

Paging

same size

internal fragmentation

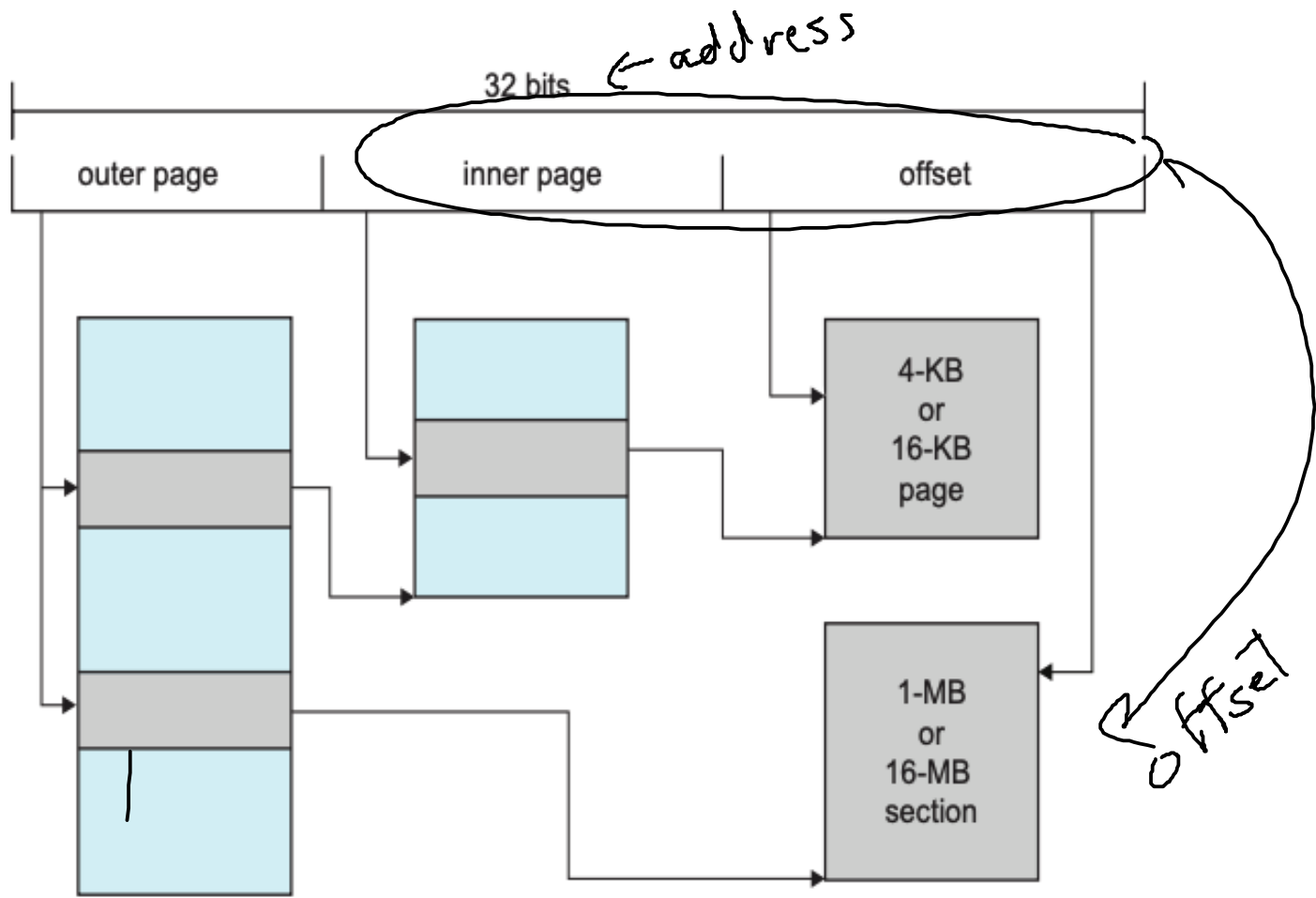
Segmentation

different size

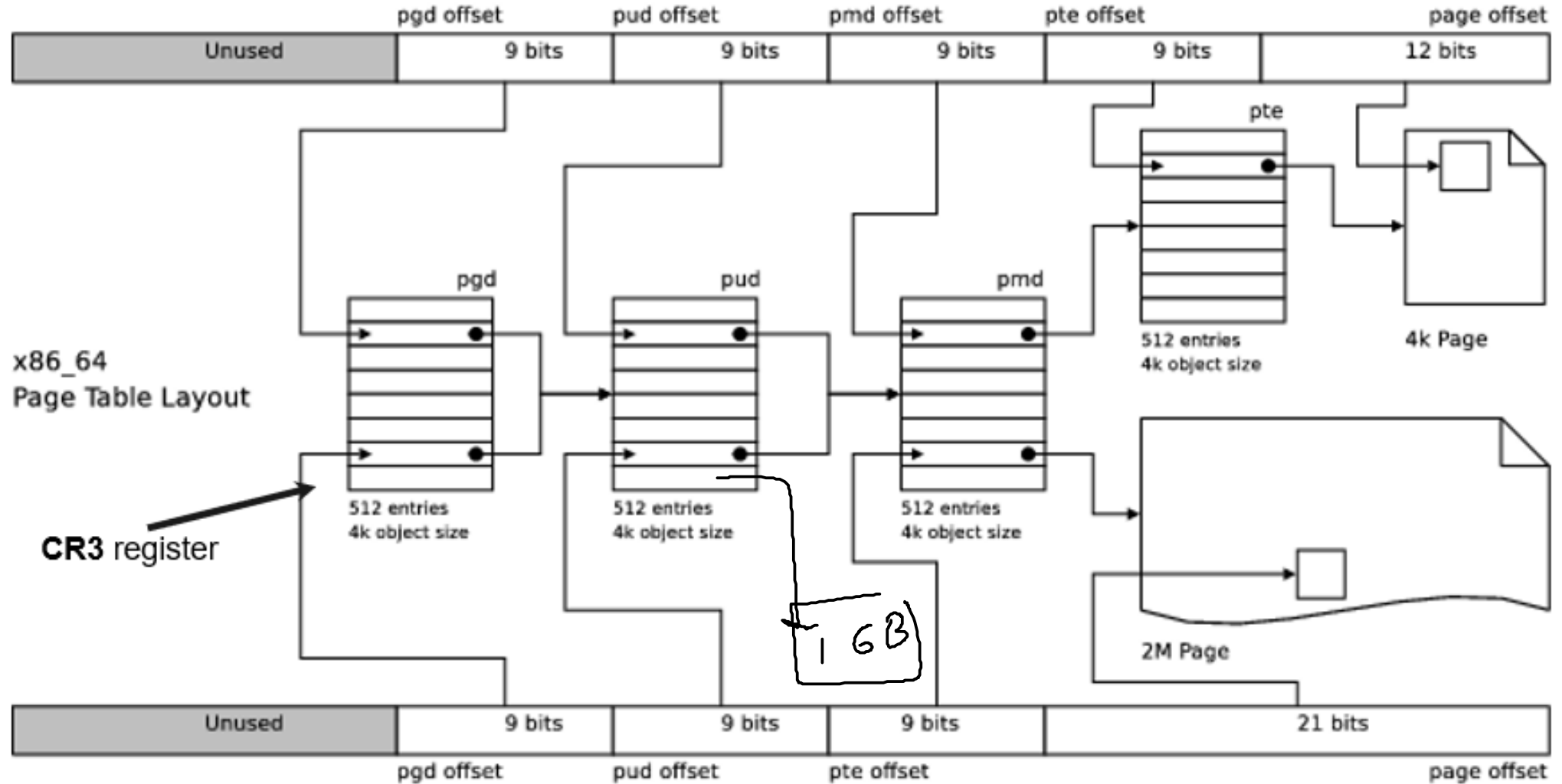
external fragmentation

Two-level page tables
(break p.t. into pages)

ARM Architecture



Four-Level Page Tables (x86-64)

