CS & IT ENGINEERING

Operating Systems

Memory Management

Lecture No. 9

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- Segmentation
- Virtual Memory Concept
- Virtual Memory Implementation

II. SEGMENTATION

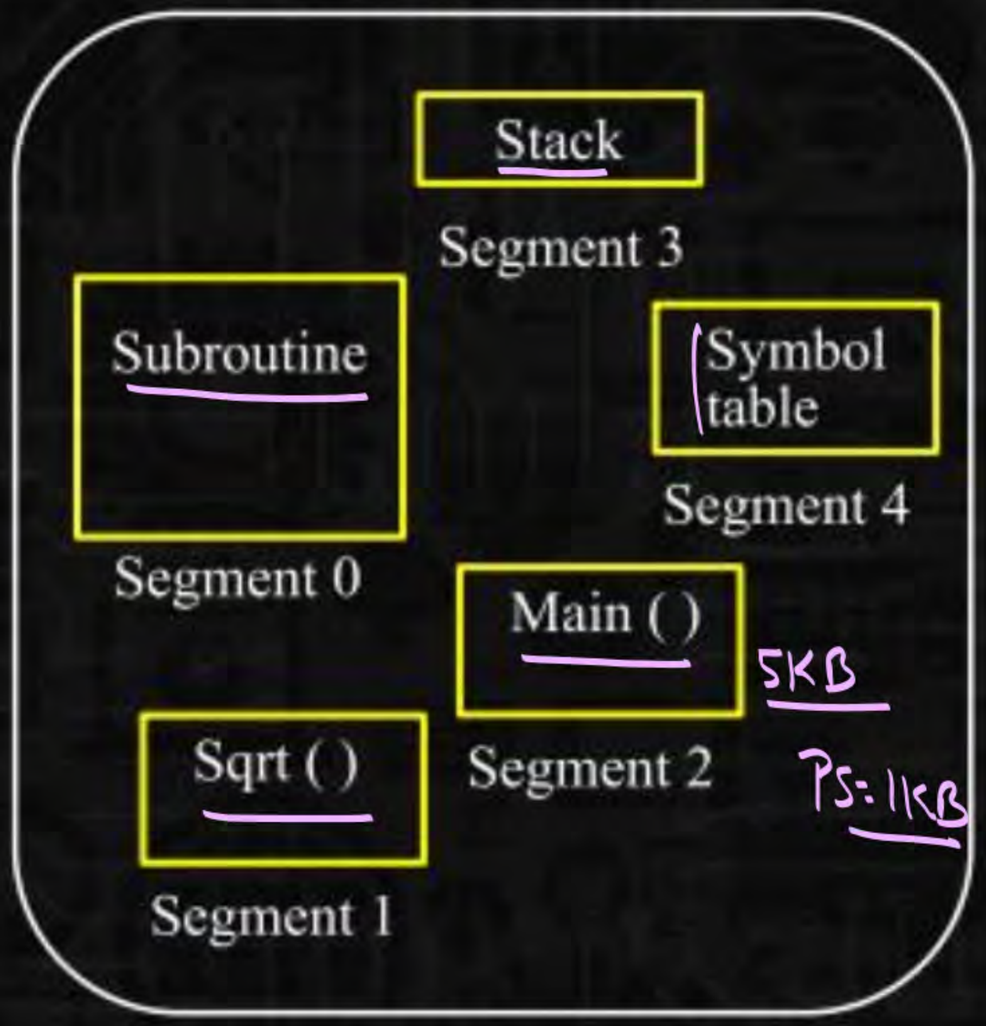
→ Paging does not preserve user's view of Mem. Alloc. to Programs;

→ As per user's view of Mem. Alloc, program is divided into Logical units, known as Segments (function; block; Procedure; D.S; class)

→ These segments are assumed to be Stored in their entirety @ Non-Cn locations in Memory;

