

- Dynamic Loading → To obtain better space utilization.

The main program is loaded to memory and executed. When a routine needs to call another routine, the calling routine first checks whether the routine is loaded or not.

→ If it isn't the relocatable linking loader is called to load the desired routine into memory.

→ The advantage of dynamic loading is that a routine is loaded when it is needed.

## LINKING

### Static Linking

## Dynamic linking

Dynamically linked libraries are system libraries that are linked to the user program when the program are running

- Some OS support only static linking in which system libraries are treated like any other object module and/or combined by the linker into the binary program image

- In dynamic linking stub is included in the image for each library routine reference.

- Stub is a small piece of code that indicates how to locate appropriate memory residence library routine.

- Swapping → ① A process can be swapped

temporarily out of memory to the backing store and brought back into memory for execution.

- It inc. degree of multiprogramming

- The system maintains a ready queue which contains all the processes whose memory images are on the M.M or backing store.

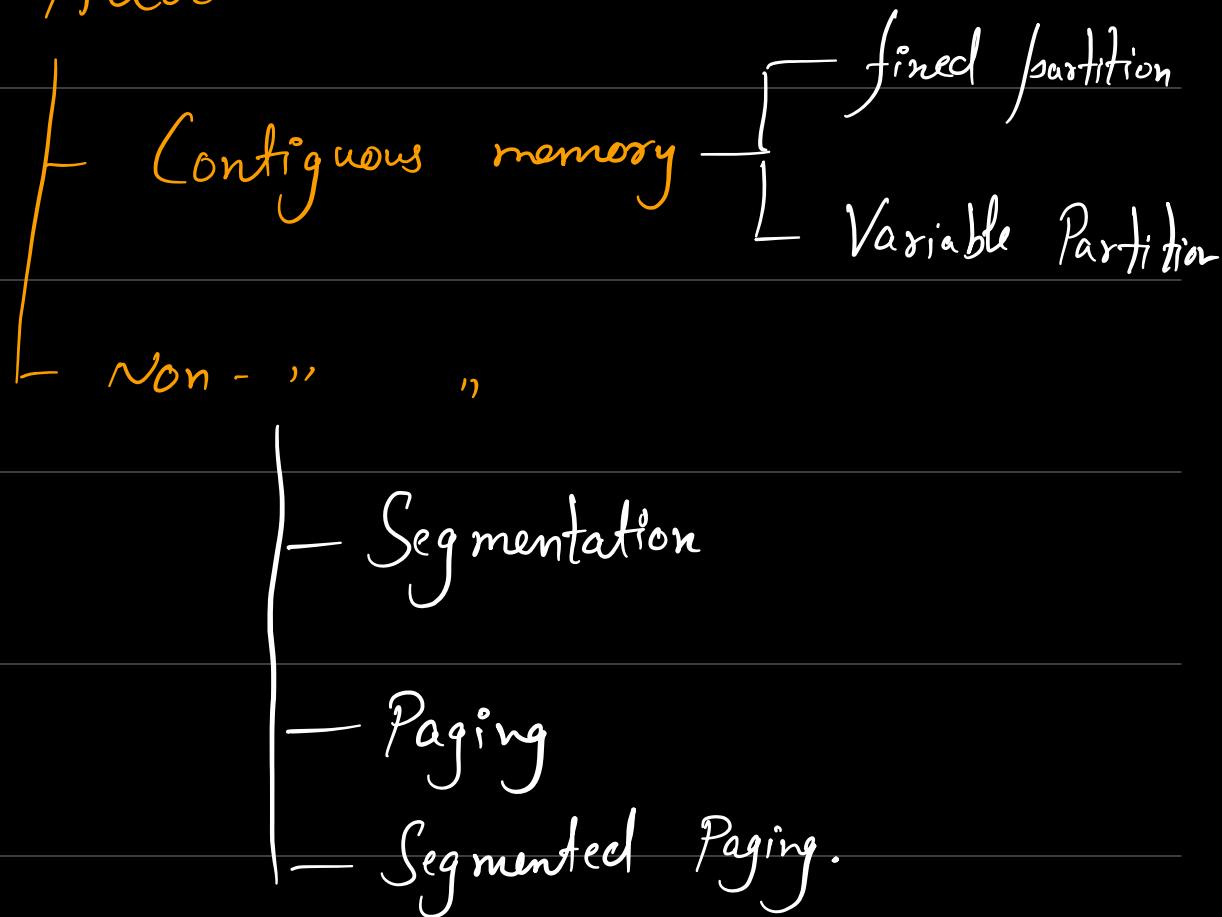
- Whenever a CPU scheduler decides to execute a process it calls the dispatcher.

