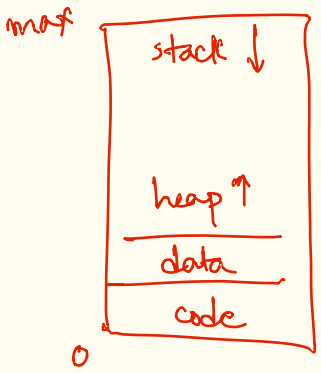
Lecture 14 CS 347/333 5.9.2022

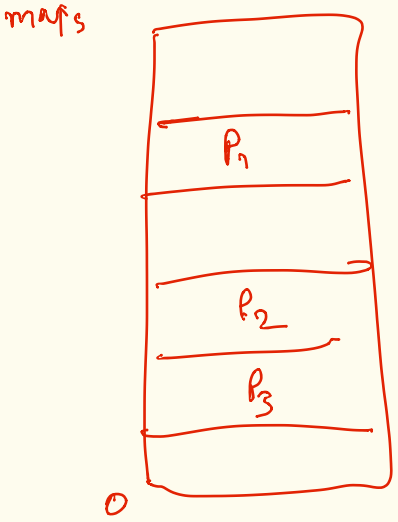
⊛ memory virtualization (& memory management).

process view



(logical view of memory region)

system/OS view

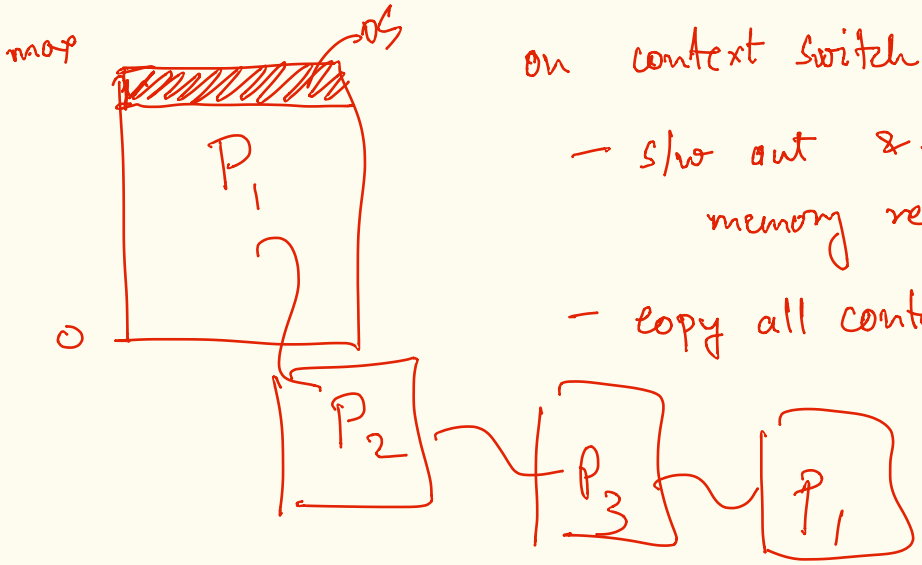


⊛ design -1 : similar to LDE model — intercept every access & map to physical/real address.

CPU >> mem. bus speed >> OS processing (slow)

design 0 : similar to the context switch mech.