Program A.S

Logical Address Space



Example of Segmentation

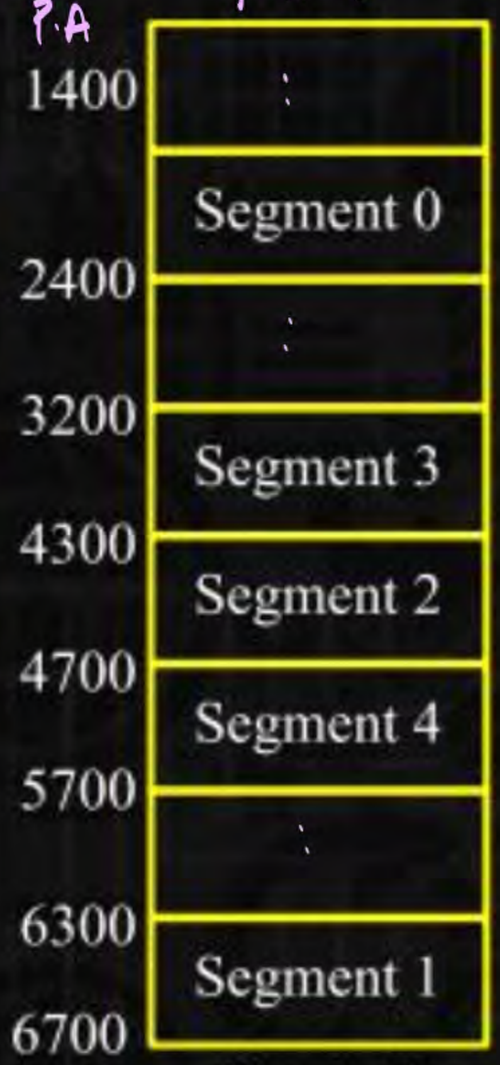
STE

S	Limit	Base
0	1000	1400
1	400	6300
2	400	4300
3	1100	3200
4	1000	4700

Segment Table

L.A: | S | d |

(Variable) P.A.S



Physical Memory

Performance of Segmentation

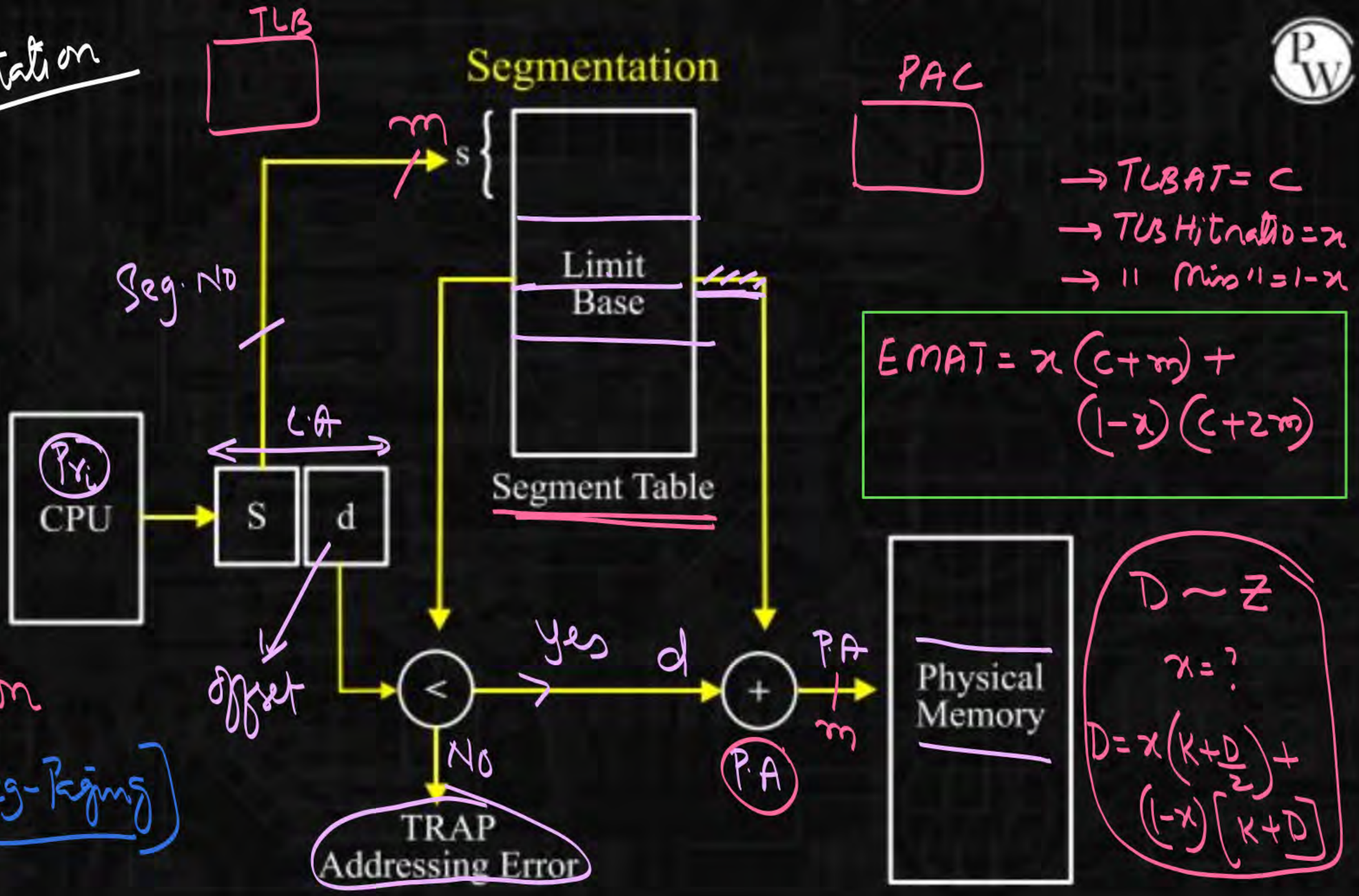
1) Time:

MMAT : 'm'

EMAT : 2m

2) Space:

When S.T become large, Apply Paging on S.T [Seg-Paging]