The dispatcher checks to see whether the next process in the queue is in memory or not.

If it's not and there is no

memory space also the dispatcher swaps out the process currently in the memory and swaps in the desired process.

- **Memory Allocation**



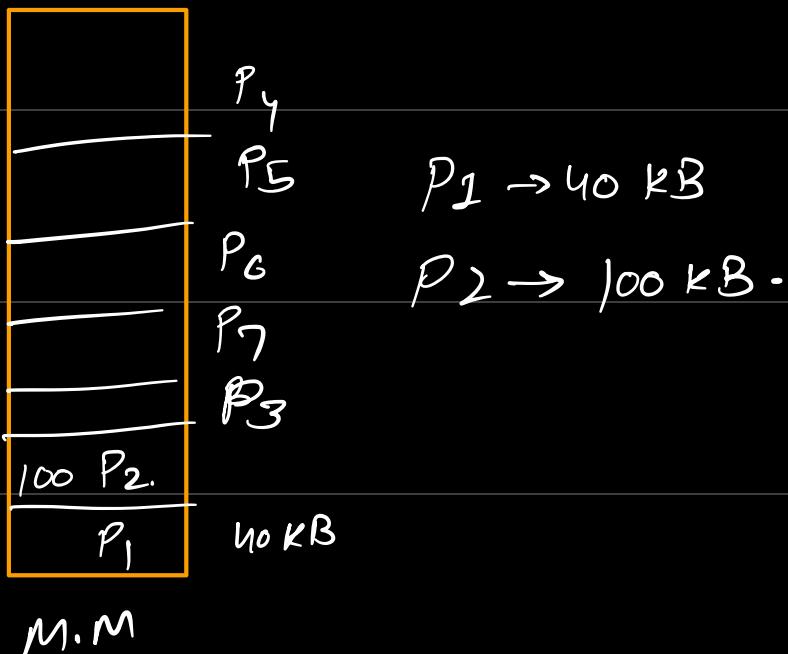
- Fixed Partition →





M.M.

## Variable Partition



M.M

Draw back  $\rightarrow$  External fragmentation.

- Fixed Size Partition  $\rightarrow$  Each partition contain exactly one process thus degree of multiprogramming is bound by the no. of partitions.

In this when a

partition is free. The process is selected from ready queue and loaded to free partition.

Variable Partition → OS keeps a table indicating which parts of memory are available.

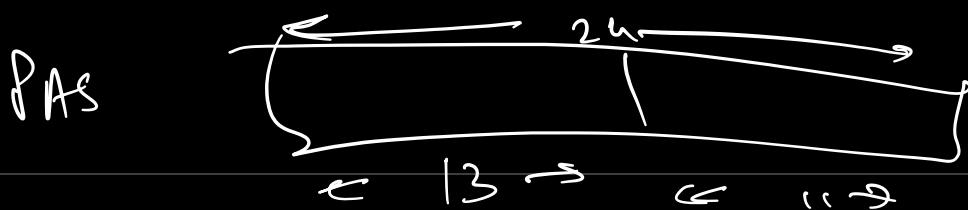
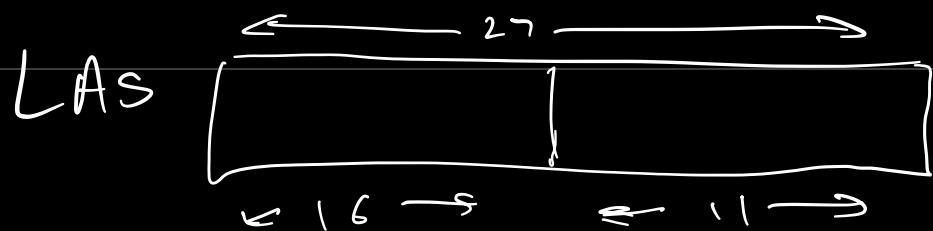
Initially all memory is available for user processes and is considered one large block of available memory called hole.

