

# Computation Structures — Tutorial 3

October 10, 2017

## $\mu$ -code for ULg02 – User & Supervisor modes

### Reminder

- ULg02 introduces the *supervisor (SVR) mode* that can execute privileged instructions.
- The current mode is encoded in the most significant bit of the PC:
  - PC31 == 0 corresponds to *user* mode;
  - PC31 == 1 corresponds to *SVR* mode.
- SVR mode can be activated in two ways:
  1. When using the SVC()  $\beta$ -assembly instruction.
  2. Following an interrupt.
- Jumping instructions (JMP, JMPI,...) use *absolute addressing*: they can be used to come back to user mode.
- Jumping to a privileged address (i.e., an address whose MSB is 1) from user mode is **not possible**: see the PC register circuitry.
- Branching instructions (BR, BT, BEQ,...) use *PC-relative addressing*: they cannot be used to come back to user mode nor to try to reach SVR mode.

### Exercises

1. Provide the ULg02 supervisor micro-code for the following instruction:

```
JMPI(Ra, lit, Rc): PC <- PC + 4
                  EA <- (Reg[Ra]+SEXT(lit)) & 0xfffffc
                  Reg[Rc] <- PC
                  PC <- Mem[EA]
```

2. Provide the ULg02 user *and* supervisor micro-code for the BT(Ra, label, Rc) instruction. If Reg[Ra] is zero, it does nothing. Else, it saves the address of the instruction following BT then transfers execution to the address  $PC + 4 \times Lit$  where *Lit* is computed from *label* as it is done in BEQ:

$$Lit = \frac{OFFSET(label) - OFFSET(CurrentInstruction)}{4} - 1$$

3. Provide the ULg02 user *and* supervisor micro-code for the JMPB(Ra, Rb, Rc) that behaves like JMP(Ra, Rc) if Reg[Rb]  $\geq 0$  and does nothing otherwise.