→ TLBAT = C

→ TLB Hit ratio = x

→ TLB Miss = 1 - x

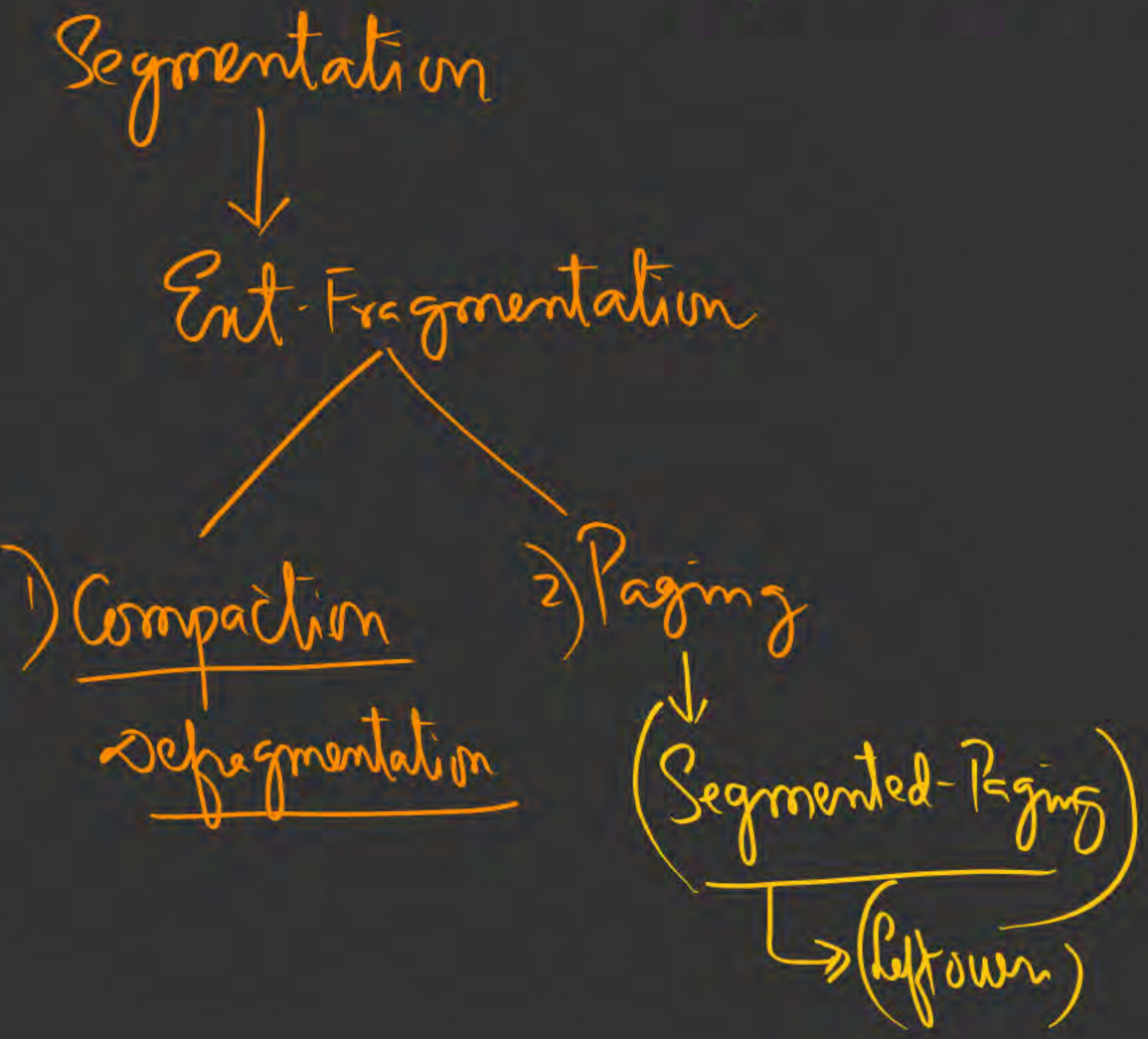
$$EMAT = x(C+m) + (1-x)(C+2m)$$

D ~ Z

x = ?

$$D = x\left(K+\frac{D}{2}\right) + (1-x)[K+D]$$

* Compare Paging vs Segmentation w.r.t to Fragmentation



Q.

Consider the following segment table:

Segment	Base	Length
0	1219	600
1	3300	14
2	90	100
3	2327	580
4	1952	96

What are the physical addresses for the following logical addresses?

A. 0, 4302 : TRAP

B. 1, 15 : TRAP

C. 2, 50 : 90+50=140

D. 3, 400 : 2327
400
2727 ✓

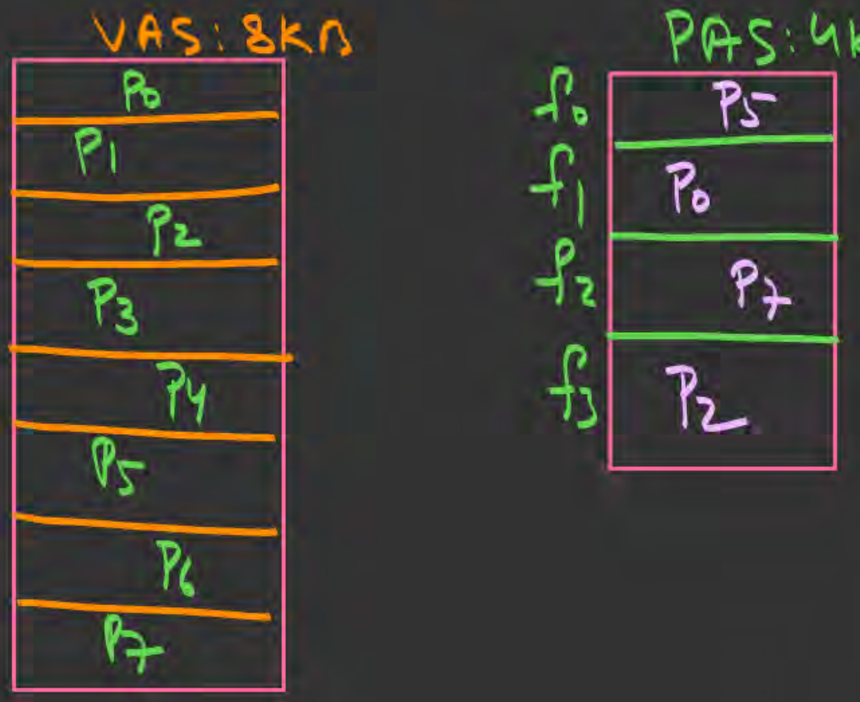
E. 4, 112 : Trap

Virtual Memory (VM)

→ V.M gives an illusion to the Programmer that a huge/large amount of Memory is available for executing Programs, that are larger than the available/given Physical Mem;

V.A.S = 8KB; P.A.S = 4KB;

P.S = 1KB



V.M

↓

Demand Paging (DP)

