### ARM Instructions Worksheet #6

#### Conditional Branch

*Signed versus Unsigned*

Prerequisite Reading: Chapter 6  
Revised: March 25, 2020

**Objectives:** To use the web-based simulator (“CPUlator”) to better understand...

1. Single versus unsigned conditional branch instructions.

**To do offline:** Answer the questions that follow the listing below. (Numbers at far left are memory addresses.)

```plaintext
.syntax unified
.global _start

0000000 _start: LDR R0,=0xFFFFFFFF  // *** EXECUTION STARTS HERE ***
0000004 loop: LDR R1,=0x11111  // Turn on all flags
0000008 CMP R0,1
000000C test1: BLO test2  // Branch if R0 <  1 (unsigned)
0000010 SUB R1,R1,0x10000  // Did not branch: Turn off LO flag
0000014 test2: BHI test3  // Branch if R0 >  1 (unsigned)
0000018 SUB R1,R1,0x10000  // Did not branch: Turn off HI flag
000001C test3: BLT test4  // Branch if R0 < +1 (signed)
0000020 SUB R1,R1,0x01000  // Did not branch: Turn off LT flag
0000024 test4: BGT test5  // Branch if R0 > +1 (signed)
0000028 SUB R1,R1,0x00010  // Did not branch: Turn off GT flag
000002C test5: BEQ next  // Branch if R0 == 1
0000030 SUB R1,R1,0x00001  // Did not branch: Turn off EQ flag
0000034 next: ADD R0,R0,1  // Increment R0
0000038 B loop  // and repeat.

.end
```

**Note:** The least-significant four hex digits of register R1 will be used to indicate which conditions were satisfied according to the table shown at the right:

<table>
<thead>
<tr>
<th>R1 contents</th>
<th>LO</th>
<th>HI</th>
<th>LT</th>
<th>GT</th>
<th>EQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00010000</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00020000</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00030000</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00040000</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>0x00050000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

What is in R0 the 1st time execution arrives at address 0000003816?

Which conditions does R1 indicate as true for R0 compared to 1?
What is in $R_0$ the 2\textsuperscript{nd} time execution arrives at address 00000038\textsubscript{16}?

Which conditions does $R_1$ indicate as true for $R_0$ compared to 1?

Getting ready: Now use the simulator to collect the following information and compare to your earlier answers.

Step 1: Press F3 exactly once to run the simulation and stop at the breakpoint.

Step 2: Press F3 exactly once to run the simulation and stop at the breakpoint.

Step 3: Press F3 exactly once to run the simulation and stop at the breakpoint.

Step 4: Press F3 exactly once to run the simulation and stop at the breakpoint.

Notes:

1. The BLO instruction in the “Editor” window will appear as an equivalent BCC instruction in the “Disassembly window.
2. You can change the number format in the “Settings” window between hex, unsigned decimal and signed decimal as needed.

1. Click here to open a browser for the ARM instruction simulator with pre-loaded code.
2. In the “Disassembly” window, click in the grey area left of the ADD instruction. The red dot (●) is a breakpoint where the simulation will pause before executing this instruction.