Computer Architecture and Programming Languages
Jacobs University Bremen
Arsenij Percov

Course: CO20-320241
November 25th, 2019

Homework 10

Problem 10.1

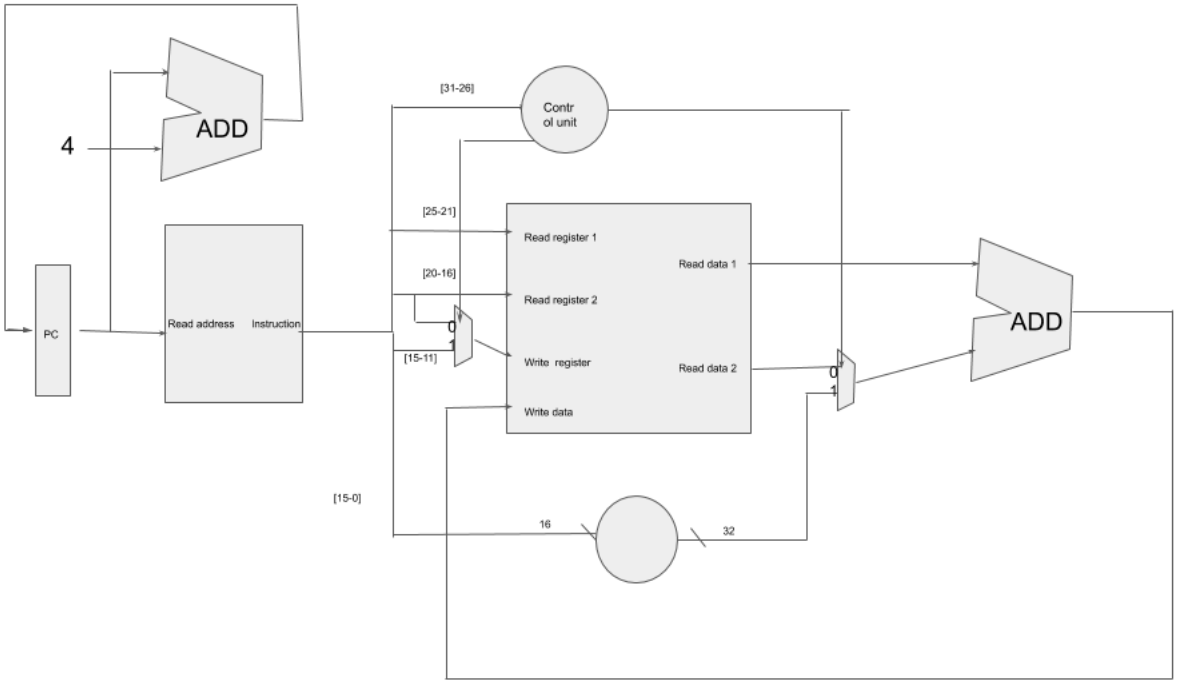
Solution:

Controls lines are necessary to select input type for shared elements, like for example ALU, also they are needed to define the format of the input(R-type or I-type or J-type for example) and like for example ALUsrc. They communicate with multiplexers, and dictate which input to select as output for multiplexer, which are used to direct the result, and choose some operation-specific manipulations.