↓

Loading the Pages on Demand @ R.T from disk to Memory

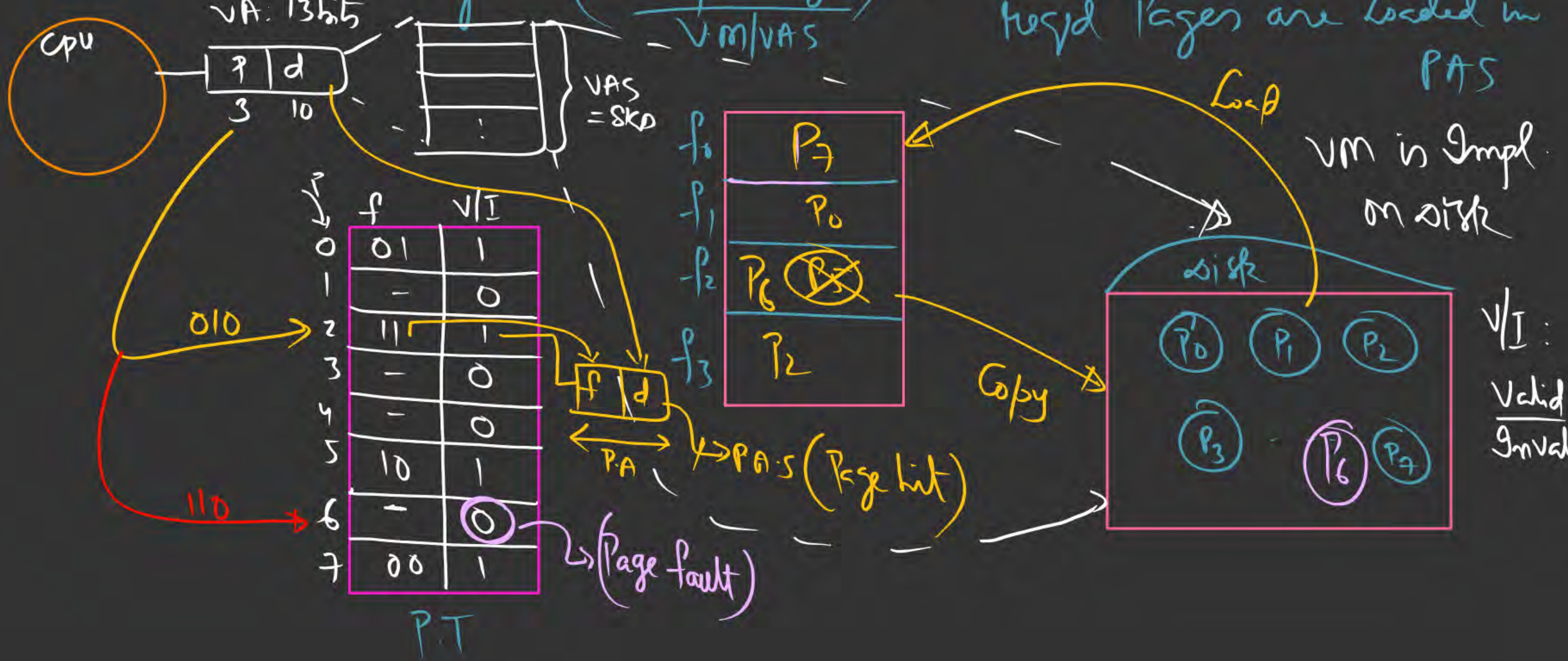
→ V.M is Impl. thru Demand Paging (DP)

→ Demand Paging:

VMM

Program (8KB | 8 Pages) is Stored initially on disk
Req'd Pages are Loaded in PAS

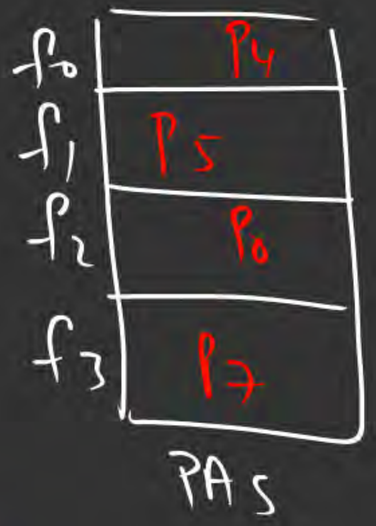
V.M/VAS



Demand Paging (D.P)

- Pure D.P
- Prefetch D.P

(Execution of the Process will start with all Empty frames)



