UNIVERSITÉ CÔTE D'AZUR

POLYTECH NICE-SOPHIA

Architecture : PARM

Groupe Polycrew

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- Structure du projet (CPU)
- Composants
- Assembleur
- Passage des tests
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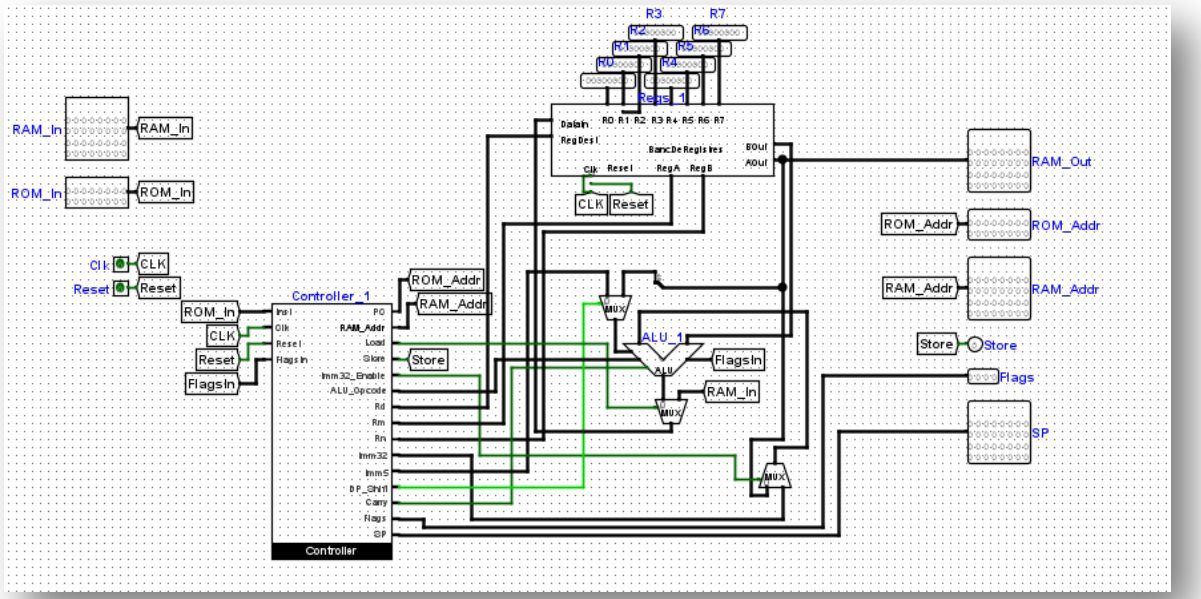
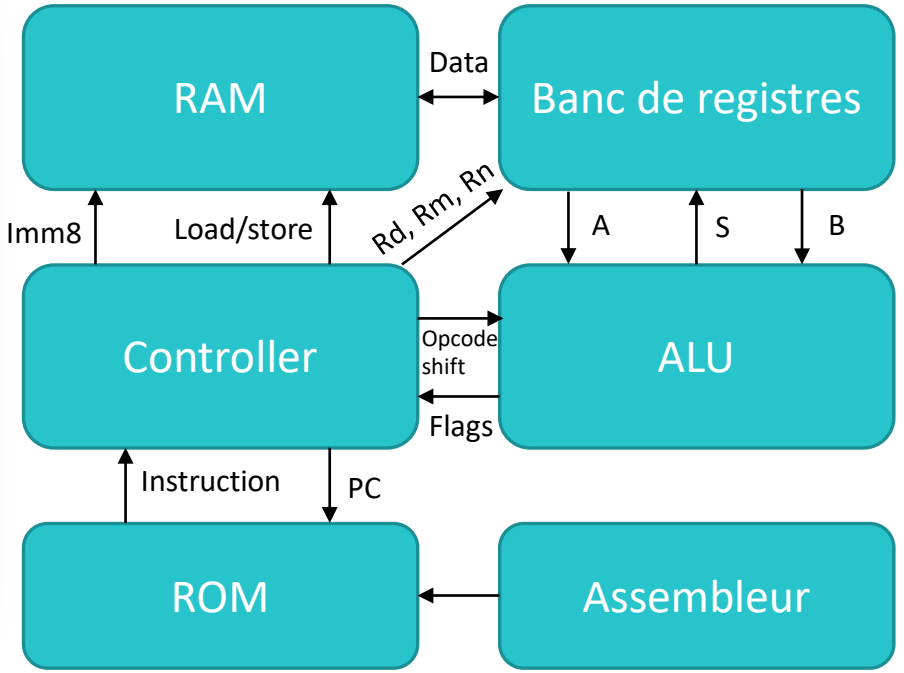
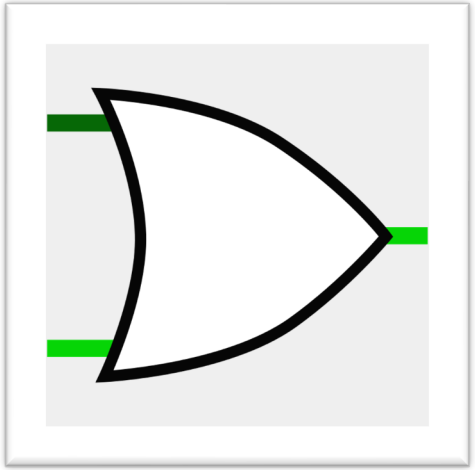
Structure du projet (CPU)