Eventually memory contains a set of holes of various sizes.

Wednesday  
2.30  
class  
we notes  
Vasili Bhejdo

## Problems

Q1.) Consider a system with LAS of 128 MW and PA -  $2^4$  bits. The PAS is divided into 8K frames. What is page size and how many pages.



$$\# \text{ pages} = 2^{16} = 64 \text{ KB}$$

$$\# \text{ page size} = 2^{11} \rightarrow 2 \text{ KB}$$

$$\text{frame size} = \text{page size}$$

Q2) Consider a single level paging scheme.

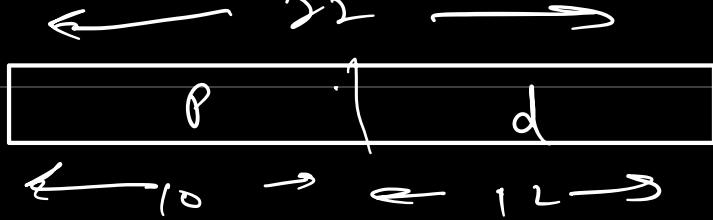
The Virtual address space is 4 MB & page

Size is 4 KB. What is the maximum page table entry size possible s.t. no entire page table fits well in one page?

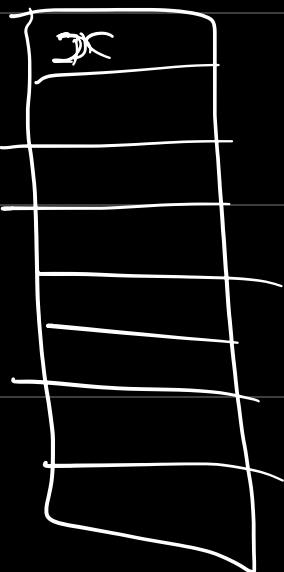
VAS  $\rightarrow$  4 MB

Page Size  $\rightarrow$  4 KB

Max P.T.E size  $\rightarrow$  ??



$$\# \text{page} = 2^{10} - 1 \text{K}$$

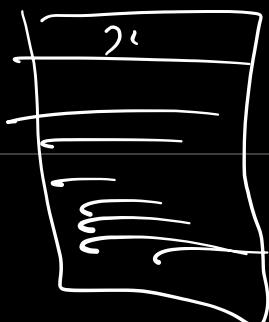
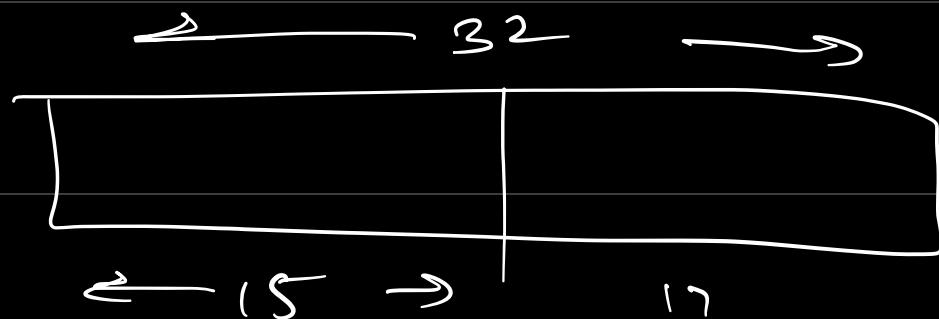