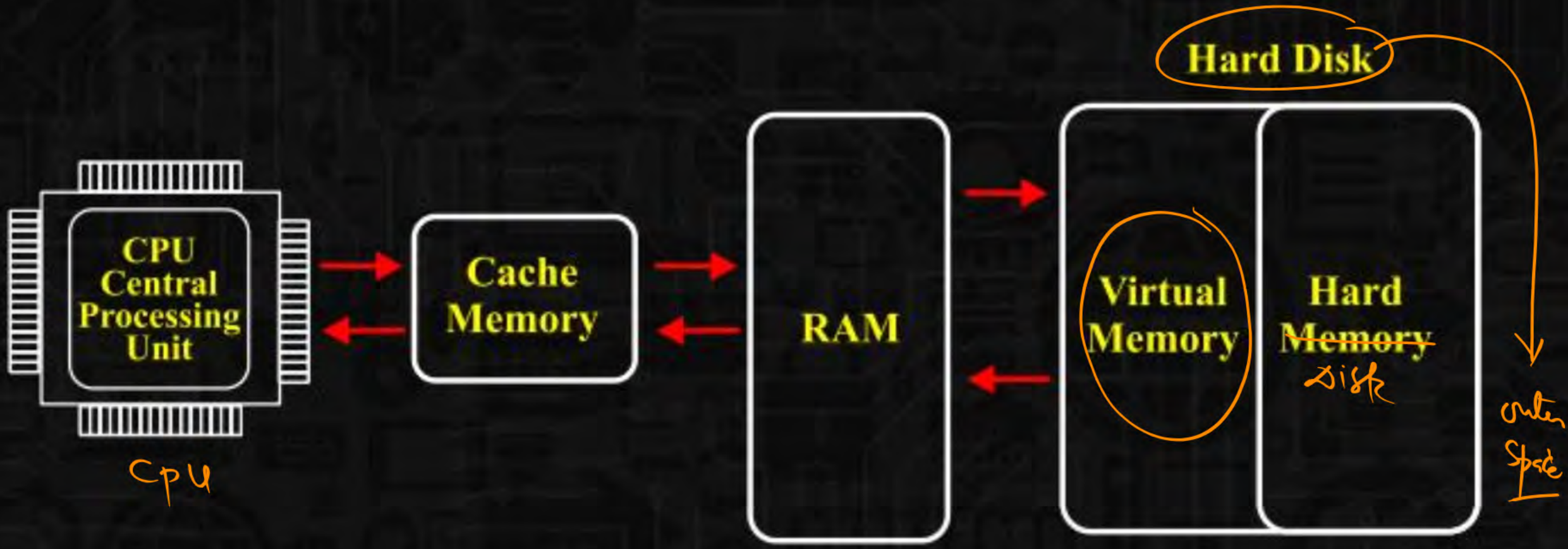
1) In Impl. of V.M

→ P.A.S ; VAS / VM ; Disk A.S

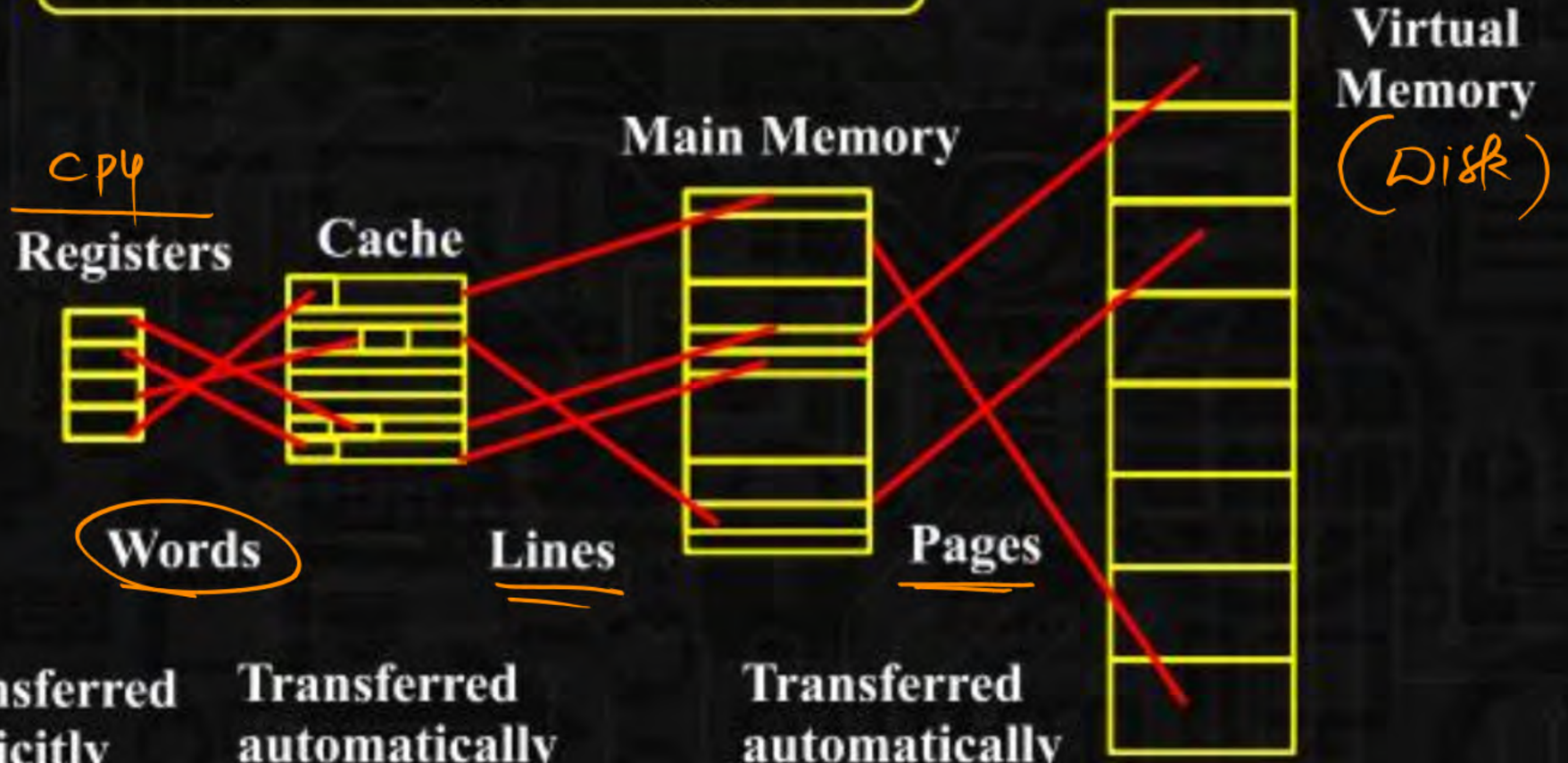
In practice:

$$P.A.S \leq V.A.S \leq Disk\ AS$$

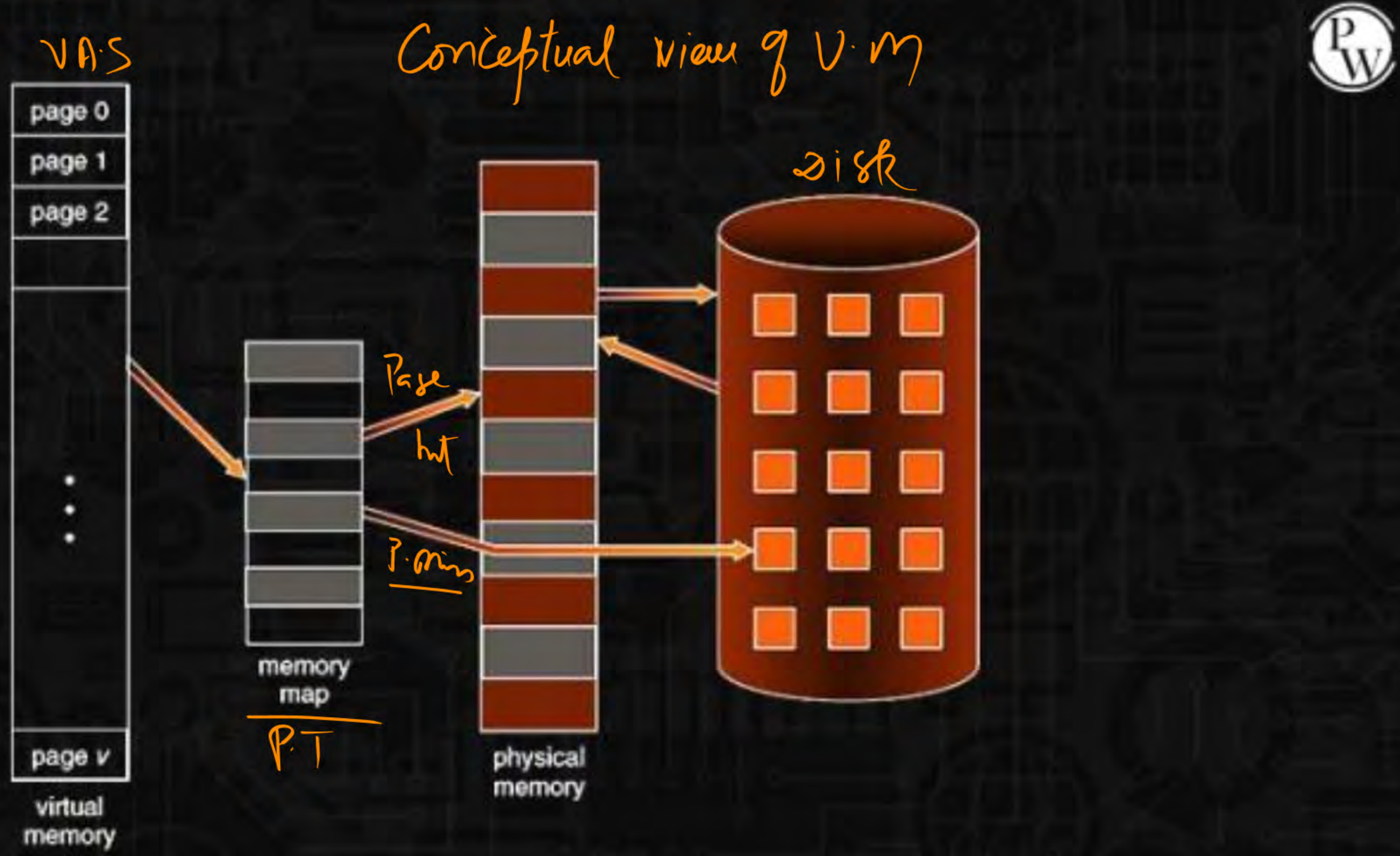
2) The Size of V.M (VAS) is limited by Size of Disk,


