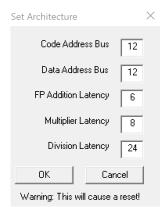
Architetture dei Sistemi di Elaborazione 02GOLOV GRB-7777 Laboratory 3 Expected delivery of lab_03.zip must include: - program_1_a.s, program_1_b.s and program_1_c.s - this file compiled and if possible in pdf format.

Please, configure the winMIPS64 simulator with the *Base Configuration* provided in the following:

- Code address bus: 12
- Data address bus: 12
- Pipelined FP arithmetic unit (latency): 6 stages
- Pipelined multiplier unit (latency): 8 stages
- Divider unit (latency): not pipelined unit, 24 clock cycles
- Forwarding is enabled
- Branch prediction is disabled
- Branch delay slot is disabled
- Integer ALU: 1 clock cycle
- Data memory: 1 clock cycle
- Branch delay slot: 1 clock cycle.



1) Starting from the assembly program you created in the previous lab called program_1.s:

```
for (i = 0; i < 60; i++){
	v5[i] = ((v1[i]+v2[i]) * v3[i])+v4[i];
	v6[i] = v5[i]/(v4[i]*v1[i]);
	v7[i] = v6[i]*(v2[i]+v3[i]);
}
```

- a. Detect manually the different data, structural and control hazards that provoke a pipeline stall
- b. Optimize the program by re-scheduling the program instructions in order to eliminate as many hazards as possible. Compute manually the number of clock cycles the new program (**program_1_a.s**) requires to execute, and compare the obtained results with the ones obtained by the simulator.
- c. Starting from program_1_a.s, enable the *branch delay slot* and re-schedule some instructions in order to improve the previous program execution time. Compute manually the number of clock cycles the new program (program_1_b.s) requires to execute, and compare the obtained results with the ones obtained by the simulator.
- d. Unroll 3 times the program (**program_1_b.s**), if necessary re-schedule some instructions and increase the number of used registers. Compute

manually the number of clock cycles the new program (program_1_c.s) requires to execute, and compare the obtained results with the ones obtained by the simulator.

Complete the following table with the obtained results:

Program	program_1.s	program_1_a.s	program_1_b.s	program_1_c.s
Clock cycle				
computation				
By hand	<u>3907</u>	<u>3607</u>	<u>3547</u>	<u>3049</u>
By simulation	<u>3907</u>	<u>3607</u>	<u>3547</u>	<u>3049</u>

Compare the results obtained in point 1, and provide some explanation in the case the results are different.

Eventual explanation:
Il simulatore effettua il calcolo dei clock cycle in maniera leggermente differente rispetto
a quanto visto a lezione ma, nonostante ciò, il numero di clock cycle calcolati a mano non
differisce in quanto la differenza, nel mio codice, sta solo nel fatto che il simulatore effettua
il primo stage delle operazioni aritmetiche anche quando il dato non è ancora disponibile e
successivamente stalla per un colpo di clock in più rispetto al calcolo a mano.