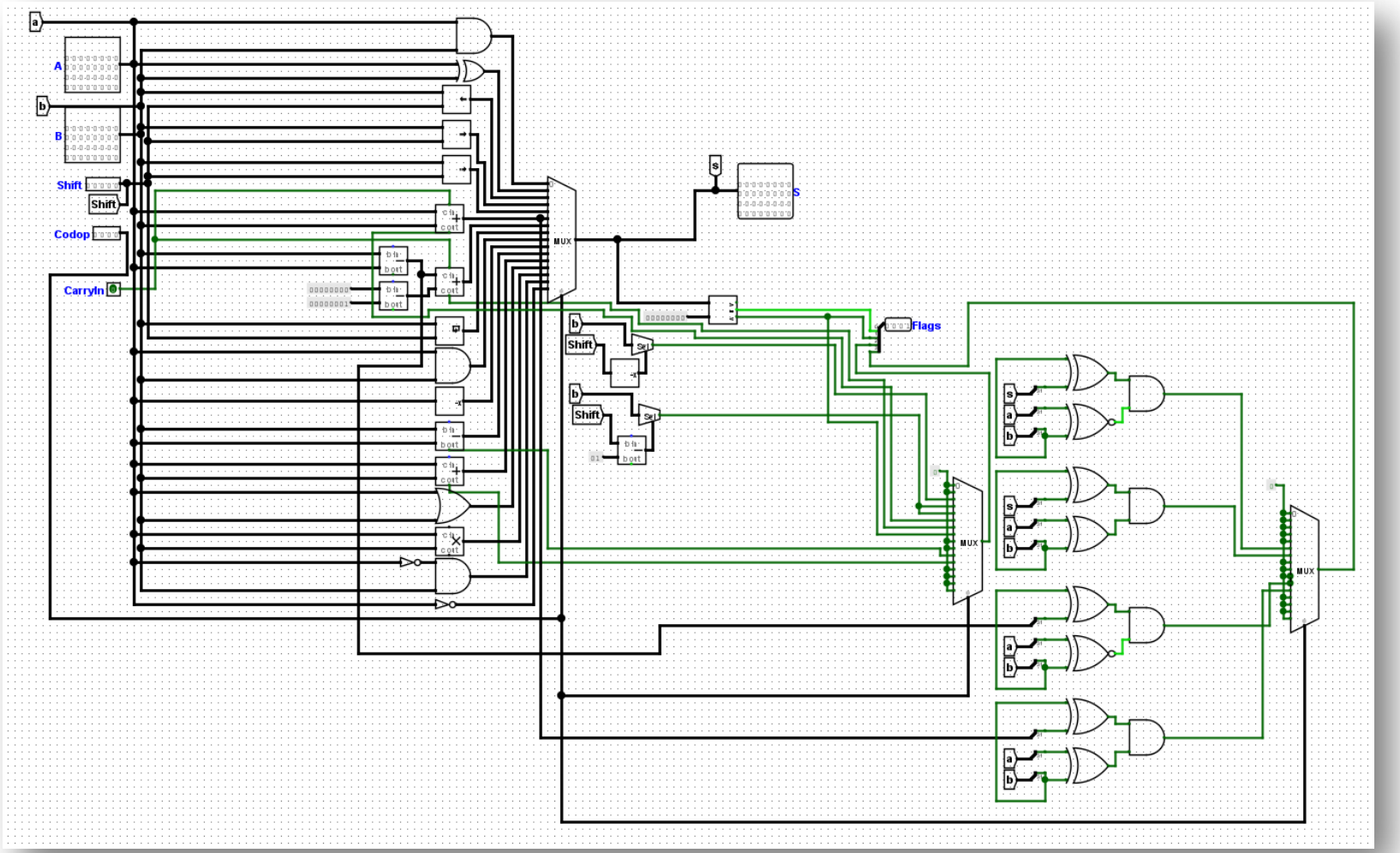


Composants Logisim

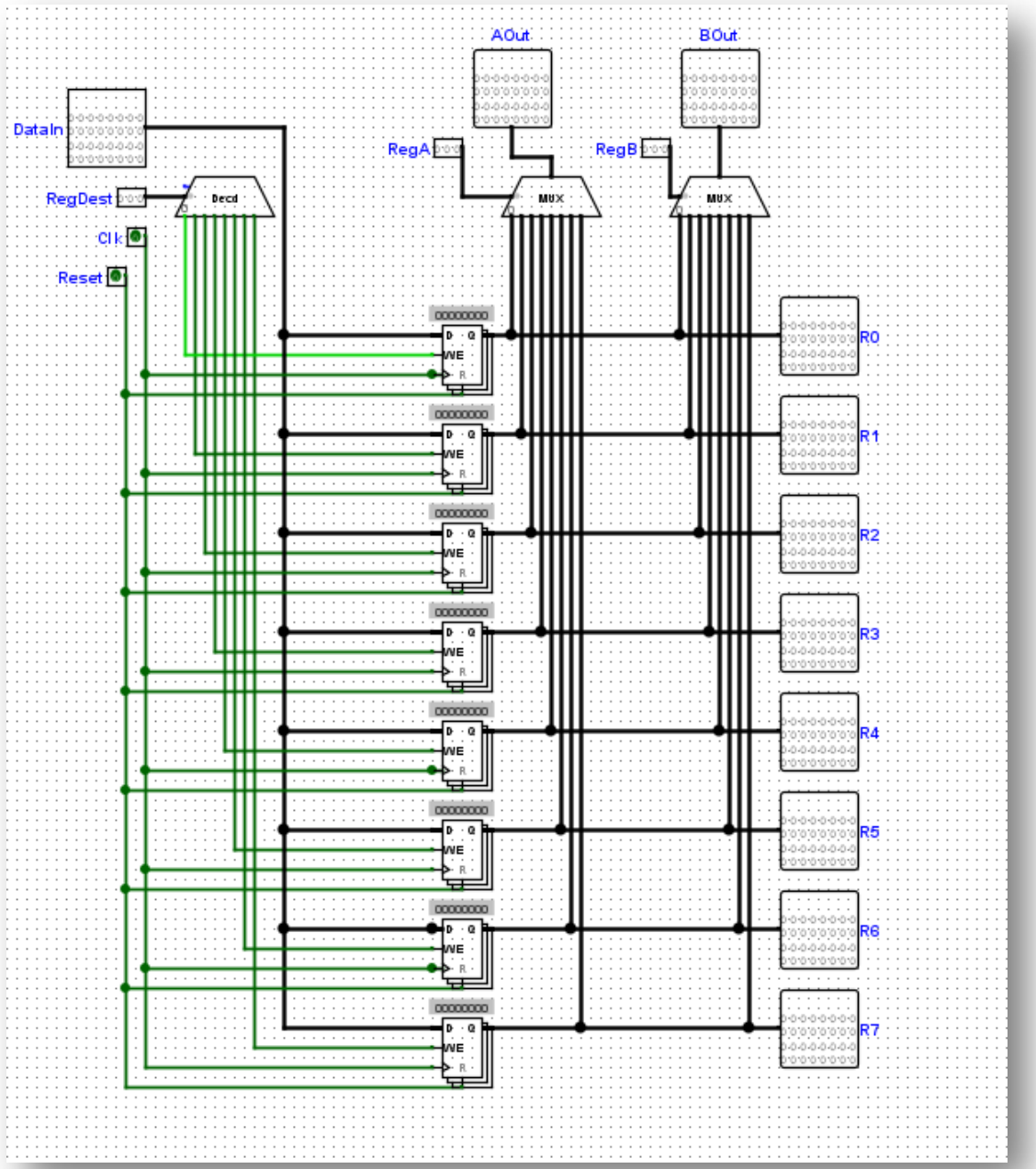
- ALU
- Banc de registres
- Opcode décodeur
- Shift, Add, Sub, Move
- Data processing
- Flag APSR
- Load store
- SP address
- Conditional
- Contrôleur (regroupement)



