

$LAS = 1MB$ ~~PA~~ Page offset = 10 bits # frames = 256 $PTS = ?$

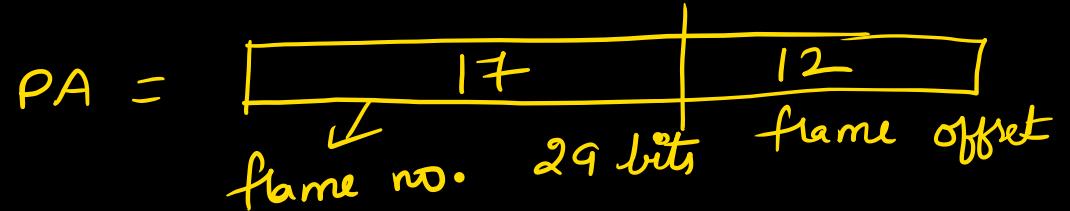


$PTS = \text{no of Pages} * \underline{\text{frame no size}}$.

$$= 2^{10} * 8 \text{ bits}$$

$$= 1KB.$$

$$PAS = \underline{\underline{512 \text{ MB}}} \quad \text{Page size} = 2^{12} \text{ B} \quad \# \text{ pages} = \underline{\underline{256}} \quad PTS = ?$$



$$\begin{aligned} PTS &= \text{no of Pages} * \text{frame no} \\ &= 256 * 17 \cdot \text{bits} \cdot \end{aligned}$$

$$2^8 \times 17 \text{ bits}$$

Page size = $2^{12} B$, # pages = 2^{10} # frames = 2^9 PTS = ?

LAS = ? PAS = ?

$$PTS = \underline{2^{10} * 9}$$

$$\begin{aligned} LAS &= \# \text{pages} * \text{page size} \\ &= 2^{10} * 2^{12} B = 2^{22} B = 4 \text{ MB} \end{aligned}$$

$$\begin{aligned} PAS &= \# \text{frames} * \text{frame size} \\ &= 2^9 * 2^{12} B = 2^{21} B = 2 \text{ MB} \end{aligned}$$

Page size = $2^{14} B$, # pages = 2^8 . PTS = $256 B$ LAS=? PAS=?

$$PTS = \# \text{pages} * (\text{bits for frame no})$$

$$256 B = 2^8 * (\text{bits "})$$

$$\text{bits frame no} = 8 \text{ bits. } \therefore \# \text{frames} = 256.$$

$$\begin{aligned}PAS &= \# \text{frames} * \text{frame size} \\&= 256 * 2^{14} B = 2^{22} B.\end{aligned}$$

$$\begin{aligned}\cancel{PAS LAS} &= \# \text{pages} * \text{page size} \\&= 2^8 * 2^{14} B = 2^{22} B.\end{aligned}$$