process view ⟺ OS view



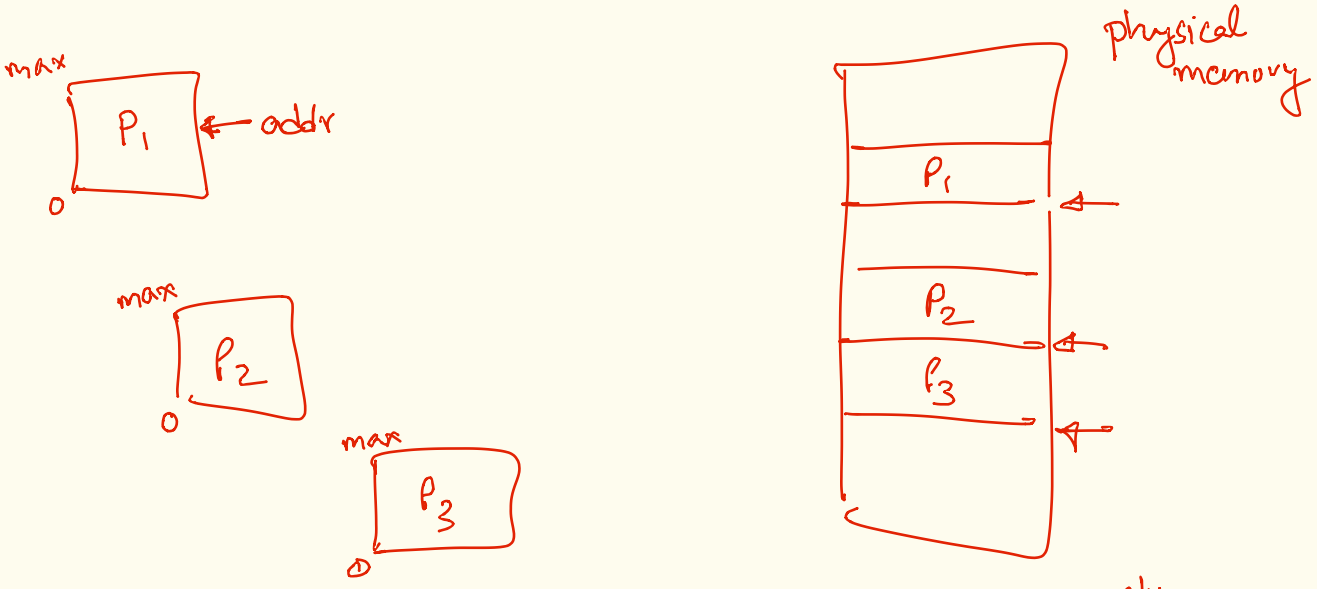
on context switch

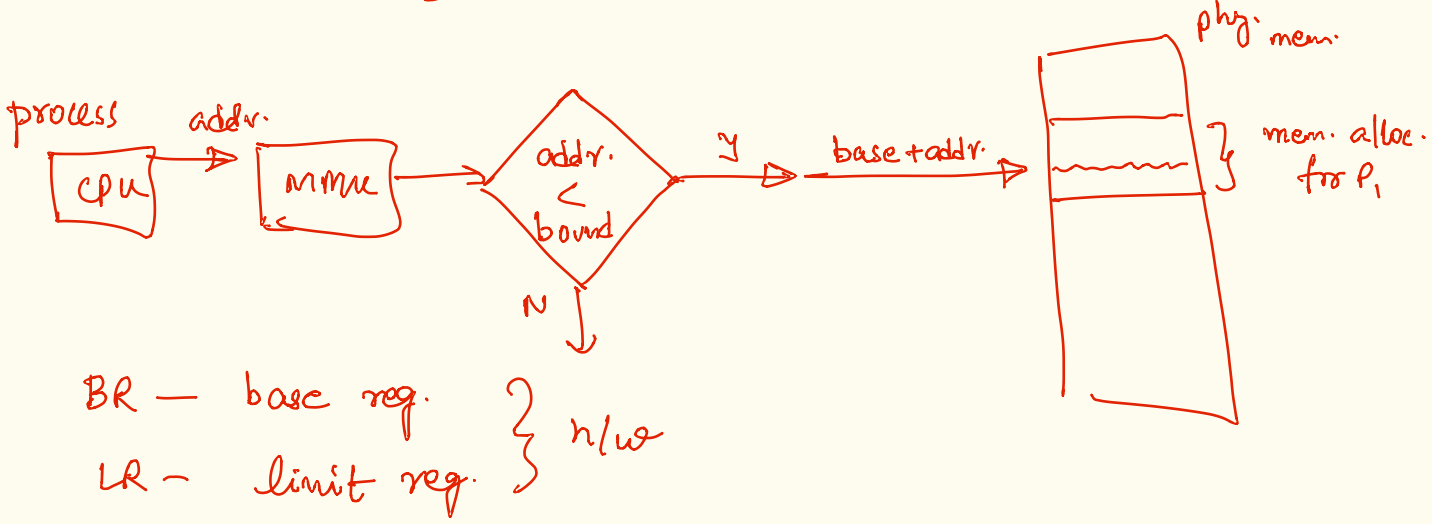
- s/w out & s/w in memory region.
- copy all contents to disk in & out.