ALU

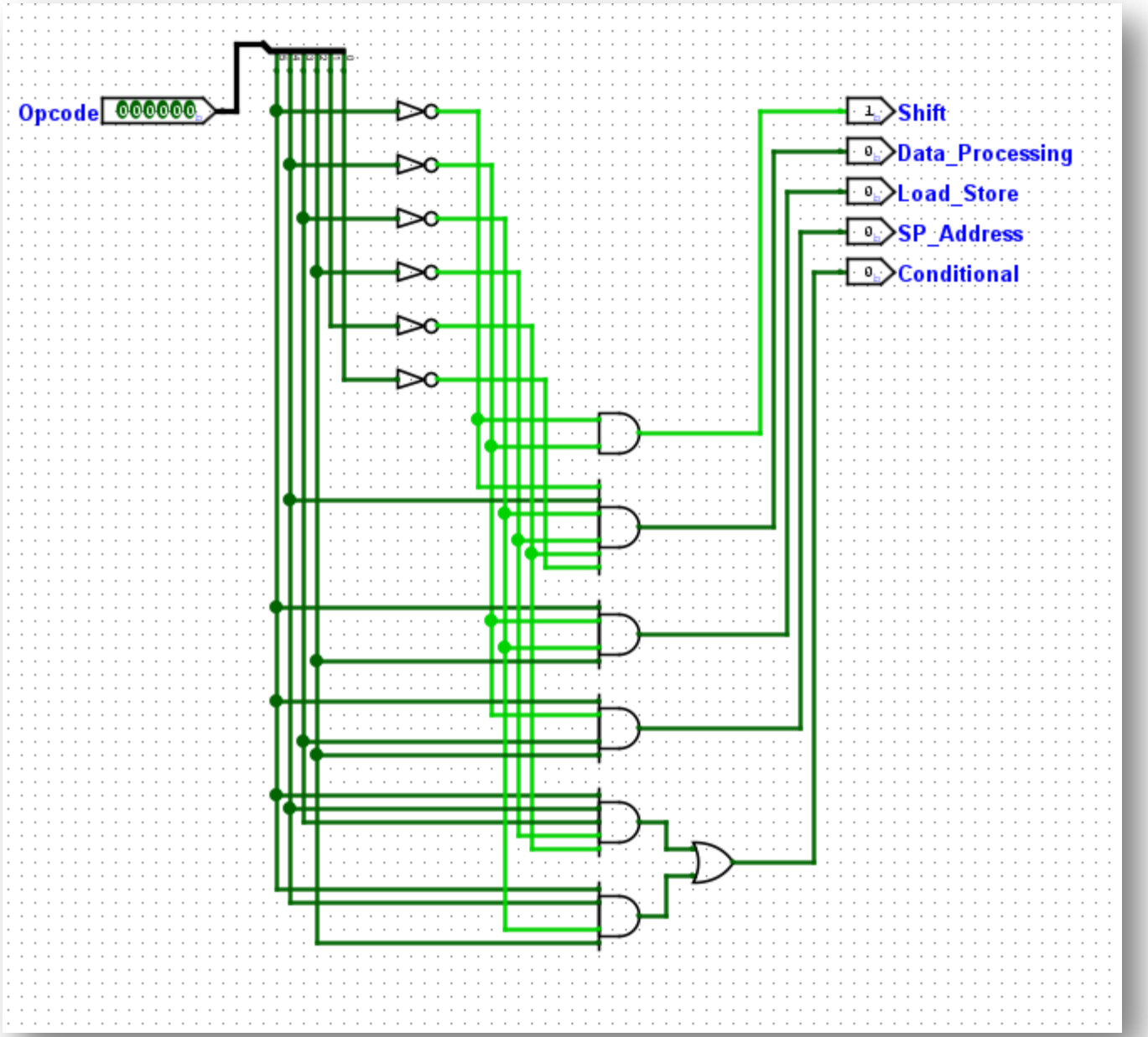

a
A
b
B
Shift
Shift
Codop
CarryIn
MUX
s
S
Flags
b
Shift
b
Shift
MUX
MUX

Banc de registres

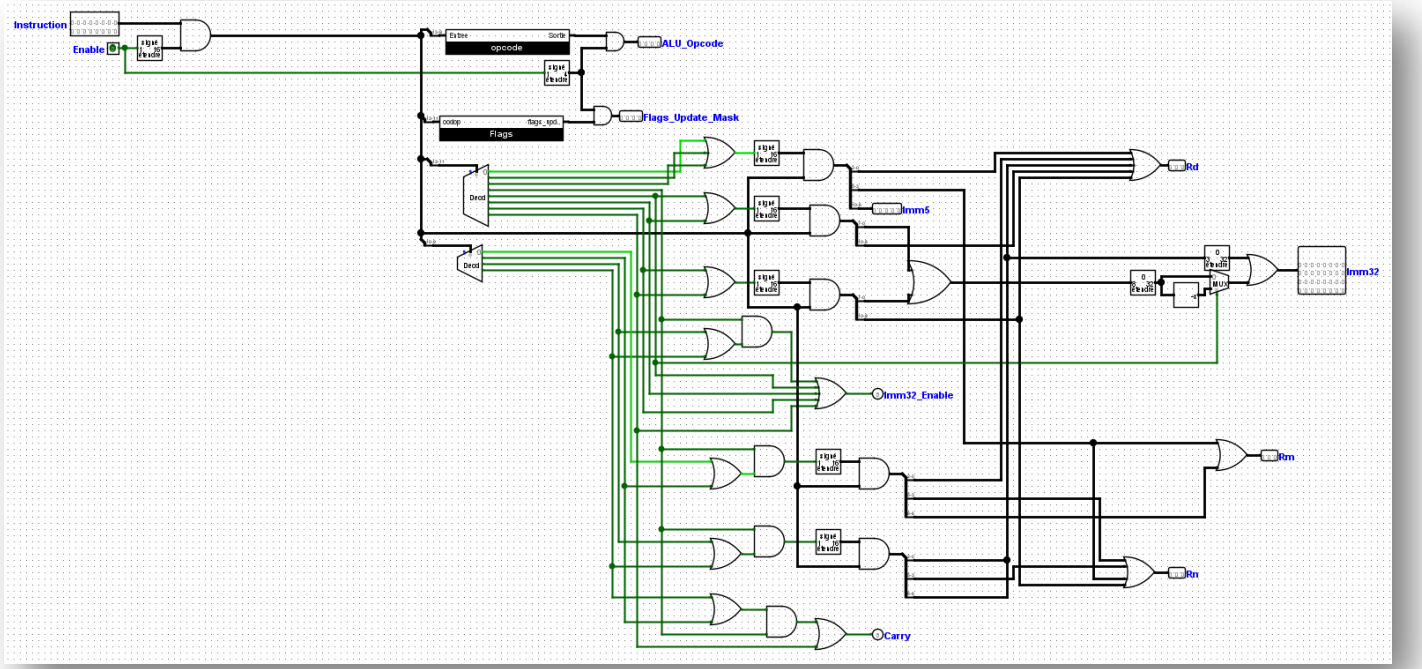


Opcode decoder

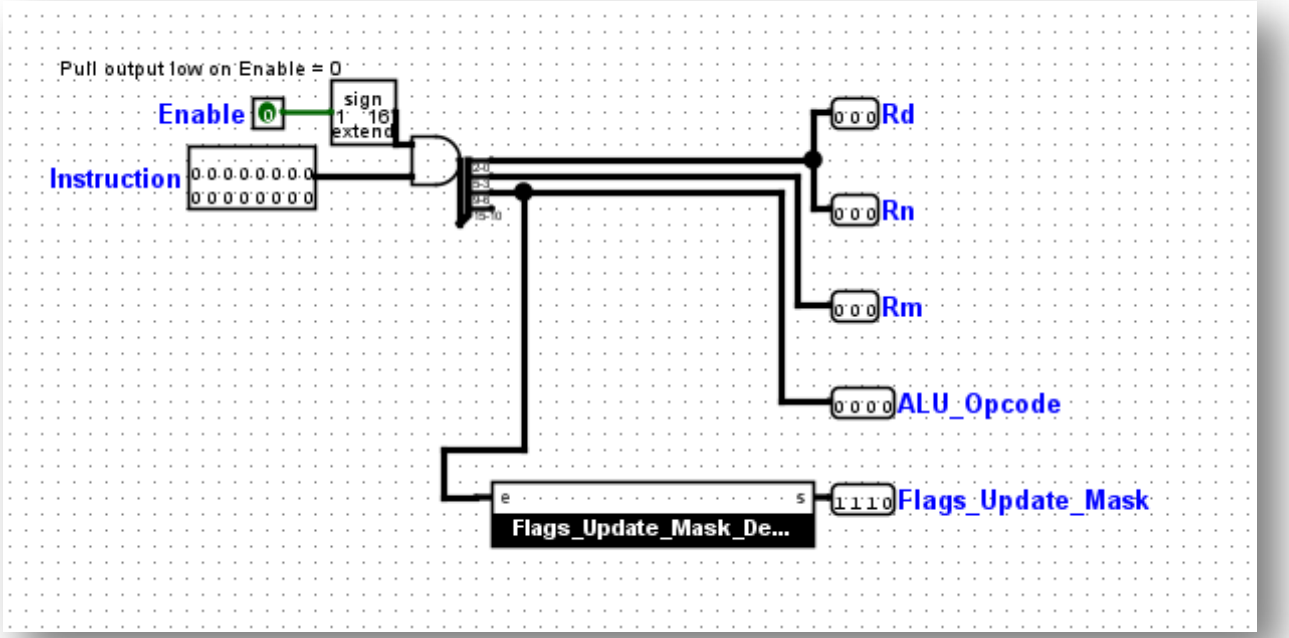
Opcode[5..0]	Shift	Data_Processing	Load_Store	SP_Address	Conditional
000000	1	0	0	0	0
000001	1	0	0	0	0
000010	1	0	0	0	0
000011	1	0	0	0	0
000100	1	0	0	0	0
000101	1	0	0	0	0
000110	1	0	0	0	0
000111	1	0	0	0	0
001000	1	0	0	0	0
001001	1	0	0	0	0
001010	1	0	0	0	0
001011	1	0	0	0	0
001100	1	0	0	0	0
001101	1	0	0	0	0
001110	1	0	0	0	0
001111	1	0	0	0	0
010000	0	1	0	0	0
010001	0	0	0	0	0
010010	0	0	0	0	0
010011	0	0	0	0	0
010100	0	0	0	0	0
010101	0	0	0	0	0
010110	0	0	0	0	0