Hard Disk
CPU
Central
Processing
Unit
Cache
Memory
RAM
Virtual
Memory
Hard
Memory
Disk
CPU
Swap
Space

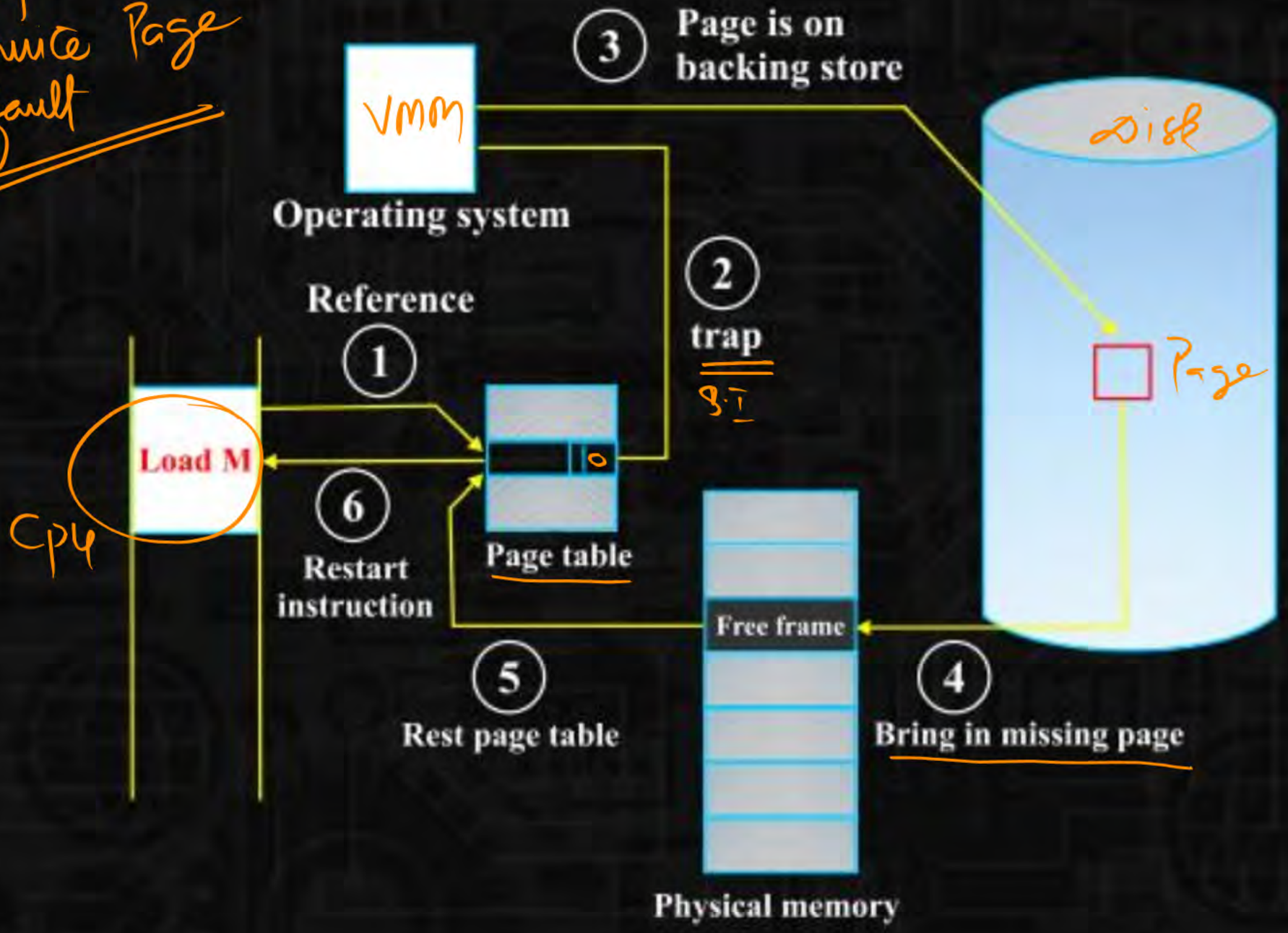
Memory Hierarchy: The Big Picture



Data movement in a memory hierarchy


VAS
Conceptual view of V.M
page 0
page 1
page 2
page v
virtual memory
memory map
PT
Page hit
Page miss
physical memory
disk

Steps taken to Service Page fault



Amount of Time taken by O.S (VMM) to Service a Page fault is known as Page fault Service time (PFST) = (ms)

