Computer Architecture (Unit 2)

DATE : 23-02-2022

Course structure

- Theory
- Assembly

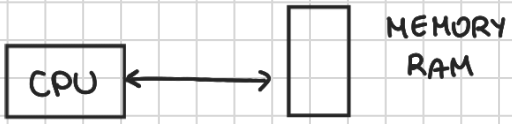
EXAMS

- Midterm
- Final

} Average

HOW DOES THE CPU WORK

- CPU : does all the computation
- Memory : stores programs and data



Memory has sequences of bytes inside

SRAM (static)

- expensive
- made of flip flops
- fast
- used if you have few bits to store

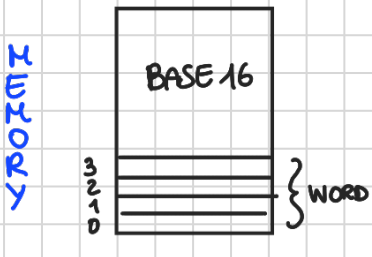
DRAM (Dynamic)

- cheaper
- slow
- mostly used if we need a lot of storage

- KILO-BYTE 10^3
- MEGA-BYTE 10^6
- GIGA-BYTE 10^9 ⟶ example : 8 GB = 8 billion bytes
- TERA-BYTE 10^{12}

NOTE : 1024 Kibibytes

- CPU needs to read and write data from the memory so it's necessary for each byte to have a name (address) to identify it



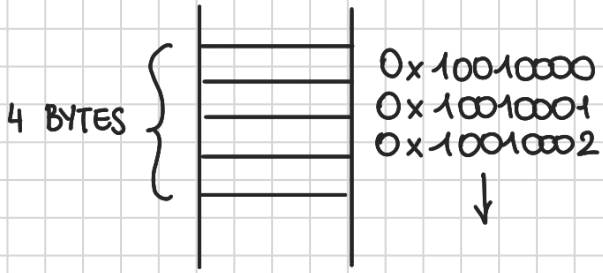
- We tipically use base 16 because it's easier to convert it into binary
- CPU reads and writes 4 bytes (WORD) at a time to get more information

- We normally use a x32 architecture since we are reading 4 bytes

1 byte = 8 bit ⇒ 4byte · 8 bit = 32 bit

(x64 bit architecture reads 8 bytes at a time, 8 · 8 = 64)

MEMORY

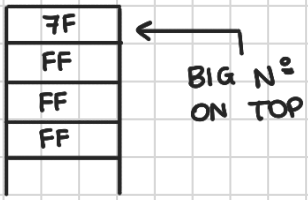


NOTE: "0x" means base 16

8 bit - range [-128; +127]
↓ base 16
[-80; 7F]

LARGEST 2-comp n° REPRESENTABLE IN 32 BITS (4 byte) → 0x7FFFFFFF ($2^{32-1}-1$)

BIG ENDIAN COMPUTER



SMALL ENDIAN COMPUTER

- C language is close to assembly

We need to encode our data in order to put it in the memory:

- ASCII (ENCODING STANDARD)

HOW TO STORE A STRING IN MEMORY?

- Each byte will contain ONE character
- In order to store "Ale" we need to convert each character into ASCII

65
108
101
32

A → 65 in ASCII
l → 108 " "
e → 101 " "
space → 32 " "

HOW TO KNOW THE STRING ENDED?

- we put zero in the last byte
- we put the length of the string anywhere in the string

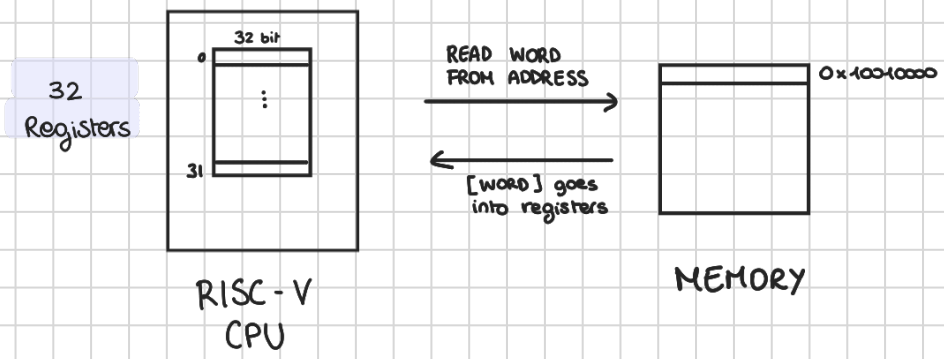
HOW TO KNOW IF THE CONTENT OF A BYTE IS A NUMBER OR AN ASCII ENCODING?

You can't. The problem will specify it

We have small memory (REGISTER) inside the CPU.

RISC-V CPU → 32 registers

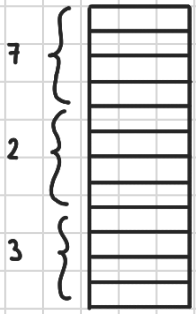
- CPU can read words in a particular address and store it inside the register.



HOW TO STORE ARRAYS

- We store arrays elements one after the other

$$a = [7, 2, 3]$$



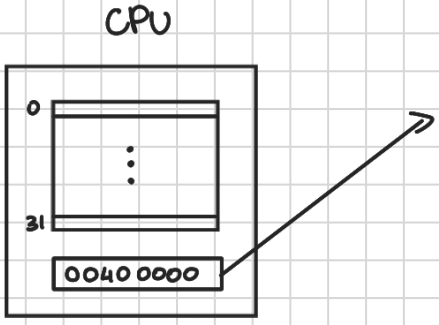
- we can put the length of the array wherever you want in order to know when it ends

HOW TO STORE PROGRAMS

ADD (instruction) → adds the content of two registers and puts it into another =

NOTE: YOU CANT ADD THE CONTENT OF TWO ADDRESSES IN A MEMORY. YOU HAVE TO PUT IT IN THE CPU FIRST.

We have instructions for many purposes which are executed in the CPU.



PC (PROGRAM COUNTER)

Another register that contains the address of the next instruction to execute

1. We read the address and take the word contained in the memory
2. We put it inside a register in the CPU
3. We perform the instruction inside the CPU and put the result in another specified register. Meanwhile, the address in the PC will be increased by 4
   NOTE: CPU reads 4 bytes at a time)
4. Read next address / instruction in the PC

FETCH & EXECUTE

NOTE: RISC-V starts at 0x00400000 while DATA at 0x10010000