010111	0	0	0	0	0
011000	0	0	0	0	0
011001	0	0	0	0	0
011010	0	0	0	0	0
011011	0	0	0	0	0
011100	0	0	0	0	0
011101	0	0	0	0	0
011110	0	0	0	0	0
011111	0	0	0	0	0
100000	0	0	0	0	0
100001	0	0	0	0	0
100010	0	0	0	0	0
100011	0	0	0	0	0
100100	0	0	1	0	0
100101	0	0	1	0	0
100110	0	0	1	0	0
100111	0	0	1	0	0
101000	0	0	0	0	0
101001	0	0	0	0	0
101010	0	0	0	0	0
101011	0	0	0	0	0
101100	0	0	0	1	0
101101	0	0	0	1	0
101110	0	0	0	1	0
101111	0	0	0	1	0
110000	0	0	0	0	0
110001	0	0	0	0	0
110010	0	0	0	0	0
110011	0	0	0	0	0
110100	0	0	0	0	1
110101	0	0	0	0	1
110110	0	0	0	0	1
110111	0	0	0	0	1
111000	0	0	0	0	1
111001	0	0	0	0	1
111010	0	0	0	0	0
111011	0	0	0	0	0
111100	0	0	0	0	0
111101	0	0	0	0	0
111110	0	0	0	0	0
111111	0	0	0	0	0



