LC3 Processor Implemented in FPGA
Nexys 2 System

You will find two folders:

- **vhdl**: VHDL code for the LC3 processor, the bus interconnection subsystem, the serial communication module, the memory interface, and a naive peripheral.
- **asmtest**: a simple ASM code for the LC3 processor to be download into the FPGA memory using a serial terminal. You will also find a HEX file and a couple of cmd files that might be useful.

The asmtest example called **WritingMEM** is meant to be executed in the LC3 processor implemented in the FPGA. Please follow to following steps to download this code into the FPGA Memory:

1. Create an ISE Xilinx project and add all the VHDL files to it. Then, synthesize it (it should be error-free). Determine the different components of the system.
2. Study the protocol for writing/reading to/from the FPGA memory, determining all the steps required (progcomm.vhd).
3. Assemble the ASM code to generate *.obj and *.sym files.
4. Convert the resulting code (.obj) to HEX.
   a) In Windows, use the LC3Edit program (might need additional steps).
   b) In Linux, use the following command: hexdump -v -e '/1 "%02X\n"' filename.obj > filename.hex.
   c) Remove the two first HEX values (00, 00) in the HEX file generated (Why?).
5. Count the number of 1-byte HEX values in the HEX file generated and divide it by 2. Keep this value in mind (SIZE = HEXValues / 2, Why?).
6. Use an RS-232 cable to connect the PC to the Nexys 2 system.
7. Execute a serial terminal such as CuteCom, Minicom, etc. and configure it for serial communication: 9600 bps, 8 bits for data, 1 bit for stop (Why these values?).
8. Program the FPGA using the .bit file generated in step 1).
9. Send a 0x55 value from PC to FPGA through the serial terminal (Why?).
10. Use the protocol studied in step 2) to write the values in the HEX file into the FPGA memory starting at address 0x0000 (Why?). Then, verify the writing and finally, start the LC3 processor (How?).
11. Reset the FPGA with the appropriate button (Which one?).
12. Use the protocol studied in step 2) to read data from the FPGA memory at address 0x5000 (Why? How many values should be read?).

Be aware that the LC3 processor (in the FPGA) starts its execution at address 0x0000.

Pay attention to the files you find along with the asm file before performing the previous steps. You might already have everything you need. Have you looked at the files: 01_writingmem.wcmd, 01_writingmem.rcmd? Any idea why are they for?