Page table

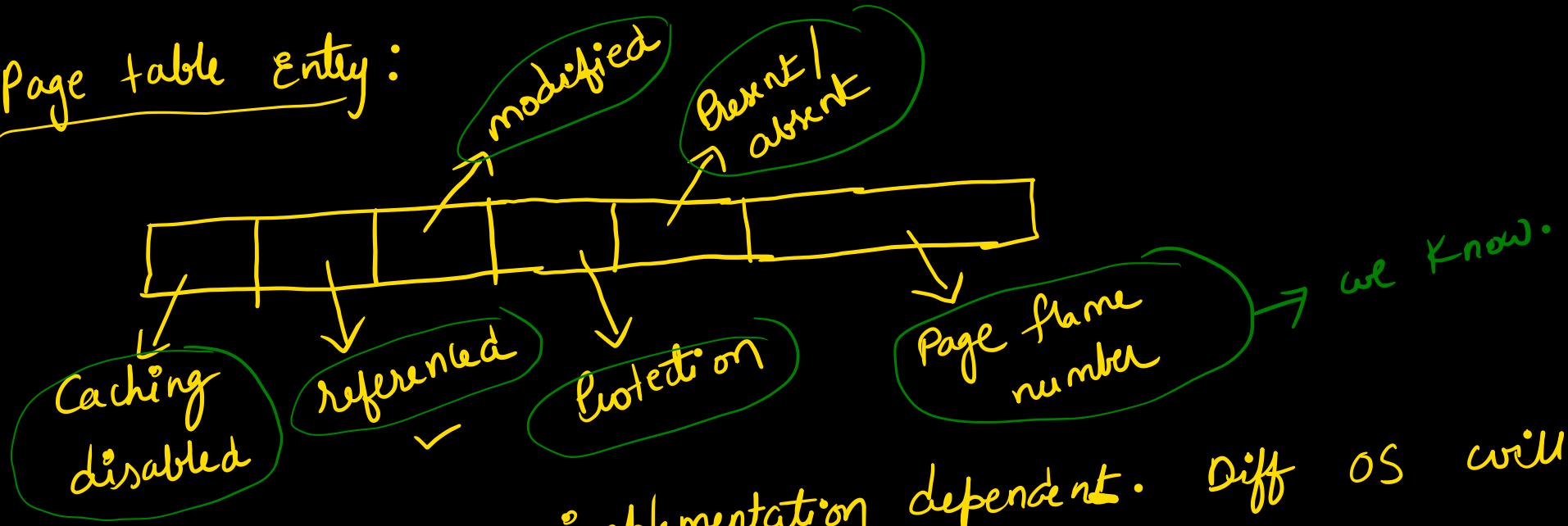
frame number				

Some extra useful information
will be present.

∴ Size of PTE is greater than
frame number at practice.

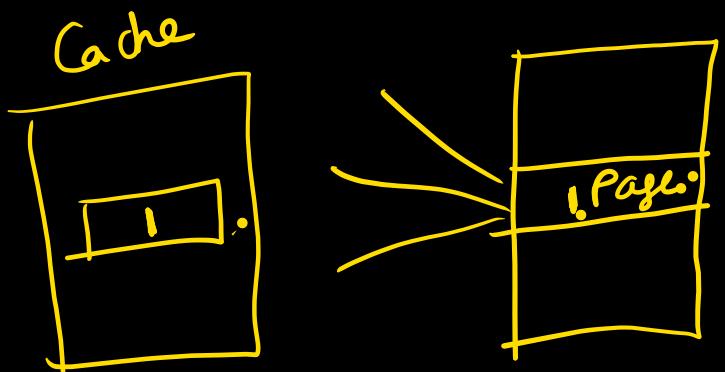
In exam, if nothing is given,
then PTE = frame no bits.

Page table entry :

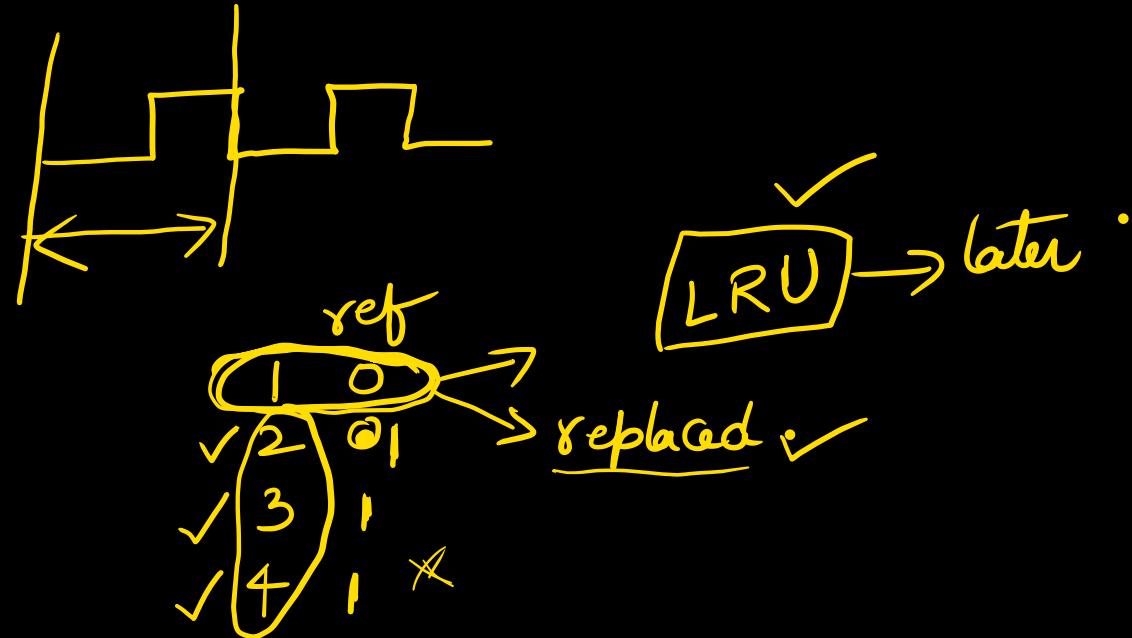


The fields are implementation dependent. Diff OS will have different fields but these are the most popular.

