People's Democratic Republic of Algeria
Ministry of higher education and scientific research
University of Mohamed Boudiaf - M'sila

Faculty of Mathematics and Computer Science
Department of Computer Science

2nd Year License (2L)

Operating Systems 1 (OS 1)

Semester : 04

2025/2026

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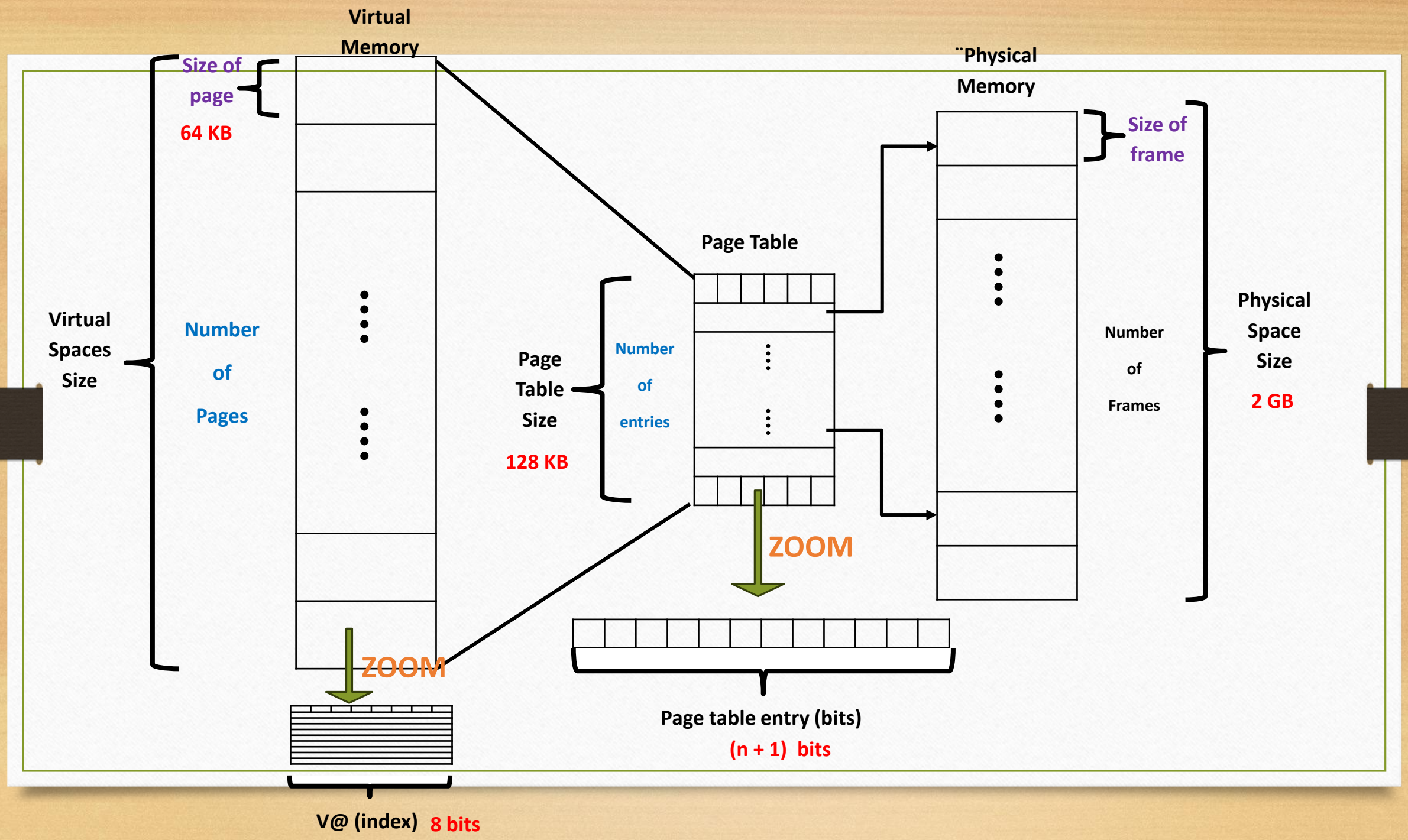
- In case of problems or difficulties, please contact me or your TD / TP teacher.
- We are at your disposal to help you

CHAPTER 5

Memory Management

Exercise V.8

- Consider a system using paging technology and having the following characteristics:
- A page table of size **128 KB**
- Each page table entry contains a reference to a 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 is indexed by **1 Byte**
- Answer the following questions, always justifying your answer:


Virtual Memory
Size of page
64 KB
Virtual Spaces Size
Number of Pages
Page Table
Page Table Size
128 KB
Number of entries
ZOOM
¨Physical Memory
Size of frame
Number of Frames
Physical Space Size
2 GB
ZOOM
Page table entry (bits)
(n + 1) bits
V@ (index) 8 bits

Exercise V.8

1) How many frames does physical memory contain?

$$Size\ of\ physical\ address\ space = \#\ of\ frames \times frame\ size$$

- $$\Rightarrow\ of\ frames = \frac{\text{Size of physical address space}}{frame\ size}$$
- We have :

$$frame\ size = page\ size = 64KB = 2^6 \times 2^{10}$$

$$= 2^{16}\ Byte$$

- $$\#\ of\ frames = \frac{2 \times 2^{30}}{2^{16}} = \frac{2^{31}}{2^{16}} = 2^{15}\ Frames$$

Exercise V.8

2) What is the size of a page table entry in bits?

$$Size\ of\ a\ PT\ entry$$

$$=$$

$$\#\ number\ of\ bits\ to\ code\ a\ frame + 1 \text{ presence/absence bit}$$

- $\#\ of\ frames = 2^{15}\ Frames$
- $\Rightarrow\ \#\ of\ bits\ to\ code\ a\ frame = 15\ bits$

$$Size\ of\ a\ page\ table\ entry = 15 + 1 = 16\ bits$$

Exercise V.8

3) How many entries are there in the page table?

- $\text{Size of PT} = \#\ of\ entries\ in\ PT \times Size\ of\ a\ PT\ entry$
- $\Rightarrow \#\ of\ entries\ in\ PT = \text{Size of PT} / Size\ of\ a\ PT\ entry$
- $\Rightarrow \#\ of\ entries\ in\ PT = \frac{128KB}{16bits} = \frac{2^7 \times 2^{10}B}{2B} = 2^{16}\ Entries$

OR

- $\Rightarrow \#\ of\ entries\ in\ PT = \frac{128KB}{16bits} = \frac{2^7 \times 2^{10} \times 2^3 bits}{2^4 bits} = 2^{16}\ Entries$

Exercise V.8

4) What is the virtual memory size of this architecture?

- $Size\ of\ virtual\ memory = \#\ of\ pages \times page\ size$
- $We\ have: \#\ of\ pages = \#\ of\ entries\ in\ PT = 2^{16}\ pages$
- $Size\ of\ virtual\ memory = 2^{16} \times 2^{16} = 2^{32} = 4\ GB$

Exercise V.8

5) What is the size of the address bus in bits for this system?

- Address bus size (m) = number of bits required to encode virtual memory
- $\boldsymbol{A\ virtual\ address\ is\ indexed = size\ of\ one\ @\ = 1\ Byte}$
- $$2^m = \frac{Size\ of\ virtual\ memory}{Size\ of\ one\ @} = \frac{2^{32} Byte}{1 Byte} = 2^{32}$$
- $\boldsymbol{\Longrightarrow m = 32\ bits}$

Exercise V.8

6) Consider the following two logical addresses expressed in decimal: **1024** and **65540**.

If possible, give the corresponding physical addresses (in decimal) based on the first **10** entries in the page table given below.

Exercise V.8

Page Number	Frame Number	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

Exercise V.8

- Logical @ = (# of Pages, Offset)
- We have : $Page\ Size = 2^{16} = 65536\ Byte$
- **We use the following calculation rule:**

Logical @	**Page Size**
Offset	**# of Pages**

Exercise V.8

- Logical @ = (# of Pages, Offset)
- We have : $Page\ Size\ = 2^{16}\ =\ 65536\ Byte$
- **We use the following calculation rule:**

65540	**65536**
4	**1**

Exercise V.8

- $\boldsymbol{Logical\ @ = 1024}$
- $\#\ of\ Pages = 0 \xrightarrow{In\ Page\ Table}$ Presence/Absence bit $= 1, \#\ of\ Frames = 0$
- $\boldsymbol{Offset = 1024}$
- ➔ $\boldsymbol{Physical\ @ = 0 \times 65536 + 1024 = 1024}$

Exercise V.8

- $\boldsymbol{Logical\ @\ =\ 65540}$
- $\boldsymbol{\#\ of\ Pages = 1} \xrightarrow{\boldsymbol{In\ Page\ Table}}$ Presence/Absence bit = 0,
- so this page is not loaded into memory.
- $\boldsymbol{Offset\ =\ 4}$
- ➔ $\boldsymbol{Physical\ @\ cannot\ be\ known.}$

Questions ?