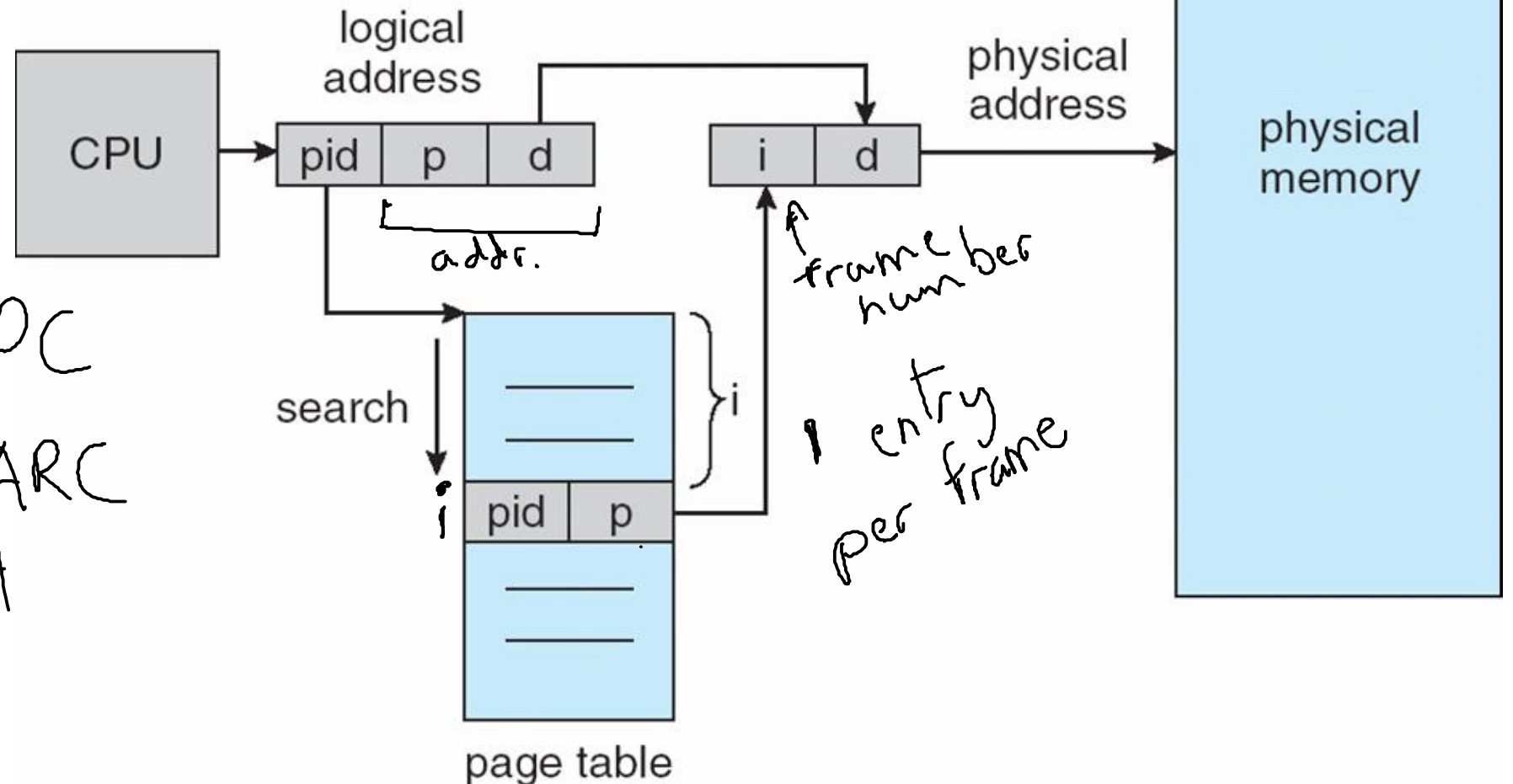


PGD: Page Global Directory, **PUD:** Page Upper Directory **PMD:** Page Mid-level Directory, **PTE:** page table entry

