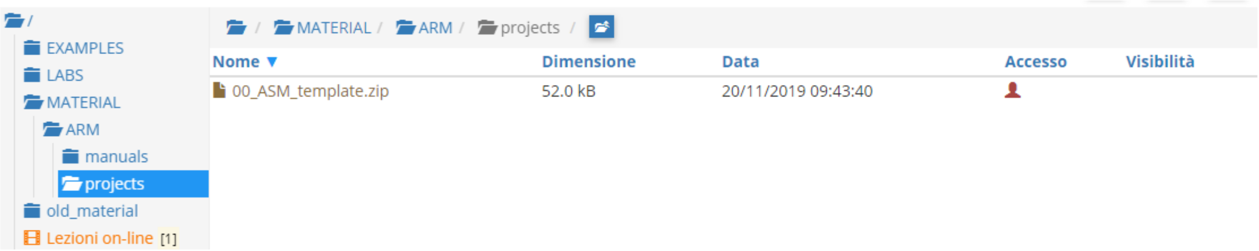
Architetture dei Sistemi di Elaborazione [AAA-GRA]
Laboratory 6

Delivery date:
25th November 2022

Expected delivery of lab_06.zip must include:
- Solutions of the exercises 1, 2 and 3
- this document compiled possibly in pdf format.

Starting from the ASM_template project (available on Portale della Didattica), solve the following exercises:



/
EXAMPLES
LABS
MATERIAL
ARM
manuals
projects
old_material
Lezioni on-line [1]

/ MATERIAL / ARM / projects /

Nome ▼	Dimensione	Data	Accesso	Visibilità
00_ASM_template.zip	52.0 kB	20/11/2019 09:43:40		

1) Write a program using the ARM assembly that performs the following operations:
   a. Initialize registers R3 and R4 to random signed values
   b. Sum R0 to R3 (R0+R3) and store the result in R2
   c. Subtract R4 to R2 (R4-R2) and store the result in R5
   d. Force, using the debug register window, a set of specific values to be used in the program to provoke the following flag to be updated **once at a time** (whenever possible) to 1:
      - carry
      - overflow
      - negative
      - zero
   e. Report the selected values in the table below.

	Please, report the hexadecimal representation of the values			
Updated flag	R0 + R3		R4 – R2	
	R0	R3	R4	R2
Carry = 1	0xB0000000	0x60000000	0x20000000	0x10000000
Carry = 0	0x05000000	0x04000000	0x00000000	0x90000000
Overflow	0xB0000000	0xB0000000	0x90000000	0x60000000
Negative	0x70000000	0x80000000	0x80000000	0xF0000000
Zero	0x00000000	0x00000000	0x00000000	0x00000000

Please explain the cases when it is **not** possible to force a **single** FLAG condition:

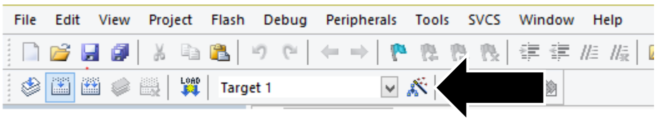
It is not possible to activate only the overflow flag because having an overflow means having a carry flag activated.

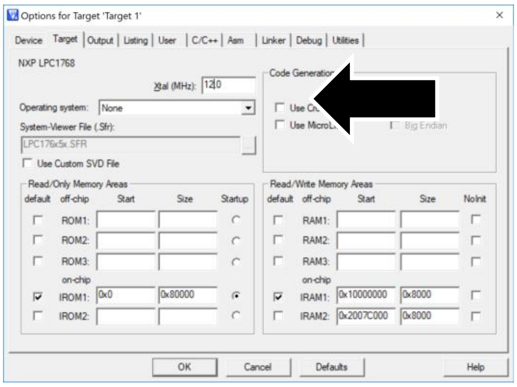
In the case of subtraction, it is not possible to have only the zero flag activated because you must necessarily have the carry flag active because of the complement to 2 made to R2.

2) Write two versions of a program that performs the following operations:
   a. Initialize registers R2 and R3 to random signed values
   b. Compare the two registers:

- If they differ, store in the register R5 the maximum among R2 and R3
- Otherwise, perform a logical right shift of R3, sum R2 and store the result in R4

First, solve it by resorting to 1) a traditional assembly programming approach using conditional branches and then compare the execution time with a 2) conditional instructions execution approach.
Report the execution time in the two cases in the table that follows: **NOTE**, report the number of clock cycles (cc) considering a cpu clock (clk) frequency of 16 MHz, as well as the simulation time in milliseconds (ms).
Notice that the processor clock frequency is setup in the menu "*Options for Target: 'Target 1'*".





NXP LPC1768

Xtal (MHz): 12.0

Operating system: None

System-Viewer File (.Sfr): LPC176x5x.SFR

☐ Use Custom SVD File

Read/Only Memory Areas

default	off-chip	Start	Size	Startup
☐	ROM1:			○
☐	ROM2:			○
☐	ROM3:			○
	on-chip			
☑	IROM1:	0x0	0x80000	●
☐	IROM2:			○

Read/Write Memory Areas

default	off-chip	Start	Size	NoInit
☐	RAM1:			☐
☐	RAM2:			☐
☐	RAM3:			☐
	on-chip			
☑	IRAM1:	0x10000000	0x8000	☐
☐	IRAM2:	0x2007C000	0x8000	☐

	R2==R3 [cc]	R2==R3 [ms]	R2! =R3 [cc]	R2! =R3 [ms]
1) Traditional	10	0.00063	11 13	0.00069 (r2 > r3) 0.00081 (r2 < r3)
2) Conditional Execution	15	0.00092	15	0.00092

3) Write a program that calculates the leading zeros of a variable. The leading zeros are computed by counting the number of zeros starting from the most significant bit and stopping at the first 1 encountered: e.g., the leading zeros of 0b00000101 are 5. The variable to check is in R1. After the count, if the number of leading zeros is odd, perform the sum between R2 and R3. If the number of leading zeros is even, perform the difference between R2 and R3. In both cases the result is placed in R4.

Implement the ASM code that performs the following operations:

a. Determines whether the number of leading zeros of R1 is odd or even.
b. As a result, the value of R4 is computed as follows:
    - If the leading zeros are even, R4 is the difference between R2 and R3
    - Else, R4 is the sum of R2 and R3
c. Report code size and execution time (with 15MHz clk) in the following table.

	Code size [Bytes]	Execution time [ms]	
		If R2 is even	Otherwise
Exercise 3) computation	560	0.00473	0.00487

ANY USEFUL COMMENT YOU WOULD LIKE TO ADD ABOUT YOUR SOLUTION:

For the exercise number 3, I developed two types of algorithms:
1. Calculate the number of leading zeros by comparing the current value with the next value shifted to the left and looking at the Negative flag
2. Calculate the number of leading zeros by shifting the value to the left and looking at the Carry flag

But, for performance reasons I chose the second type because the first was slower in terms of calculation.