* Performance of V.M

1. Time (Temporal Issue)

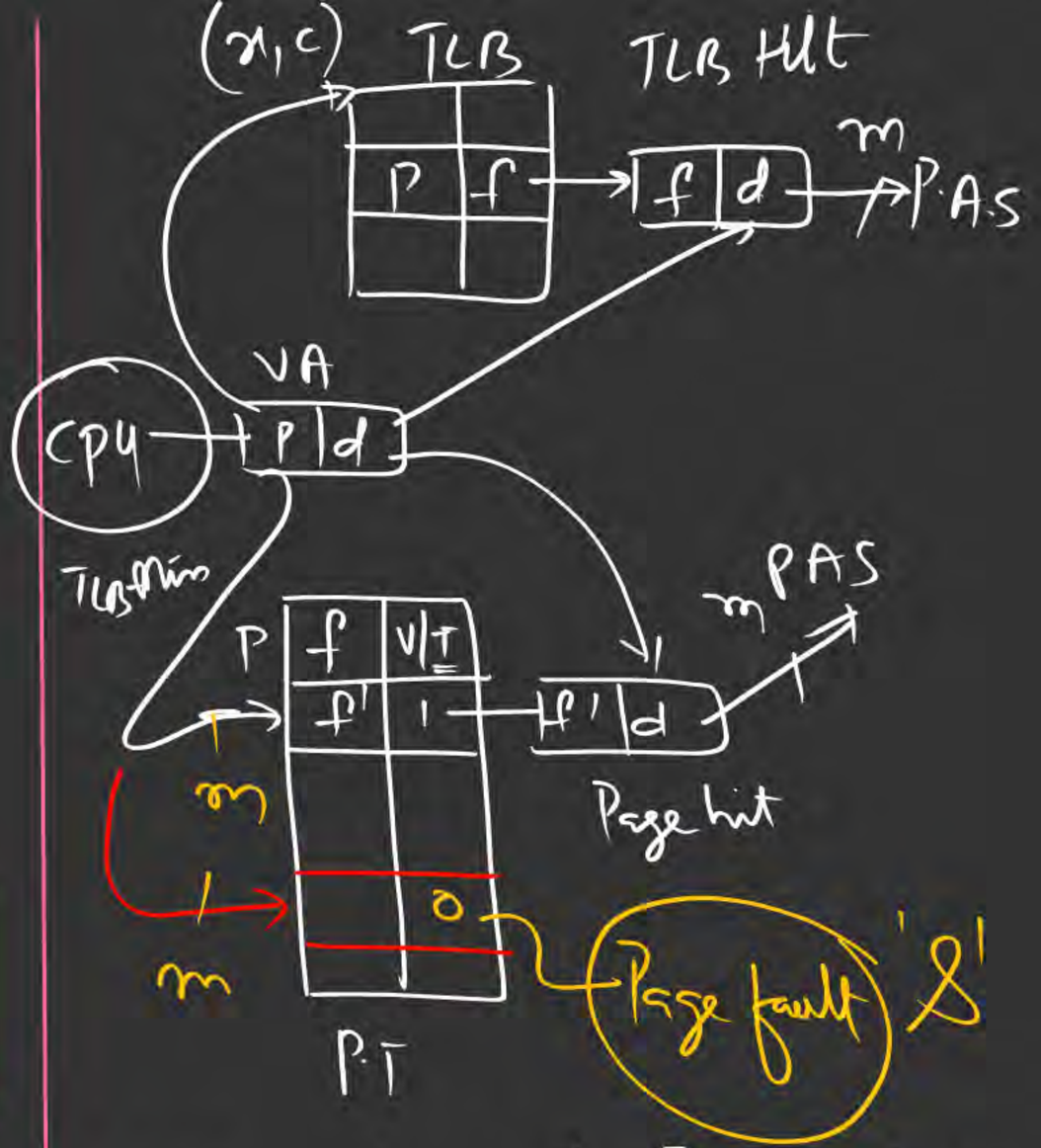
→ MMAT = 'm'

→ PFST = 'S' [S >> m]

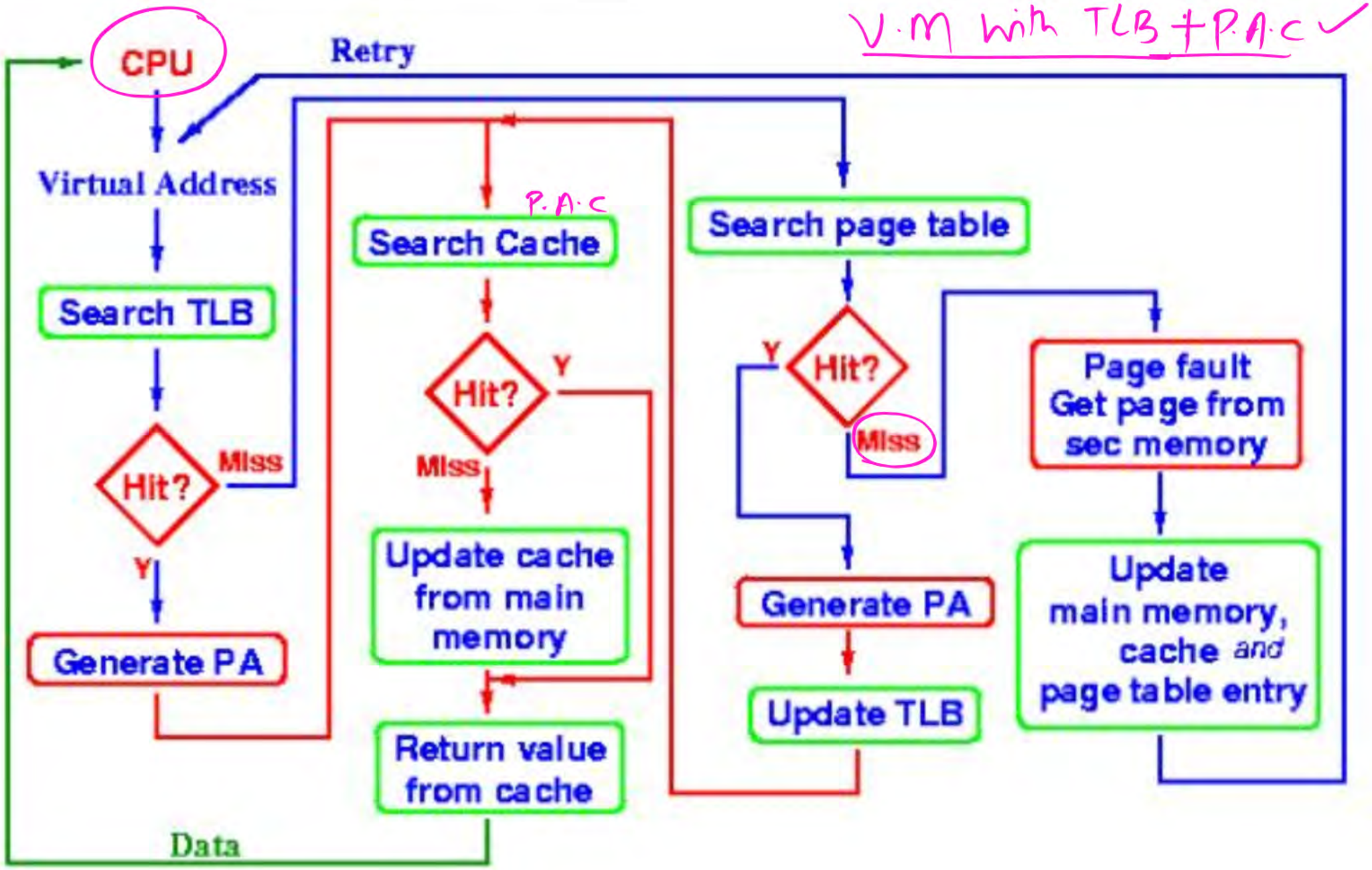
→ Page fault rate = 'P'