Page table size  $\leq$  4 KB

$$x \times 2^{16} \leq 2^{12}$$

$$x \leq 4$$

Q. Same question as above but,  $\sqrt{A} = 4$  GB  
Page size - 128 KB

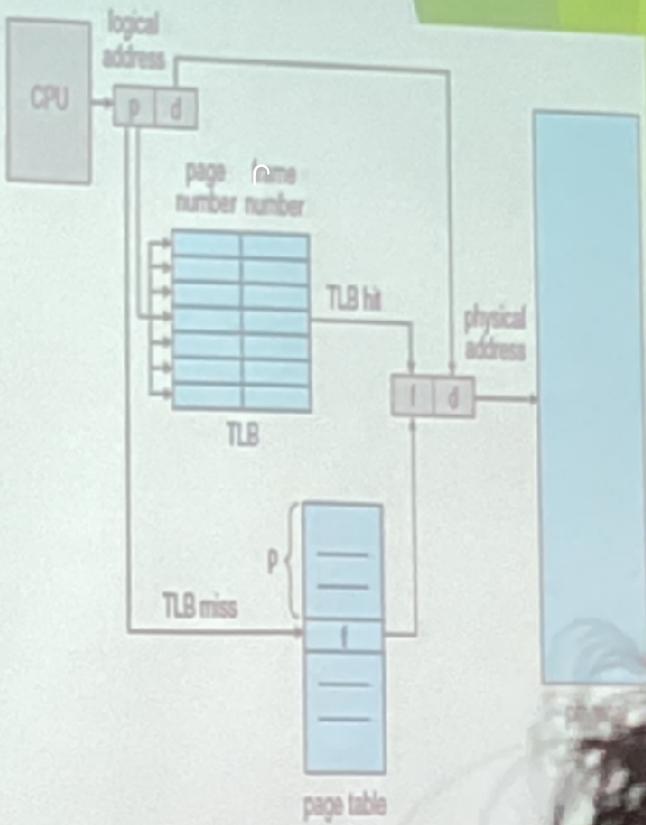


$$x \times 2^{15} \leq 2^{17}$$

$$x \leq 4$$

$$x = 4 \text{ Bytes}$$

- If the page number is not in the TLB (known as a TLB miss), a memory reference to the page table must be made.
- In addition, we add the page number and frame number to the TLB so that they will be found quickly on the next reference.
- If the TLB is already full of entries, an existing entry must be selected for replacement. Replacement policies range from least recently used (LRU) through round-robin to random.