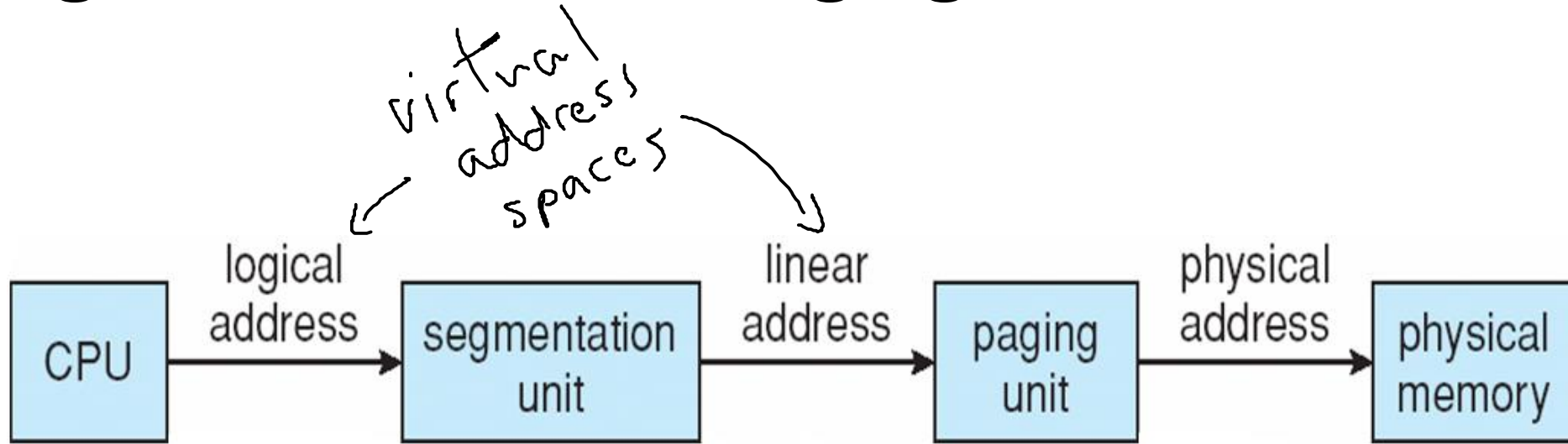
Inverted Page Tables

1 page table for all processes

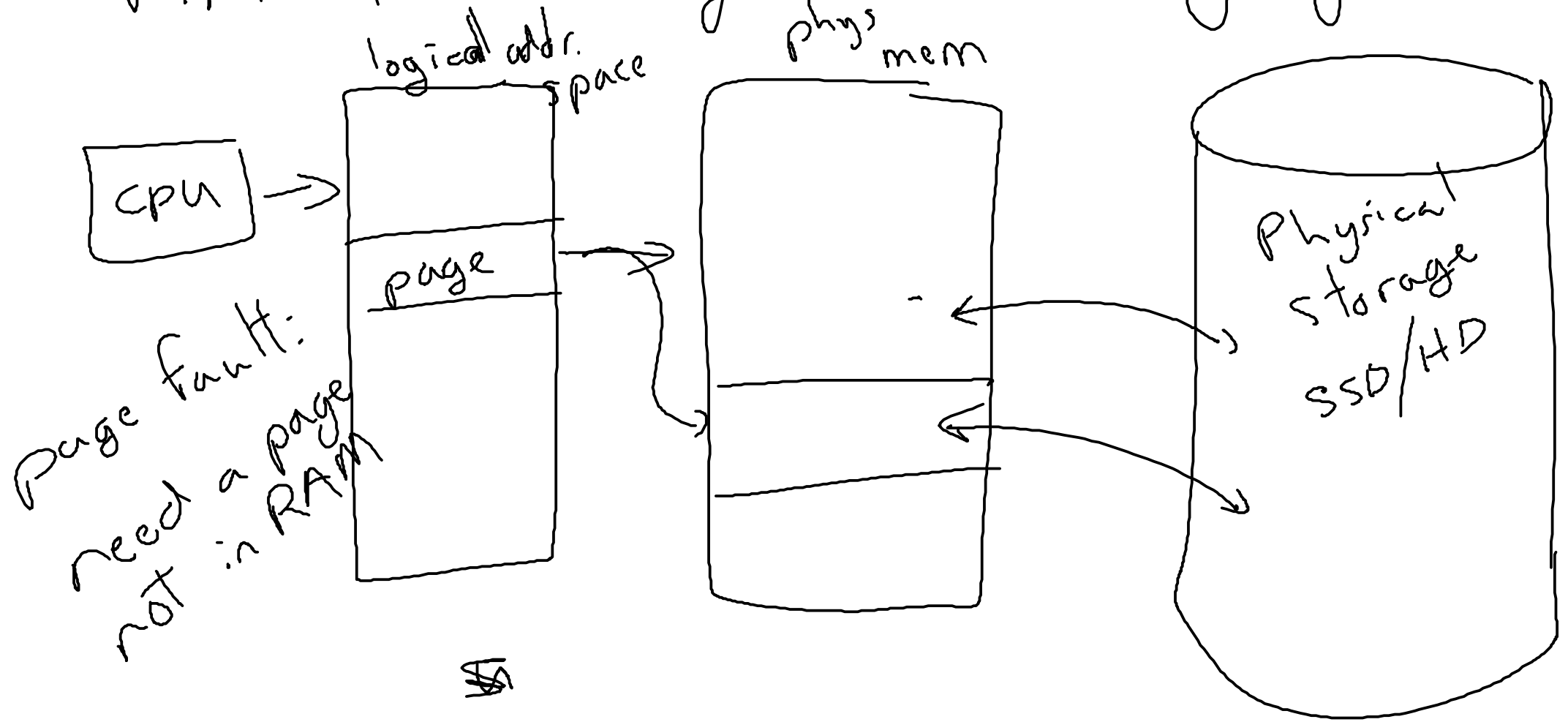
PowerPC
UltraSPARC
IA-64



Segmentation with Paging



Virtual Memory / Demand Paging / swapping



Windows: c:\pagefile.sys , swapfile.sys

Mac: /private/var/vm/swapfile*

Linux /swapfile

Demand Paging: no pages in memory

- victim selection
- write back? modified bit

Page reference string (page #'s)

2 3 5 3 2 1 3 5 2 7 0 2 4 6 2 3 1 5

frames		FIFO		
0		2	7	6
1		~~3~~	~~0~~	3
2		5	2	1
3		4	5	

12 page faults

Optimal

0	~~2~~	5			
1	3				
2	~~5~~	~~7~~	~~0~~	~~4~~	6
3	1				

page faults: 9

Thrashing

LRU: least recently used

0	2				
1	~~3~~	~~0~~	3		
2	~~5~~	4	1		
3	~~7~~	~~6~~	5		

page faults 11