→ Page hit rate = '1-P'

$$\underset{D.P}{E.M.A.T} = (1-P) * m + P * S$$



$$\underset{TLB+DP}{EMAT} = x(c+m) + (1-x)\left[c + (1-P)(2m) + P*(m+S)\right]$$


V.M with TLB + P.A.C
CPU
Retry
Virtual Address
Search TLB
Hit?
Miss
Y
Generate PA
P.A.C
Search Cache
Hit?
Y
Miss
Update cache from main memory
Return value from cache
Data
Search page table
Hit?
Y
Miss
Generate PA
Update TLB
Page fault
Get page from sec memory
Update main memory, cache and page table entry

Q.

In a virtual memory system the address space specified by the address lines of the CPU must be Larger than the physical memory size and Smaller than the secondary storage size.

A. smaller, smaller

B. smaller, larger

C. larger, smaller ✓

D. larger, larger

Q. The total size of address space in a virtual memory system is limited by:

A. Length of MAR

B. Available secondary storage

C. Available main memory

D. None

Q. The essential content(s) in each entry of a page table is/are

mcq

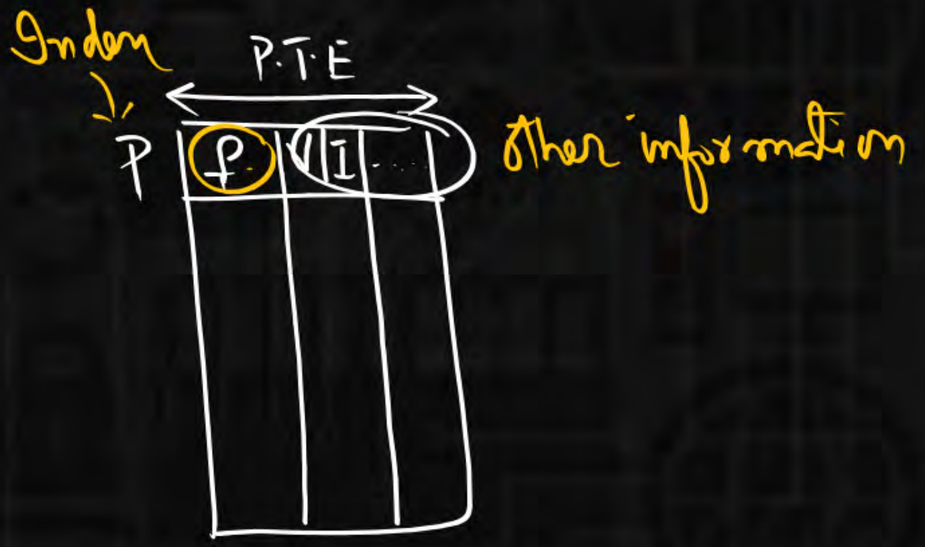
A. virtual page number. ×

B. page frame number. ✓

C. × both virtual page number and page frame number,

D. ✓ access right information.

PAS ≤ VAS ≤ D.A.S



Q. In a system with 32 bit virtual addresses and 1KB page size, use of one-level page tables for virtual to physical address translation is not practical because of

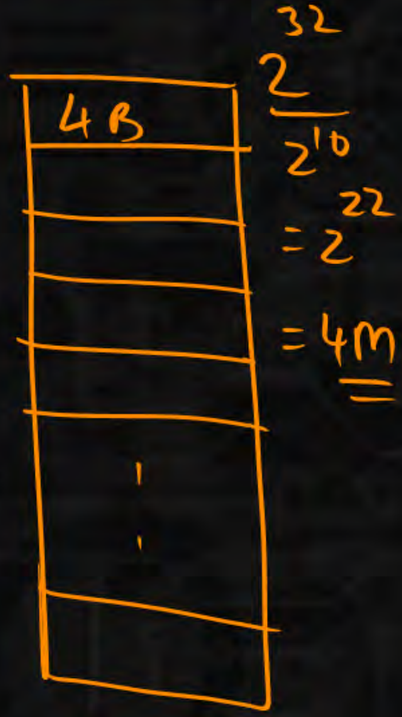
Large P.T. Size

A. the large amount of internal fragmentation

B. the large amount of external fragmentation

C. the large memory overhead in maintaining page tables ✓

D. the large computation overhead in the translation process



THANK YOU!