TD n° 2.

1/ Exercice 1 : Rappel : { bus d'adresse sert à sélectionner une case mémoire.
{ avec A lignes d'adresse, on peut former 2^A adresses différentes

a/ $D = 8$ bits , $A = 20$

Number of adresses $= 2^{20} = (2^{10})^2 = 1024 \times 1024$

$= 1048576$ adresses.

Total bits $= D \times 2^A = 8 \times 1048576$

$= 8388608$ bit

Bytes ? $= \div 8 = 1048576$ Bytes.

words (word $= D = 8$ bits) $=$ number of adresses $= 2^{20}$

$= 1048576$ words of 8 bits.

b/ $D = 16$ bits , $A = 30$

Number of adresses $= 2^{30} = 1073741824$ adresses

Total bits $= D \times 2^A = 16 \times 1073741824$

$= 17179869184$ bits

Bytes ? $17179869184 \div 8 = 2147483648$ Bytes

words (word $= D = 16$ bits)

$2^{30} = 1073741824$ words of 16 bits

c/ $D = 32$ bits , $A = 30$

Number of adresses $= 2^{30} = 1073741824$ adresses.

Total bits $= 32 \times 1073741824$

$= 34359738368$ bits

en Bytes ? $= \div 8 = 4,294967296$ bytes

Words (32 bits) $= 2^{30} = 1073741824$ words of 32 bits.

2/ What happens if we double the number of adress lines?

The number of adress lines A determines how many memory locations can be accessed:

$$\text{Number of adress} = 2^A$$

if you double A you get:

→ (doubler le nombre de lignes)
New number of adresses : $2^{A\cdot 2}$ (the square of the original number)

This means the memory capacity becomes 2^A times larger.
so the memory size (bits) × by factor 2^A

Example:

$A = 10 \rightarrow 2^{10} = 1024$ adresses.

if you double $A = 20 \rightarrow 2^{20} = 1048576$ adresses.

$A = 20 \rightarrow 2^{20}$

if we double $A = 40 \rightarrow 2^{40}$ = huge increase

capacity of memory $\times 2^A$ (1 milliard d'énorme) énorme → énorme augmentation.

→ (Ajouter une ligne)

$$2^{A+1} = 2 \times 2^A \rightarrow (\text{memory / la mémoire double})$$

example: $A = 10 \rightarrow 2^{10} = 1024$ adresses.

$2^{A+1} \rightarrow 2^{11} = 2 \times 2^A$

$= 2048$ adresses.

mémoire double de taille.

→ capacity of memory double

3/ For a memory of 16 MB, find adress lines and data lines with assumptions (hypothèses)
فرضيات

16 MB?

$1\,MB \rightarrow 2^{20}$ Bytes $= 1048576$ Bytes

$16\,MB \rightarrow 16 \times 2^{20} = 16777216$ Bytes

mémoire peut stocker: $2^4 \times 2^{20} = 2^{24}$ Bytes

Number of adresses $= 2^A$ $\quad A$ (adress lines)

Each adress corresponds to D bits (databus width)

Total memory (in bits) $= 2^A \times D$

1/ 1 Byte adressable memory. (word 8 bits)

$2^A = 2^{24} \Rightarrow A = 24$ adress lines

Since one adresse $= 1$ Byte $= 8$ bits

$D = 8$ data lines

2/ 2 Bytes adressable memory: (word: 16 bits)

2 Bytes $= 16$ bits

$2^{24} \div 2 = 2^{23} = 8388608$ adress.

$A = 23$ adress lines

$D = 16$ data lines

3/ 4 Bytes adressable memory: (word: 32 bits).

4 Bytes $= 32$ bits

$2^{24} \div 4 = 2^{22} = 4\,194\,304$ adress

$A = 22$ adress lines

$D = 32$ data lines.

• Exercice 2:

$A = 10, \quad D = 8$

1/

$2^{10} = 1024$ Bytes. capacity (bits) $= 1024 \times 8$

$= 8192$ bits

2/ How many A lines are required to access 256 KBytes, each word = 1 Byte.

$256\,KB = 256 \times 1024$ Bytes $= 262\,144$ Bytes

write a power of 2: $256 = 2^8 \quad 1024 = 2^{10}$

$2^{8+10} = 2^{18} = 2^A$

$\Rightarrow A = 18$ adress lines

3/ main memory of 2MB

$$2MB = 2\times 2^{20} = 2^1 \times 2^{20} = 2^{21} \text{ Bytes}$$
$$= 2\,097\,152 \text{ Bytes}$$
(en bit $\times 8$)

→ For : 16 bits words (2Bytes)

$$\text{Nbr of 16bit word} = 2^{21} \div 2 \text{ Bytes/word}$$
$$= 2^{21-1} = 2^{20}$$
$$= 1\,048\,576 \text{ words.}$$