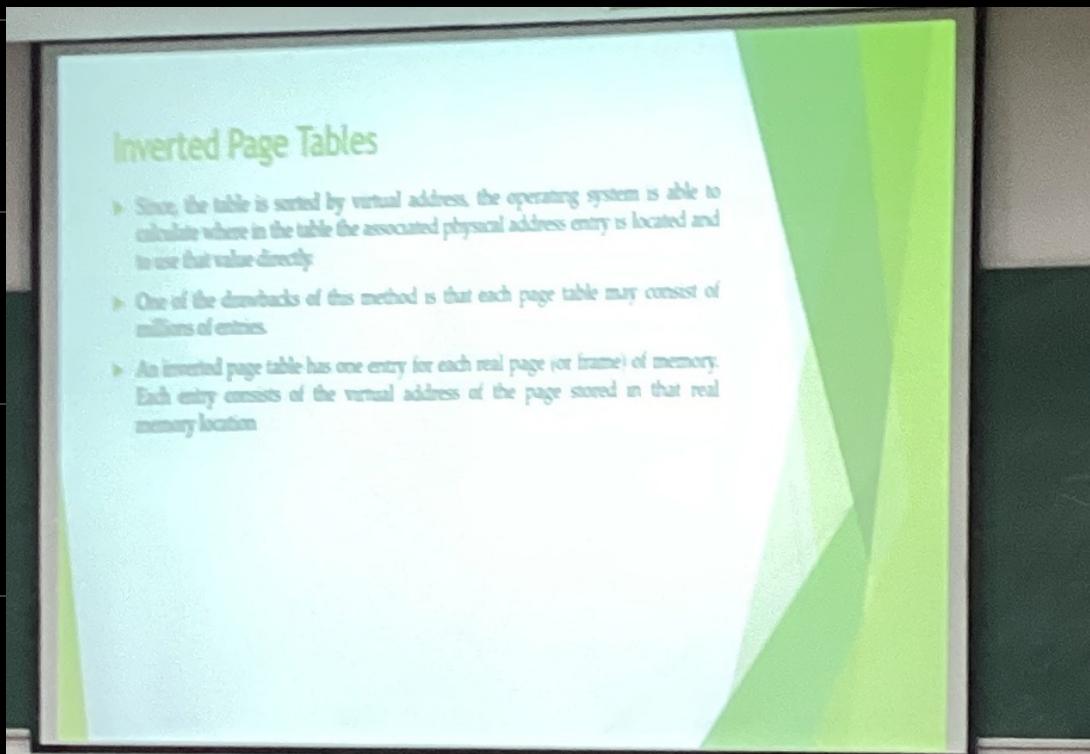
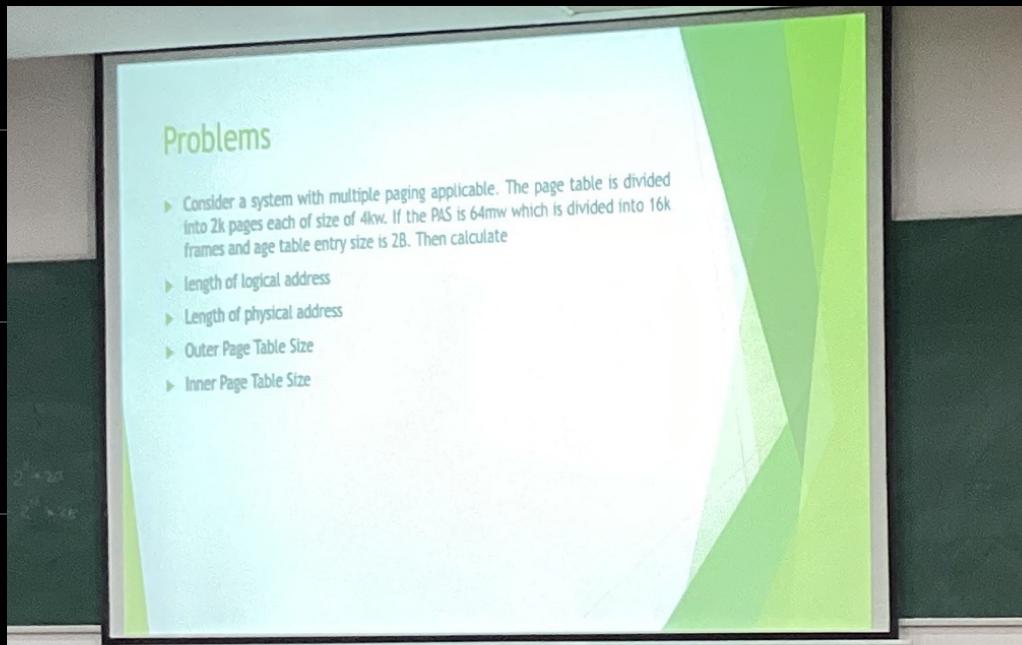


