dadd R3,R3,R4



; 10 integers addition

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

daddi R2,R2,8

daddi R1,R1,-1

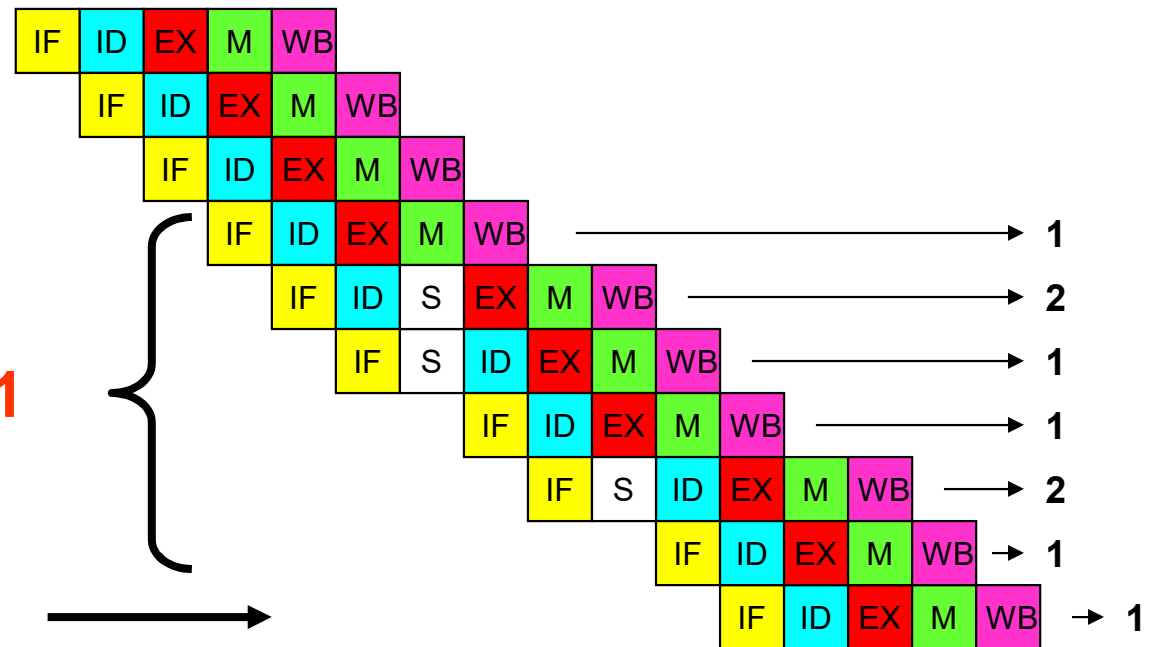
bnez R1,LOOP

sd R3,result(R0)

halt

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; 10 integers addition

;-----

.data

values: .word 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ;64-bit integers

result: .space 8

.text

MAIN: daddui R1,R0,10

dadd R2,R0,R0

dadd R3,R0,R0

LOOP: ld R4,values(R2)

dadd R3,R3,R4

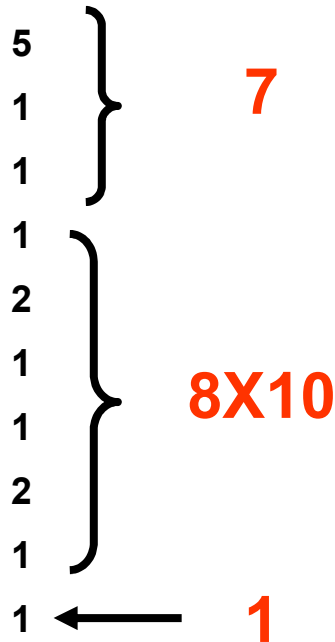
daddi R2,R2,8

daddi R1,R1,-1

bnez R1,LOOP

sd R3,result(R0)

halt



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