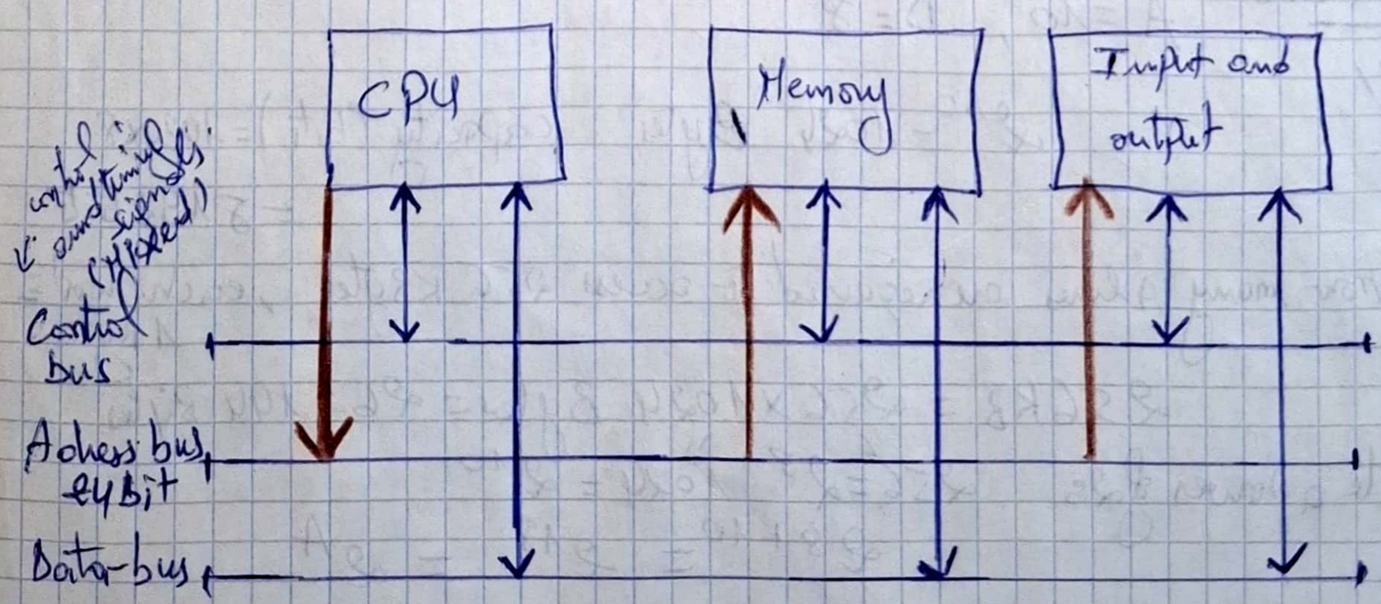
→ For : 32 bits words (4 Bytes)

$$\text{Nbr of 32 bit word} = 2^{21} \div 4 \text{ Bytes/word}$$
$$= 2^{21-2} = 2^{19}$$
$$= 524\,288 \text{ words.}$$

4/ Computer main memory 1MB, memory word size = 2B
adress bus width (number of adress lines)

$$1MB = 1\times 2^{20} = 2^{20} \text{ Bytes} = 1\,048\,576 \text{ Bytes}$$
$$\text{word size} = 2 \text{ Bytes} \longrightarrow 2^{20} \div 2 = 2^{19} \text{ word}$$
Adress lines A satisfy $2^A = 2^{19}$
$$\Rightarrow A = 19 \text{ adress lines.}$$

• Exercice 3:



2/ maximum memory capacity $A = 24$

number of adresses $= 2^{24}$ Bytes

$= 16777216$ Bytes

in ~~Binary~~ KB $= /1024 = 2^{24} \div 2^{10} = 2^{14}$

$= 16384$ KB

MB $= /1024/1024 = 2^{24} \div 2^{20}$

$= 2^{4} = 16$ MB

GB $= 16 \div 1024 = 2^{4} \div 2^{10}$

$2^{-6} = \frac{1}{64} = \frac{1}{2^6}$ $\quad 2^{-6} = 0{,}01568$ GB

$2^{24} = 16777216$ Byte $= 16384$ KB $= 16$ MB $\approx 0{,}015625$ GB

3/ frequency $f = 2{,}4$ GHz $= 2{,}4 \times 10^{9}$ Hz

$\Rightarrow T = \frac{1}{f} = \frac{1}{2{,}4 \times 10^{9}} = \frac{5}{12} \times 10^{-9}$

$\approx 4{,}166 \times 10^{-1\!8}$

$T \approx 0{,}4167$ nanoseconds (ns)

4/ Process 32bit peut accéder à 4 GB de mémoire

can access , 4 GB of memory

largeur de bus d'adresse?

nbre of lignes d'adresse (A)

$N = 2^{A}$

chaque adress correspond à 1 Byte

4 GB ?

$1 GB = 2^{30} B$

$4 GB = 4 \times 2^{30} = 2^{2} \times 2^{30} = 2^{32} B$

$2^{A} = 2^{32} \Rightarrow A = 32$ lignes

$\rightarrow$ as decimal 4×10^{9} Bytes , $\log_2 (4 \times 10^{9}) \approx 31{,}86$

≈ 32 adress lines.

5/ Add K lines $\rightarrow$ capacity multiplied by 2^{k}

because each adress line is a binary digit (bit) that doubles the number of adress combinations : $2^{A} \rightarrow 2^{A+1} = 2 \times 2^{A}$

So each extra line doubles the adressable