A64 INSTRUCTIONS IN MACHINE LANGUAGE

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ARITHMETIC AND LOGIC INSTRUCTIONS

Instr.	opcode	Source Reg. 2	Shift Amount	Source Reg. 1	Dest. Reg.
	[31 – 21]	[20 – 16]	[15-10]	[9 – 5]	[4 – 0]
ADD	100 0101 1000	BBBBB	000000	BBBBB	BBBBB
SUB	110 0101 1000	BBBBB	000000	BBBBB	BBBBB
AND	100 0101 0000	BBBBB	000000	BBBBB	BBBBB
ORR	101 0101 0000	BBBBB	000000	BBBBB	BBBBB

- We will not use the "Shift Amount" bits. They will always be set to 0 for our examples and programming assignment
- The bit numbers (e.g. [31-21]) correspond with array indexes in our Java simulation

MACHINE LANGUAGE FOR LDR AND STR

Instr.	opcode	Immediate	11-10	Base Reg	Data Reg.
bits:	[31-21]	[20-12]		[9-5]	[4-0]
LDR	111 1100 0010	B BBBB BBBB	00	BBBBB	BBBBB
STR	111 1100 0000	B BBBB BBBB	00	BBBBB	BBBBB

The bit numbers (e.g. [31-21]) correspond with array indexes in our Java simulation. The immediate values are signed, i.e., the offset could be -8 or +8.

BRANCH (B) MACHINE LANGUAGE

Instr.	opcode	Immediate
bits:	[31 – 26]	[25 – 0]
B	000101	BB BBBB BBBB BBBB BBBB BBBB BBBB

- Example: **`B afterif`**
- In the machine language, the immediate field is the number of bytes from the current position to the instruction that follows the label.
  - Current position is number of bytes from beginning of main to the current instruction (24 Bytes in testProg3.s)
  - Instruction that follows `afterif` label is at 32 Bytes
  - Immediate = 32 – 24 = 8 Bytes
- This instruction tells the computer that the next instruction is in memory at the position (current + 8 Bytes)

CONDITIONAL BRANCH (CBZ)

Instr.	opcode	Immediate	Register
bits:	[31 – 24]	[23 – 5]	[4 – 0]
CBZ	1011 0100	BBB BBBB BBBB BBBB BBBB	BBBBB

- Example: **`CBZ R12,if`**
- What is the current offset at this instruction? **16**
- What is the offset of the instruction that follows the label **`if`**? **28**
- What is the value for the immediate field for this example?

  28 – 16 = 12

Offset could be negative if the label is before

.END OR HALT INSTRUCTION (HLT)

Instr.	opcode	Not used
bits:	[31 – 21]	[20 – 0]
HLT	110 1010 0010	0 0000 0000 0000 0000 0000