Effective access time

$$EAT \rightarrow h(c+m) + (1-h)(c+2m)$$

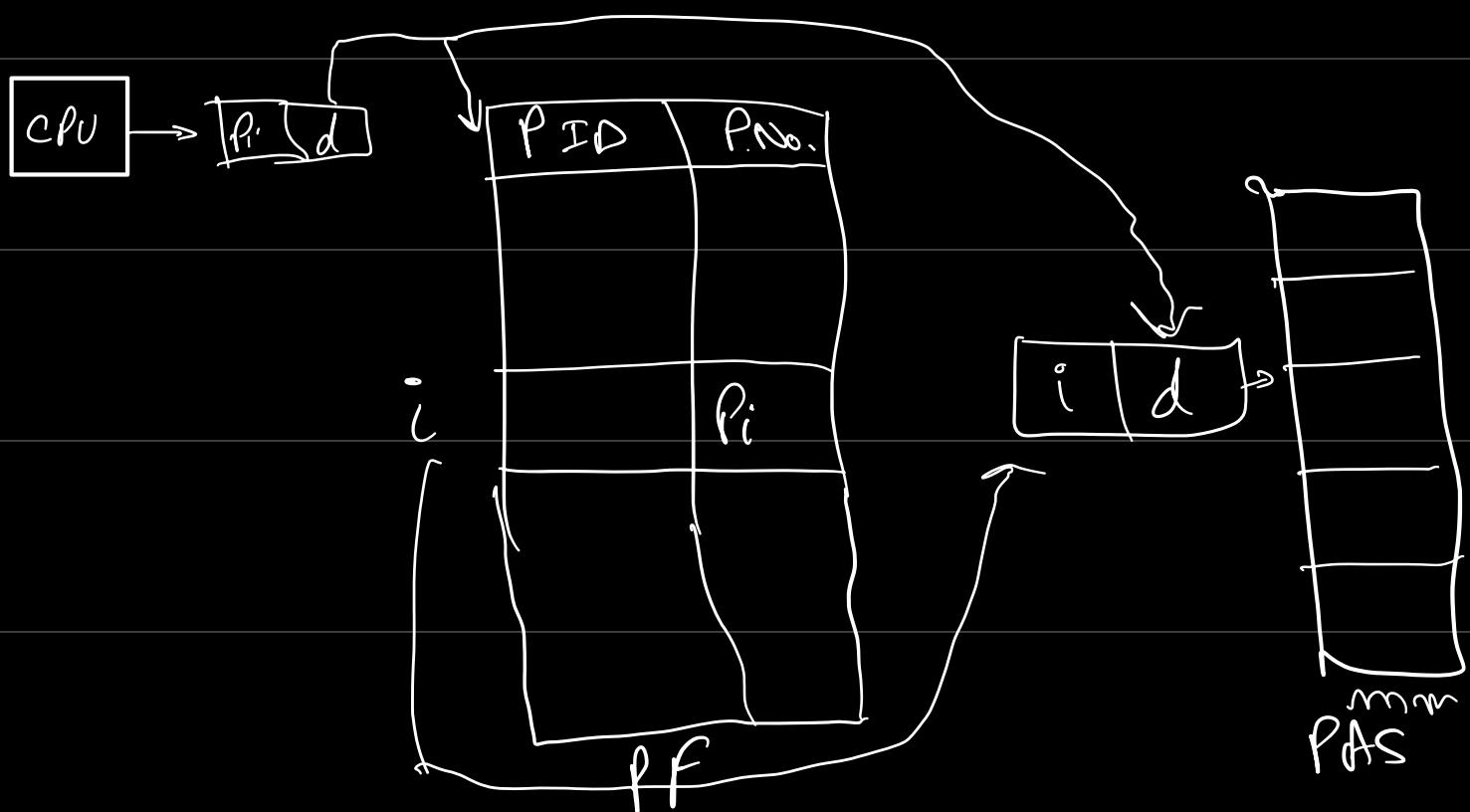
Bhai mere se na likhi karo notes,

# Mangue hi lo



Page table oh yeah, put the  
words right in my table, oh  
Yes, right more page table  
mujhe hund Samajh ni ase she

fir bhi koshish Krungs.



Consider a system which has 34 bits of logical page and physical address is 29bits and page size is 16KB and the memory is byte addressable. The page table entry size is 8 Bytes.

- i) conventional page table size
- ii) Inverted page table size

































































