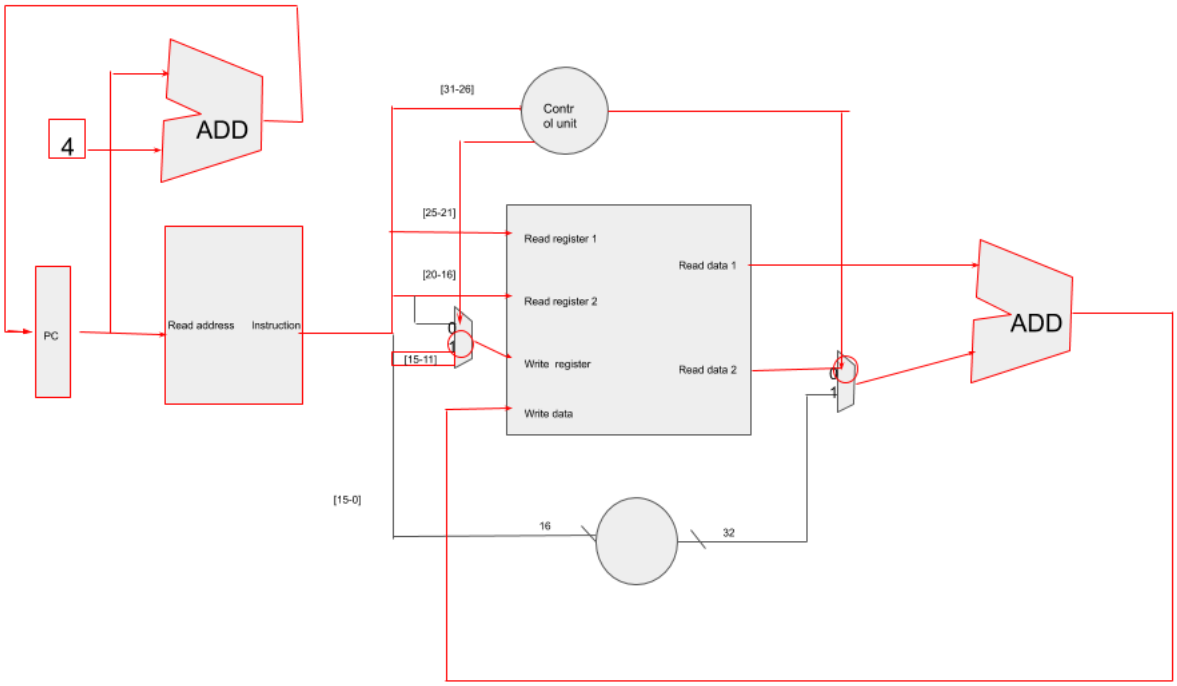
Problem 10.2

Solution:

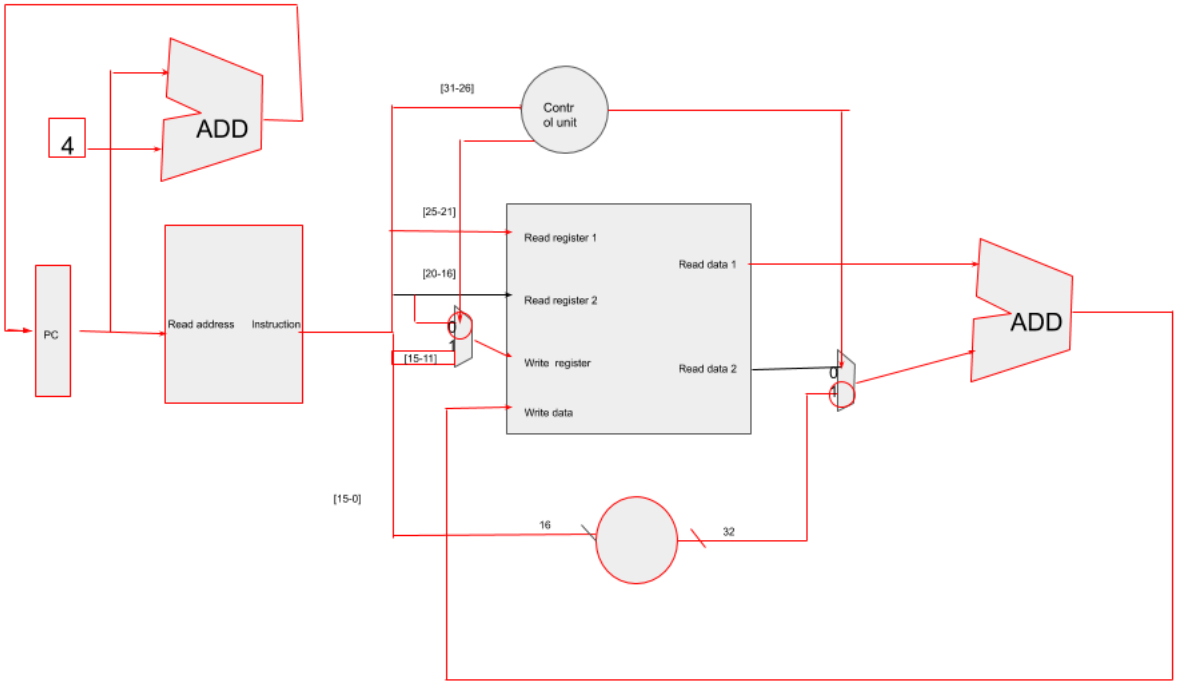
This is the datapath that is able to execute both add, and addi.



Here is the path for add(red arrows are used in the example):



Datapath for addi, reads 20-16 bits as write register with help of multiplexer, and control line, and later it uses 15-00 extended to 32 bits as parameter for add, and later stores it in write data.



Problem 10.3

Solution:

Find the longest instruction paths.

a)Out of all possible paths for instructions, this one is the longest one. We start operation, go throw register, from where we through multiplex send output to ALU, do the operation, and select to return it to Regs to write it there, using multiplex. I-mem, Regs, Mux, ALU, Mux, Regs

450 + 250 + 30 + 120 + 30 + 250 = 1130ps

b) The data goes from I-Mem to sign extend and Regs, however since Regs takes longer time, and instructions are parallel, then we only include Regs to calculations, then we go to AlU, adding the sign extend, and finally we store data to memory in D-Mem.

I-Mem, RegF, ALU, D-Mem

450 + 250 + 120 + 350 = 1170ps

c)We need to find the longest instruction among all of these in the datapath designed to support all of them. Longest time for sw is 1170, add is ALU instruction, and longest ALU instruction takes 1130ps, so we only need to find beq and lw longest times.

beq = I-Mem + RegF + Mux + ALU + Mux = 450+250+30+120+30=880 ps
lw = I-Mem + RegF + ALU + D-Mem + Mux + RegF = 450 + 250 + 120 + 350 +30 +250 = 1450ps.
Therefore, lw is the longest instruction with the clock cycle time of 1450 ps.