+ves : isolation, sharing

-ves : latency too high, needs non-trivial secondary resource
memory utilization can be very low.

⊛ design : base & bound register based mem. virt.





BR — base reg.
LR — limit reg.
} h/w

⊛ assumptions :

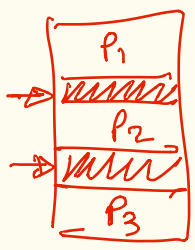
① all allocation are contiguous.

② size of process mem. is less than physical / system memory.

* ③ size of processes can be / cannot be (need not. same.)

-ve ~ internal fragmentation — memory allocated but unused.

~ external fragmentation —
cumulative memory enough for allocation but not contiguous.



design 2: segmentation

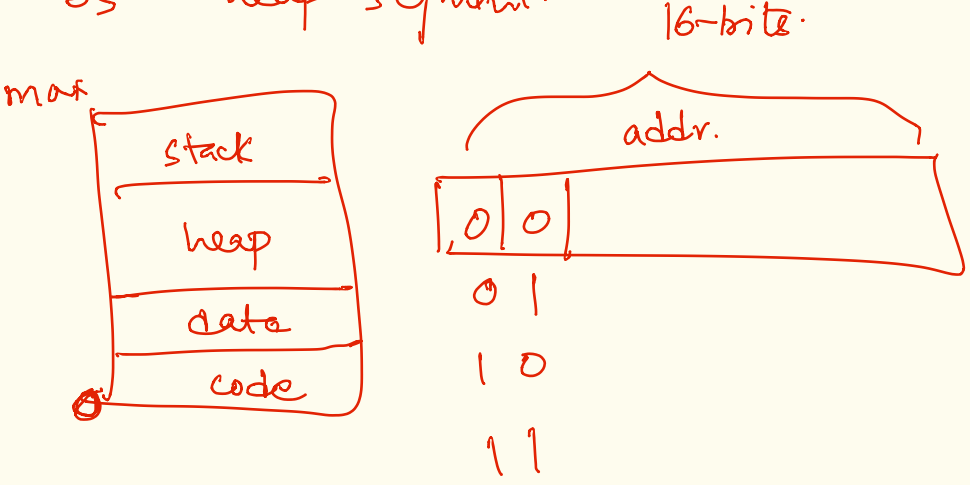
design 3: paging

CS: code segment

DS: data segment

SS: stack segment

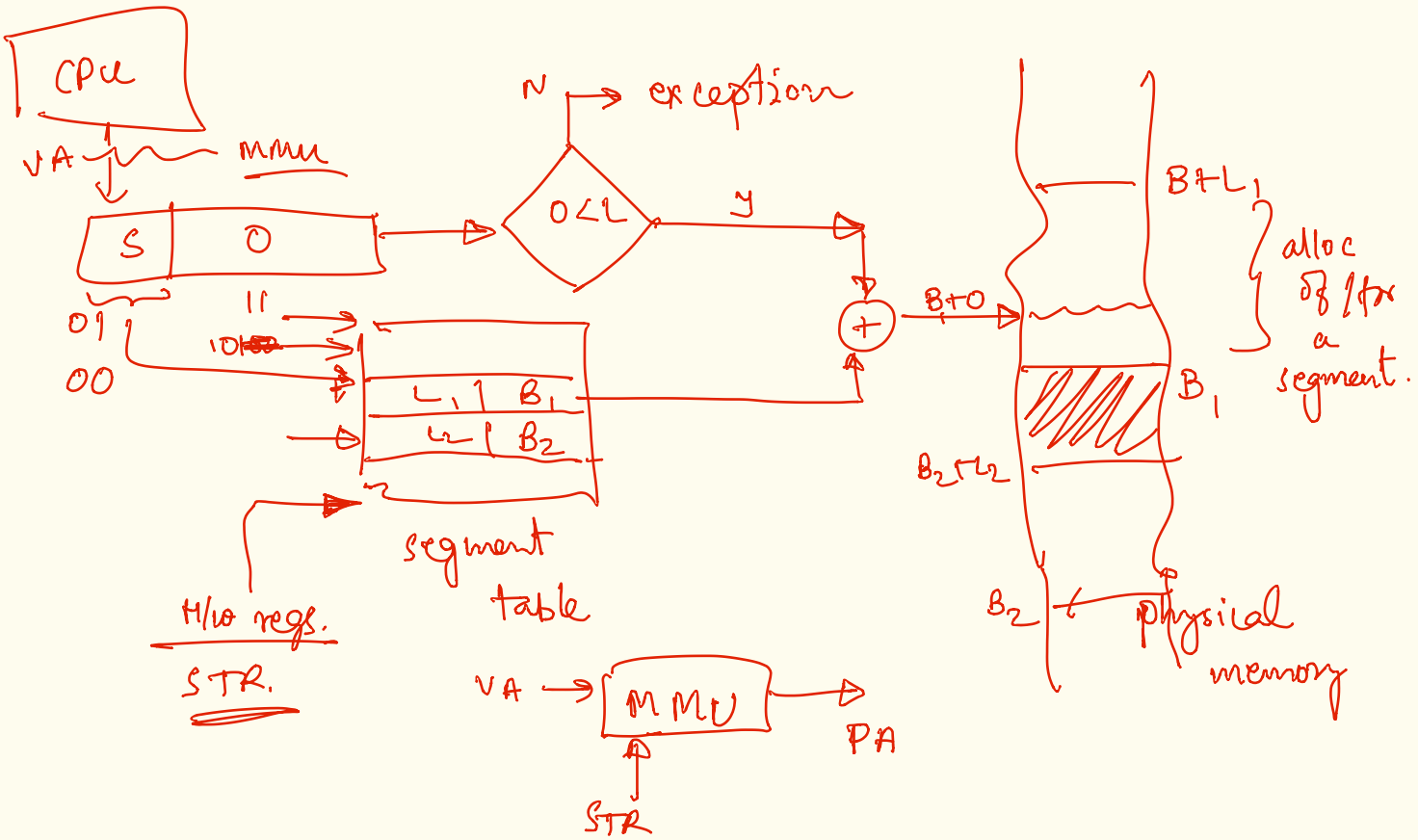
ES: heap segment

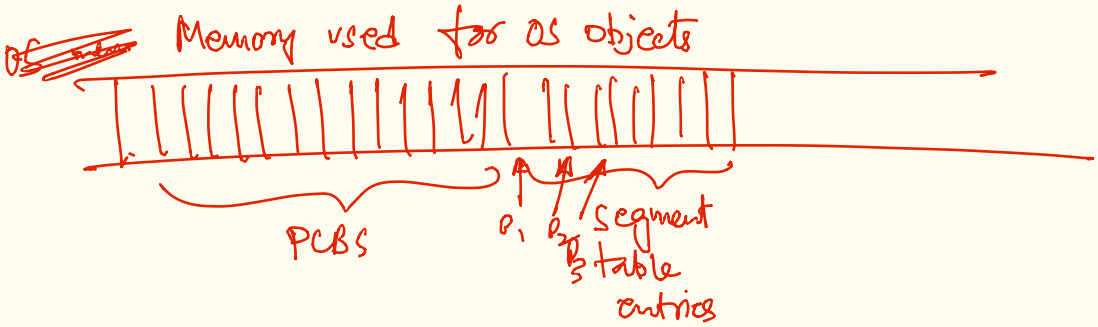


2 bits: segment id

14 bits: segment size

2^{14} ~ addresses per segment (max).



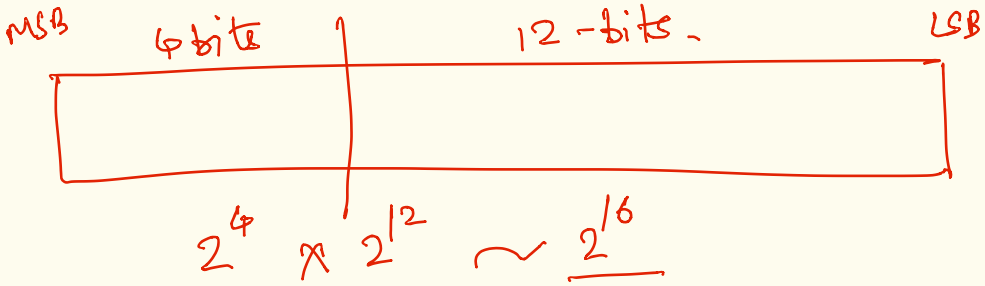


design 3 : paging. (VA → PA)