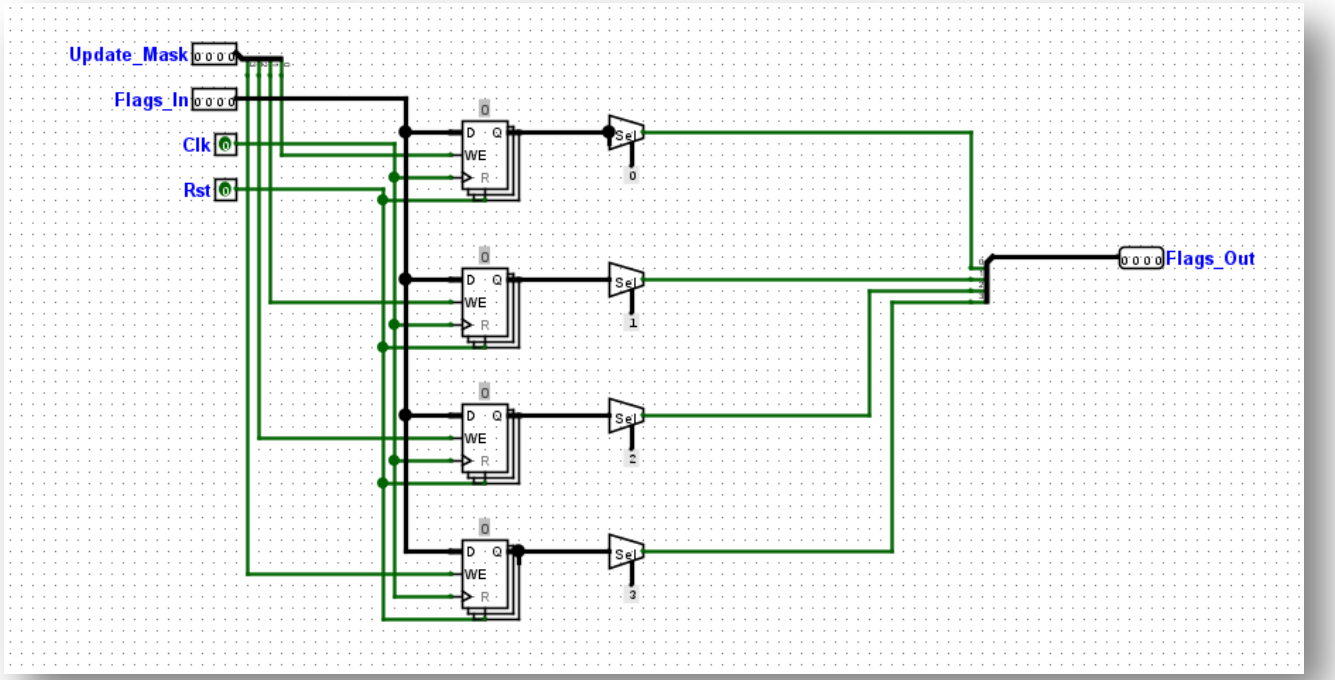
Shift
Add
Sub
Move



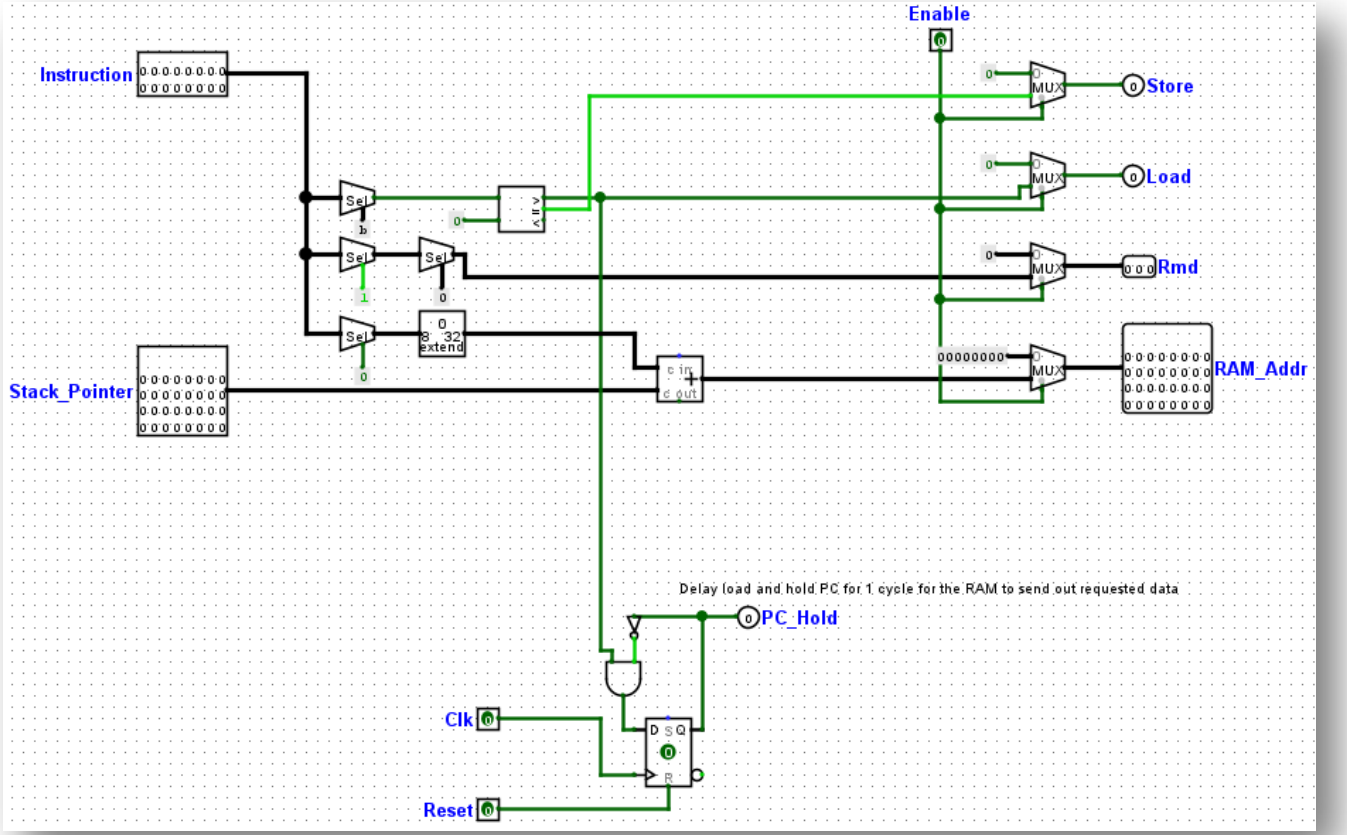
Data processing



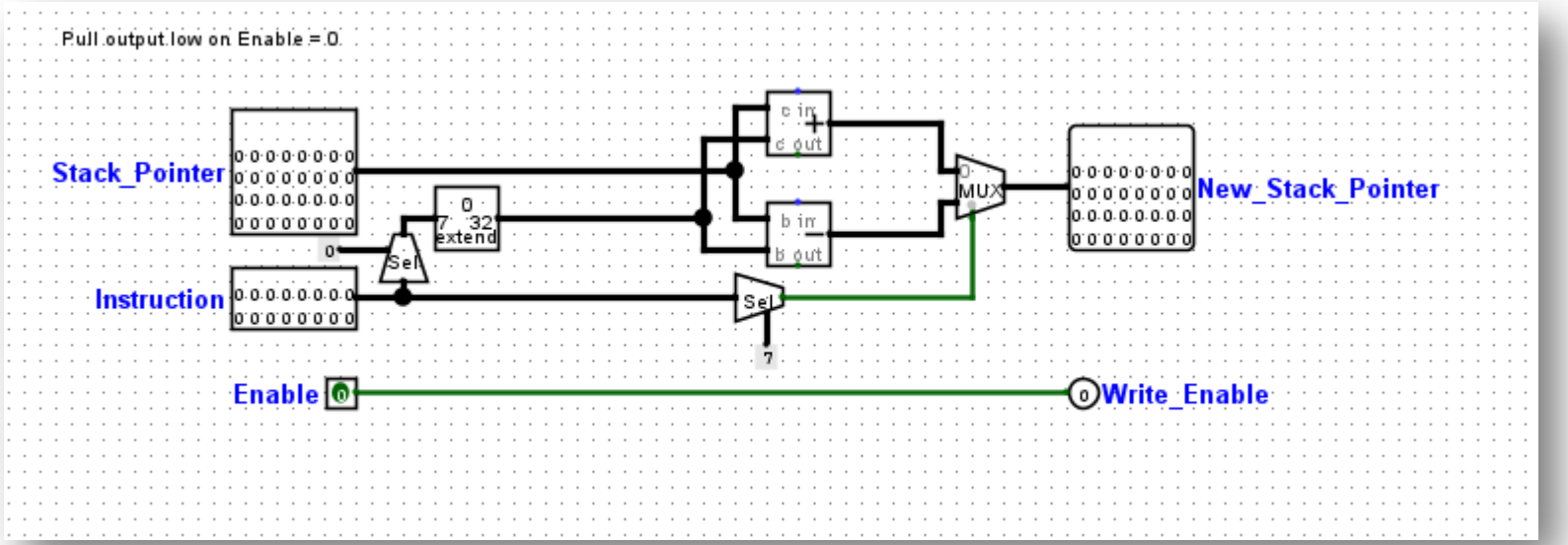
Flag APSR



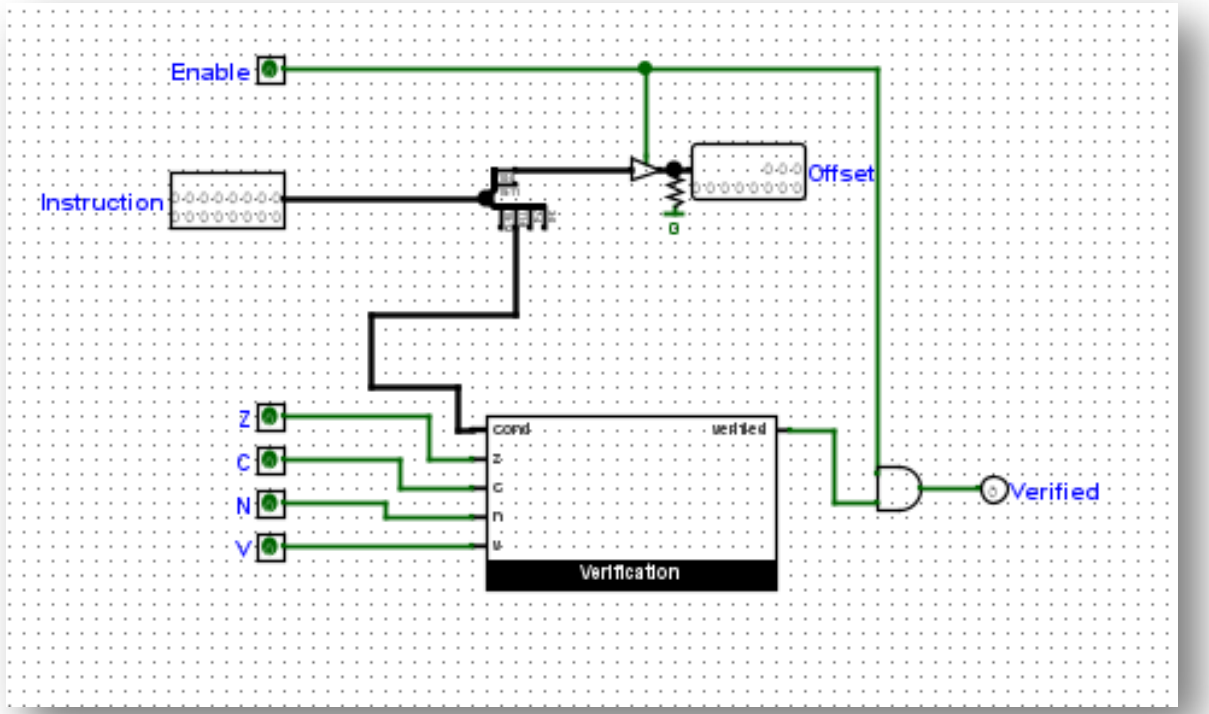
Load store


Enable
Instruction
Store
Load
Rmd
RAM_Addr
Stack_Pointer
Delay load and hold PC for 1 cycle for the RAM to send out requested data
PC_Hold
Clk
Reset
MUX
Sel
ALU
