Tlemcen University
Faculty of Science
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1st Year Engineer

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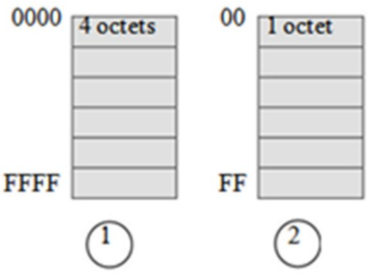
Introduction to operating systems 2

Solution of TD N°4: Management memory (Pagination)

Exercise n°1

You have the following main memory (RAM) structure:



a) Calculate the size of the main memory for the 2 types of memory.

1: 2^{16}* 4 octets = 2^{18} octets = 256 ko

2: 2^{8} *1 octet = 256 octets

b) Give the length of a physical address for the following main memories: 128MB, 512KB.

128 Mo = 2^{7} *2^{20} = 2^{27} octets => length @dresse = 27 bits

512 ko = 2^{9}* 2^{10} = 2^{19} octets = > length @adresse = 19 bits

Remarque : 1 Ko = 1024 octets = 2^{10} octets
1 Mo = 2^{20} octets
1 Go = 2^{30} octets

c) Calculate the number of bits used to address or identify the 4 kilobyte blocks in a 256 MB memory.

$$Number\ of\ blocks = \frac{Memory\ size}{Block\ size}$$

$$Number\ of\ blocks = \frac{256\ Mo}{4\ Ko} = \frac{2^{8} * 2^{20}}{2^{12}} = 2^{16}\ Blocks$$

So: there are 16 bits to identify a block

Exercise n°2

Consider the following table of pages:

0	4
1	6
2	8
3	9
4	12
5	1

Given that the virtual and physical pages are 1 KB in size, what is the memory address corresponding to each of the following virtual addresses coded in hexadecimal: 142A and 0AF1.

1 page = 1 Ko = 2^{10} ➔ offset sur 10 bits

142A

0001	0100	0010	1010
1	4	2	A

N° page = 5 offset = 2A

@ physique : n° cadre = 1 offset = 2A

0000	0100	0010	1010
0	4	2	A

0AF1

0000	1010	1111	0001
0	A	F	1

N° page = 2 offset = 2F1

@ physique : n° cadre = 8 offset = 2F1

0010	0010	1111	0001
2	2	F	1

Exercise n°3

A computer with the following characteristics:

- 2 GB physical memory,
- 32-bit architecture,
- The size of a page is 4 KB,
- A virtual address indexing one byte.

a) Give the size of the page table, giving details of your answer, knowing that each entry in the table contains: a reference to a frame + 1 bit presence absence.

$$Size_{TP} = Number\ of\ enties * \ Size_{Entry}$$

$$Size_{TP} = \frac{2^{32}}{2^{12}} * (A + 1)$$

$$Number\ of\ frames = \frac{2 * 2^{30}}{2^{12}} = 2^{19} \quad \Longrightarrow \quad A = 19$$

$$Size_{TP} = 2^{20} * 20 = 20\ Mbits$$

b) How many pages are needed to load the entire page table into memory?

$$Number\ of\ pages = \frac{Size\ of\ TP}{Size\ of\ page} = \frac{20 * 2^{20}}{8 * 2^{12}} = 640\ pages$$

Exercise n°4

Let's consider an architecture characterized by the following assumptions:

- A page table of size 128 KB,
- Each entry in the table contains a reference to a page frame and a presence/absence bit,
- The size of a page is 64 KB,
- The size of physical memory is 2 GB,
- A virtual address indexes one byte.

Answer the following questions and justify your answer:

a) How many page frames does physical memory contain?

$$Nb(Frames) = \frac{Size(Physical\ memory)}{Size_{Frame}}$$

$$Nb(Frames) = \frac{2 * 2^{30}}{2^6 * 2^{10}} = 2^{15}\ Frames$$

b) What is the bit size of a page table entry (the size in term of bits)?

$$Size\ of\ a\ page\ table\ entry = Number\ of\ bits\ to\ code\ a\ frame\ +\ 1\ presence\ bit$$
$$Size\ of\ a\ page\ table\ entry = 15 + 1 = 16\ bits$$

c) What is the number of entries in the page table?

$$\text{Number of entries (TP)} = \frac{Size_{TP}}{Size_{Enty-in-TP}}$$

$$\text{Number of entries (TP)} = \frac{128\ Ko}{16} = \frac{2^7 * 2^{10} * 2^3}{2^4} = 2^{16}$$

d) What is the size of the virtual memory for this architecture?

$$\text{Virtual memory size} = \text{Number of pages} * Size_{Page}$$

$$\text{Virtual memory size} = 2^{16} * 2^{16}\ octets = 4\ Go$$

*What is the bit size of the address bus in this architecture?

Address bus size = number of bits needed to encode virtual memory = 32 bits

e) Consider the following two logical addresses expressed in decimal: 1024 and 65540. If possible, give the corresponding physical addresses (expressed in decimal) based on the first 10 entries in the page table given below.

Page No.	Page frame no.	Presence/absence bit
0	0	1
1	2	0
2	8	0
3	2050	1
4	21054	1
5	31463	1
6	2187	0
7	260	0
8	1266	0
9	1024	1

Example 1

Logical @ = 1024

$$Size_{page} = 2^{16} = 65536$$

$$Page\ no. = div\left(logical@, Size_{page}\right)$$

$$Page\ no. = div(1024{,}65536) = \mathbf{0}$$

$$Offset\ = mod\left(logical@, Size_{page}\right)$$

$$Offset = div(1024{,}65536) = \mathbf{1024}$$

$$Page\ no.\,(\mathbf{0})\quad \rightarrow \boldsymbol{Frame\ no.}\,(\mathbf{0})$$

$$Physical\ @ =\ \boldsymbol{Frame\ no. + Offset}$$

$$Physical\ @ =\ \mathbf{0 * 65536 + 1024 = 1024}$$

Example 2

Logical @ = 65540

$$Size_{page} = 2^{16} = 65536$$

$$Page\ no. = div\left(logical@, Size_{page}\right)$$

$$Page\ no. = div(65540{,}65536) = \mathbf{1}$$

$$Offset\ = mod\left(logical@, Size_{page}\right)$$

$$Offset = div(65540{,}65536) = \mathbf{4}$$

$$Page\ no.\,(\mathbf{1})\quad \rightarrow \boldsymbol{Frame\ no.}\,(\mathbf{2})$$

For page 1, the presence/absence bit = 0, so the page is not loaded into memory.

This is a page fault.

The physical address cannot be known.