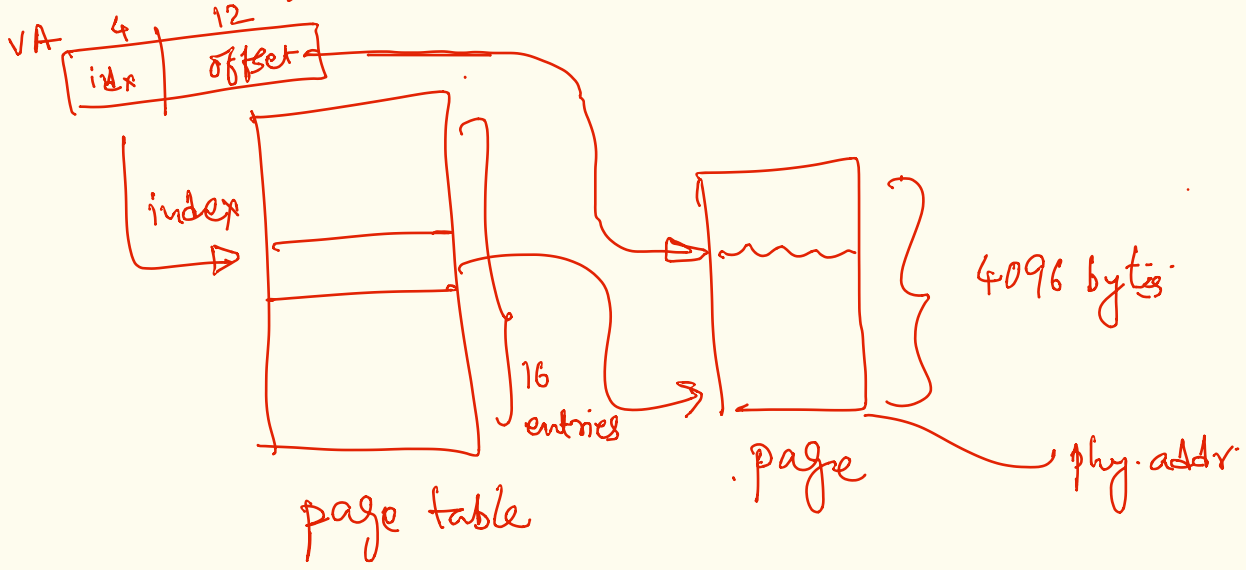
- -ves of segmentation.
  - segments can be large ⇒ internal fragmentation.
  - segment table overhead ∝ #segments & #processes.

unit of allocation is of fixed size (page) e.g. 4KB or 1KB
⇒ deterministic / bounded internal fragmentation
⇒ ~~unlimited~~ no external fragmentation.

e.g. 16-bit address & 4KB pages (4096 bytes)