extend
D S Q
R

SP Address


Pull output low on Enable = 0
Stack_Pointer
Instruction
Enable
0
7 32
extend
Sel
c in
c out
b in
b out
MUX
New_Stack_Pointer
Write_Enable

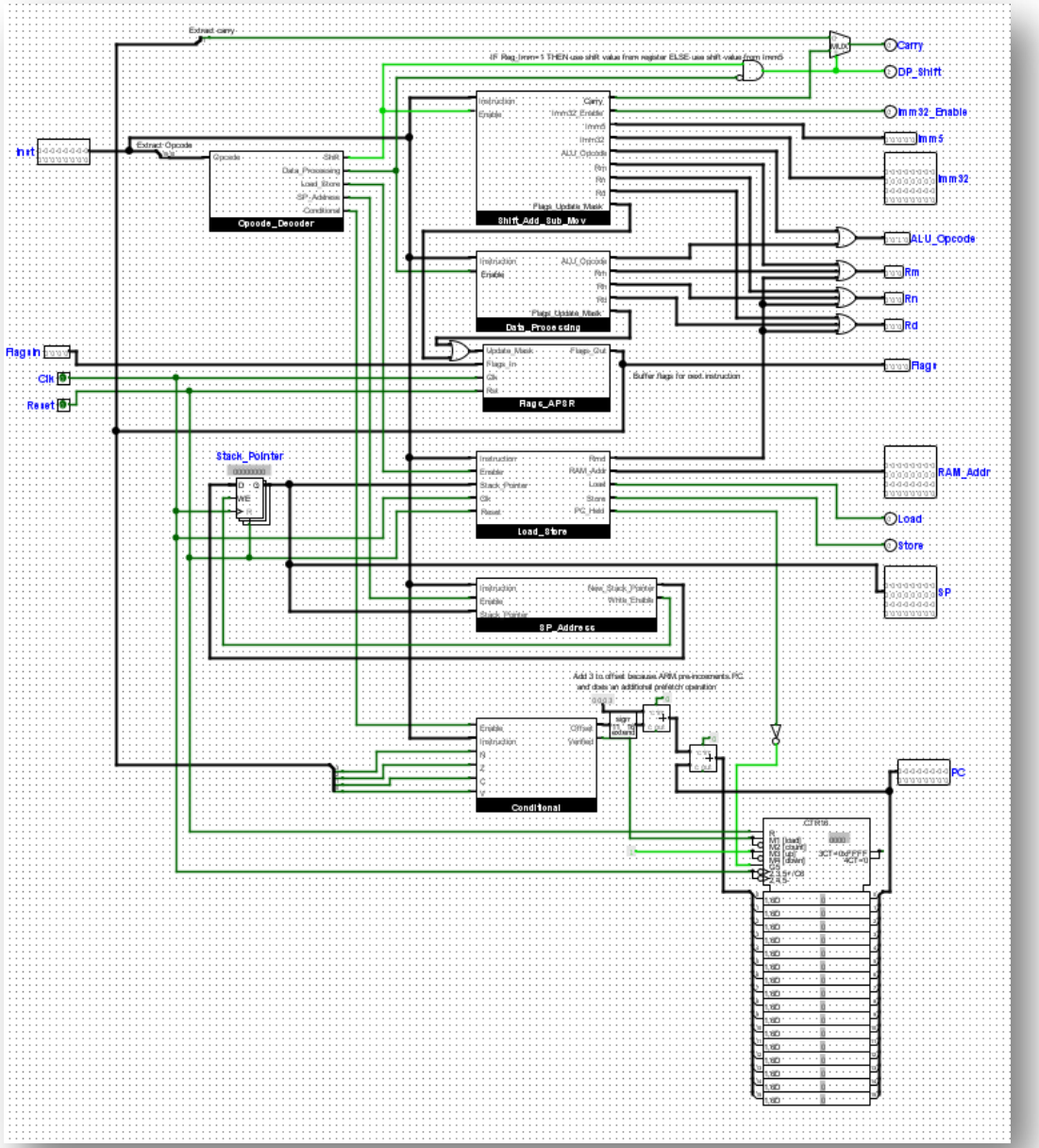
Conditional



Controller

Composants regroupés :

- Opcode decoder
- Shift Add Sub Move
- Data processing
- Load store
- SP address
- Flag APSR
- Conditional



Assembleur (python)

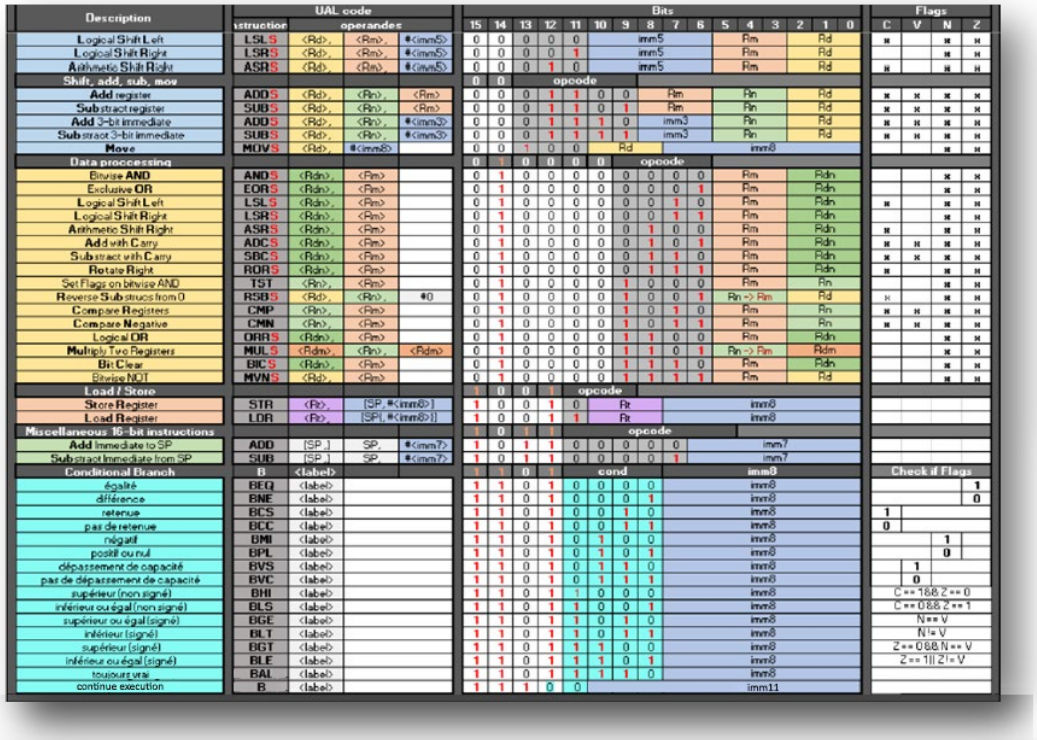
```
parsed_asm_code = [[l.strip().strip(',') for l in l.replace(
    ',', ", ").split()] for l in asm.splitlines() if len(l.split()) > 0]
machine_code = ""
```

… UNE FONCTION PAR INSTRUCTION … PUIS …

```
i = 0
for instruction in parsed_asm_code:

    keyword = instruction[0].lower()

    if keyword.endswith(':') or keyword.startswith(('@', '.')):
        continue

    try:
        fun = locals()["_Parser__" + keyword]
        binary = fun(instruction[1:], i)
    except:
        continue  # ignoring unhandled instructions according to the project
    machine_code += Parser.__convert(binary, 2,
                                     16).zfill(DEFAULT_HEXADECIMAL_SIZE) + " "

    i += 1

return machine_code[:-1]
```

```
@staticmethod
def __convert(number: str, base_src: int, base_dest: int) -> str:
    """Converts a number from one base to another (limit=16).

    Args:
        number (str): The number to convert.
        base_src (int): The base of the number to convert.
        base_dest (int): The base to convert the number to.

    Returns:
        str: The converted number.
    """
    base_map = "0123456789abcdef"
    base_10_number = int(number, base_src)
    if base_10_number == 0:
        return "0"
    result = ""
    while base_10_number > 0:
        result = base_map[base_10_number % base_dest] + result
        base_10_number //= base_dest
    return result
```

Assembleur (python)



Description	UAL code				Bits														Flags			
	Instruction	operandes			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	C	V	N	Z
Logical Shift Left	LSLS	<Rd>,	<Rm>,	#<imm5>	0	0	0	0	0	imm5					Rm			Rd			x		x	x
Logical Shift Right	LSRS	<Rd>,	<Rm>,	#<imm5>	0	0	0	0	1	imm5					Rm			Rd					x	x
Arithmetic Shift Right	ASRS	<Rd>,	<Rm>,	#<imm5>	0	0	0	1	0	imm5					Rm			Rd			x		x	x
Shift, add, sub, mov					0	0	opcode																	
Add register	ADDS	<Rd>,	<Rn>,	<Rm>	0	0	0	1	1	0	0	Rm			Rn			Rd			x	x	x	x
Substract register	SUBS	<Rd>,	<Rn>,	<Rm>	0	0	0	1	1	0	1	Rm			Rn			Rd			x	x	x	x
Add 3-bit immediate	ADDS	<Rd>,	<Rn>,	#<imm3>	0	0	0	1	1	1	0	imm3			Rn			Rd			x	x	x	x
Substract 3-bit immediate	SUBS	<Rd>,	<Rn>,	#<imm3>	0	0	0	1	1	1	1	imm3			Rn			Rd			x	x	x	x
Move	MOVS	<Rd>,	#<imm8>		0	0	1	0	0	Rd					imm8								x	x
Data processing					0	1	0	0	0	0	opcode													
Bitwise AND	ANDS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	0	0	0	Rm			Rdn					x	x
Exclusive OR	EORS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	0	0	1	Rm			Rdn					x	x
Logical Shift Left	LSLS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	0	1	0	Rm			Rdn			x		x	x
Logical Shift Right	LSRS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	0	1	1	Rm			Rdn					x	x
Arithmetic Shift Right	ASRS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	1	0	0	Rm			Rdn			x		x	x
Add with Carry	ADCS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	1	0	1	Rm			Rdn			x	x	x	x
Substract with Carry	SBCS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	1	1	0	Rm			Rdn			x	x	x	x
Rotate Right	RORS	<Rdn>,	<Rm>		0	1	0	0	0	0	0	1	1	1	Rm			Rdn			x		x	x
Set Flags on bitwise AND	TST	<Rn>,	<Rm>		0	1	0	0	0	0	1	0	0	0	Rm			Rn					x	x
Reverse Substruct from 0	RSBS	<Rd>,	<Rn>,	#0	0	1	0	0	0	0	1	0	0	1	Rn -> Rm			Rd			x		x	x
Compare Registers	CMP	<Rn>,	<Rm>		0	1	0	0	0	0	1	0	1	0	Rm			Rn			x	x	x	x
Compare Negative	CMN	<Rn>,	<Rm>		0	1	0	0	0	0	1	0	1	1	Rm			Rn			x	x	x	x
Logical OR	ORRS	<Rdn>,	<Rm>		0	1	0	0	0	0	1	1	0	0	Rm			Rdn					x	x
Multiply Two Registers	MULS	<Rdm>,	<Rn>,	<Rdm>	0	1	0	0	0	0	1	1	0	1	Rn -> Rm			Rdm					x	x
Bit Clear	BICS	<Rdn>,	<Rm>		0	1	0	0	0	0	1	1	1	0	Rm			Rdn					x	x
Bitwise NOT	MVNS	<Rd>,	<Rm>		0	1	0	0	0	0	1	1	1	1	Rm			Rd					x	x
Load / Store					1	0	0	1	opcode															
Store Register	STR	<Rt>,	[SP, #<imm8>]		1	0	0	1	0	Rt					imm8									
Load Register	LDR	<Rt>,	[SP{, #<imm8>}]		1	0	0	1	1	Rt					imm8									
Miscellaneous 16-bit instructions					1	0	1	1	opcode															
Add Immediate to SP	ADD	[SP,]	SP,	#<imm7>	1	0	1	1	0	0	0	0	0	0	imm7									
Substract Immediate from SP	SUB	[SP,]	SP,	#<imm7>	1	0	1	1	0	0	0	0	1	0	imm7									
Conditional Branch	B	<label>			1	1	0	1	cond						imm8						Check if Flags			
égalité	BEQ	<label>			1	1	0	1	0	0	0	0	imm8											1
différence	BNE	<label>			1	1	0	1	0	0	0	1	imm8											0
retenue	BCS	<label>			1	1	0	1	0	0	1	0	imm8								1			
pas de retenue	BCC	<label>			1	1	0	1	0	0	1	1	imm8								0			
négatif	BMI	<label>			1	1	0	1	0	1	0	0	imm8										1	
positif ou nul	BPL	<label>			1	1	0	1	0	1	0	1	imm8										0	
dépassement de capacité	BVS	<label>			1	1	0	1	0	1	1	0	imm8									1		
pas de dépassement de capacité	BVC	<label>			1	1	0	1	0	1	1	1	imm8									0		
supérieur (non signé)	BHI	<label>			1	1	0	1	1	0	0	0	imm8								C == 1&& Z == 0			
inférieur ou égal (non signé)	BLS	<label>			1	1	0	1	1	0	0	1	imm8								C == 0&& Z == 1			
supérieur ou égal (signé)	BGE	<label>			1	1	0	1	1	0	1	0	imm8								N == V			
inférieur (signé)	BLT	<label>			1	1	0	1	1	0	1	1	imm8								N != V			
supérieur (signé)	BGT	<label>			1	1	0	1	1	1	0	0	imm8								Z == 0&& N == V			
inférieur ou égal (signé)	BLE	<label>			1	1	0	1	1	1	0	1	imm8								Z == 1|| Z != V			
toujours vrai	BAL	<label>			1	1	0	1	1	1	1	0	imm8											
continue execution	B	<label>			1	1	1	0	0	imm11														

```python
@staticmethod
def __get_immediate(immediate: str, size: int, division_by_4: bool = False) -> str:
    """Get the binary representation of an immediate.

    Args:
        immediate (str): The immediate to get the binary representation of.

    Returns:
        str: The binary representation of the immediate.
    """
    if immediate[1:] == 'sp':
        return '0' * size
    return bin(int(immediate[1:]))[2:].zfill(size) if not division_by_4 else bin(int(immediate[1:]) // 4)[2:].zfill(size)
```

```python
@staticmethod
def __get_register(register: str) -> str:
    """Get the binary representation of a register.

    Args:
        register (str): The register to get the binary representation of.

    Returns:
        str: The binary representation of the register.
    """
    return bin(int(register[1:]))[2:].zfill(DEFAULT_REGISTER_SIZE)
```

```python
def __lsls(args: list, instruction_number: int = None) -> str:
    """Parse the lsls instruction. (Logical Shift Left) LSLS Rd, Rm, #<imm5> or LSLS Rdn, Rm"""
    if args[-1].startswith("#"):
        return "00000" + Parser.__get_immediate(args[-1], 5) + Parser.__get_register(args[1]) + Parser.__get_register(args[0])
    return "0100000010" + Parser.__get_register(args[1]) + Parser.__get_register(args[0])
```