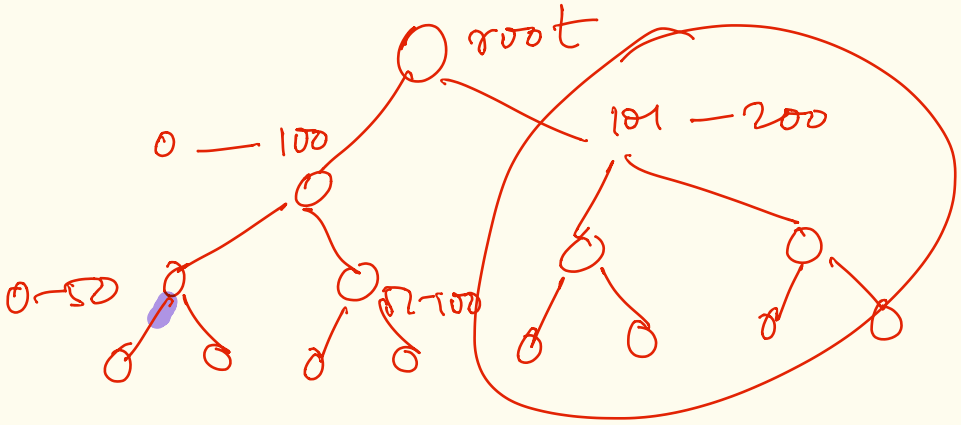
(i) single-level / linear page table



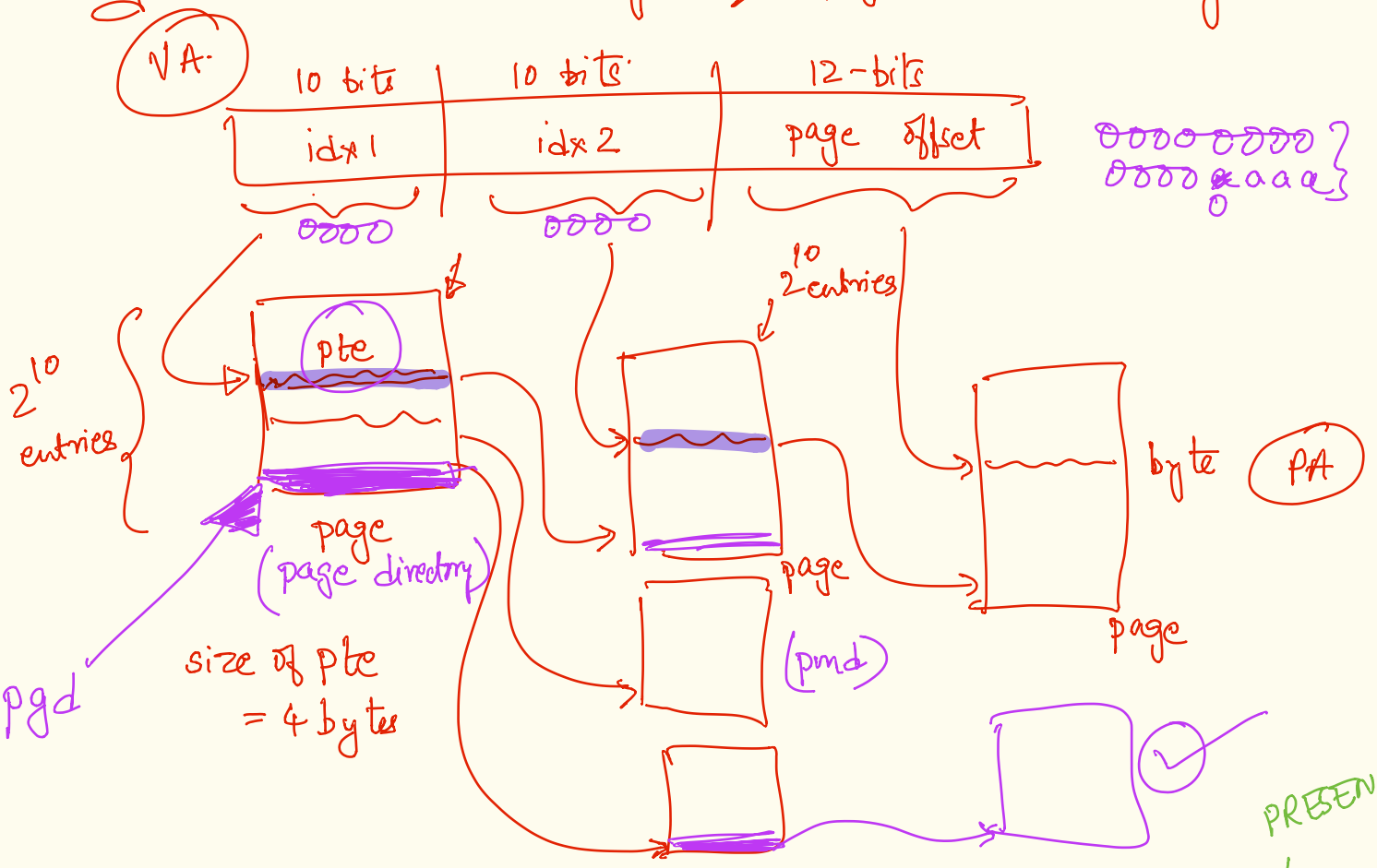
hierarchical / multi-level paging

~ do not use memory to store metadata (page table info) if virtual addr. to phy. addr. mapping not required/ used..

~



* e.g: 32-bit address range / page size: 4096 bytes



$2^{10} \times 2^{10} \times 2^{12} = 2^{32}$