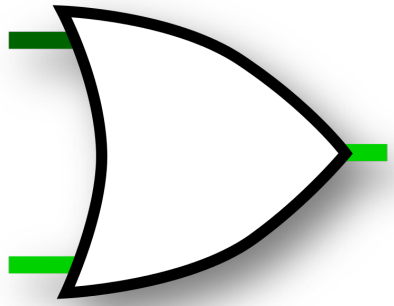
Assembleur (python)

```python
def __get_label_offset(instruction_number: int, label: str, size: int) -> str:
    """Get the the binary representation of a label offset.

    Args:
        label (str): The label to get the offset as binary representation of.

    Returns:
        str: The binary representation of the label offset.
    """
    i = 0
    for instruction in parsed_asm_code:
        if instruction[0] == label + ":":
            return bin(2**size + i - instruction_number - 3)[-size:]

        elif instruction[0].endswith(':'):
            continue

        i += 1
    raise Exception(f"Error: Label {label} not defined.")
```

```python
def __ble(args: list, instruction_number: int = None) -> str:
    """Parse the ble instruction. (Branch if less or equal) BLE <label> (with label written on 8 bits as imm8)"""
    return "11011101" + __get_label_offset(instruction_number, args[0], 8)

def __bal(args: list, instruction_number: int = None) -> str:
    """Parse the bal instruction. (Branch and link) BAL <label> (with label written on 8 bits as imm8)"""
    return "11011110" + __get_label_offset(instruction_number, args[0], 8)

def __b(args: list, instruction_number: int = None) -> str:
    """Parse the b instruction. (Branch) B <label> (with label written on 11 bits as imm11)"""
    return "11100" + __get_label_offset(instruction_number, args[0], 11)
```

<- Fonction interne à la fonction principale de parsing (ayant accès à la variable parsed_asm_code)

Démonstration du simulateur Logisim



Passage des tests (Parser)

```
C:\Users\marcp\Documents\Programming\Python\Projet PARM\asm>asm2mc.py
Testing or compiling? (t/c)
t
Testing tests\conditional\branch.s...
Test passed for tests\conditional\branch.s
Testing tests\data_processing\1-4_instructions.s...
Test passed for tests\data_processing\1-4_instructions.s
Testing tests\data_processing\11-12_instructions.s...
Test passed for tests\data_processing\11-12_instructions.s
Testing tests\data_processing\13-16_instructions.s...
Test passed for tests\data_processing\13-16_instructions.s
Testing tests\data_processing\5-10_instructions.s...
Test passed for tests\data_processing\5-10_instructions.s
Testing tests\load_store\load_store.s...
Test passed for tests\load_store\load_store.s
Testing tests\miscellaneous\sp.s...
Test passed for tests\miscellaneous\sp.s
Testing tests\more\calckeyb.s...
Test passed for tests\more\calckeyb.s
Testing tests\more\calculator.s...
Test passed for tests\more\calculator.s
Testing tests\more\simple_add.s...
Test passed for tests\more\simple_add.s
Testing tests\more\testfp.s...
Test passed for tests\more\testfp.s
Testing tests\more\tty.s...
Test passed for tests\more\tty.s
Testing tests\shift_add_sub_mov\1-4_instructions.s...
Test passed for tests\shift_add_sub_mov\1-4_instructions.s
Testing tests\shift_add_sub_mov\5-8_instructions.s...
Test passed for tests\shift_add_sub_mov\5-8_instructions.s
```

```python
def main() -> None:
    test_folder = TESTS_PATH if TESTS_PATH.endswith('/') else TESTS_PATH + '/'  # Ensure we have a well-formed path
    asm_files = glob(f"{test_folder}**/*.s", recursive=True)

    answer = input("Testing or compiling? (t/c)\n")
    test = True if answer.lower() == 't' else False

    for asm_file in asm_files:
        if test:
            print(f"Testing {asm_file} ... ")

        # Getting the machine code from the parser
        with open(asm_file, "r") as f:
            asm_code = f.read()
            machine_code = Parser.parse_asm_into_machine_code(asm_code)

        bin_file = ''.join(asm_file.split('.')[:-1]) + ".bin"

        if test:
            # Checking if the content of the machine code is the same as the content of the .bin file in the same directory
            with open(bin_file, "r") as f:
                expected_machine_code = ''.join(f.readlines()[1:])
                if machine_code.strip() != expected_machine_code.strip():
                    print(f"Error in: {asm_file}:")
                    print(f"1: {expected_machine_code}", end='')
                    print(f"2: {machine_code}")
                    exit(1)
                else:
                    print(f"Test passed for {asm_file}")
        else:
            # Writing to .bin file
            with open(bin_file, "w") as f:
                f.write(BINARY_HEADER + '\n' + machine_code.strip())

```

Fin de la présentation

Questions