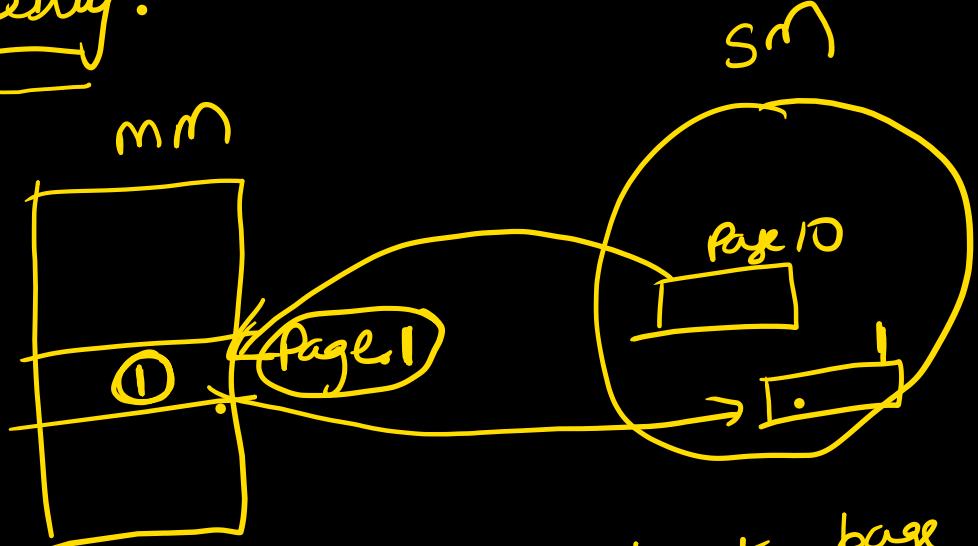
Caching disabled: This page set should not be kept in Cache. This is for consistency.



Referenced: whether the page is used in last clock cycle or not.



modified / Dirty:



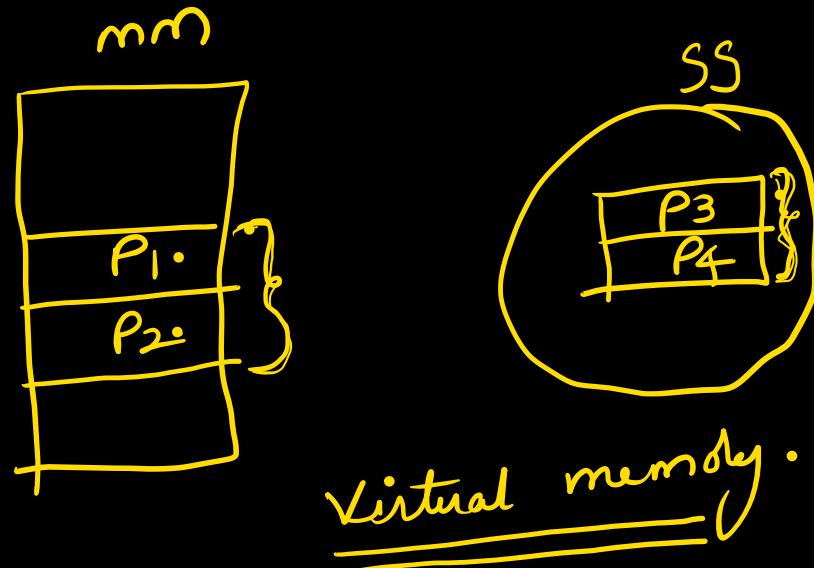
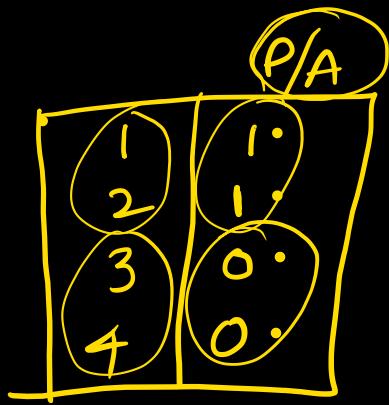
Should I write back page 1?
That depends on whether Page 1 is modified & not.

if modified \rightarrow write back
otherwise \rightarrow no write back.

Protection: Code \rightarrow R_X
data \rightarrow R^W
stack \rightarrow R^W

} protection bits .

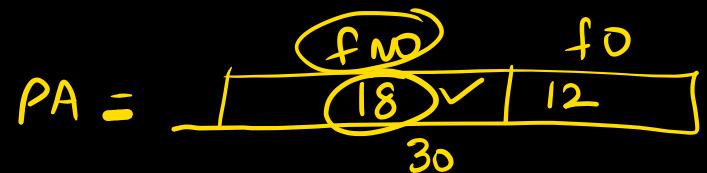
Present / absent :



Ques 04:

In a virtual memory system, size of virtual add is 32 bits, size of PA is 30 bits, page size is 4KB, and size of each page table entry is 32 bits. The main memory is byte addressable. Which of the following is maximum no of bits that can be used for protection and other info in each page table entry

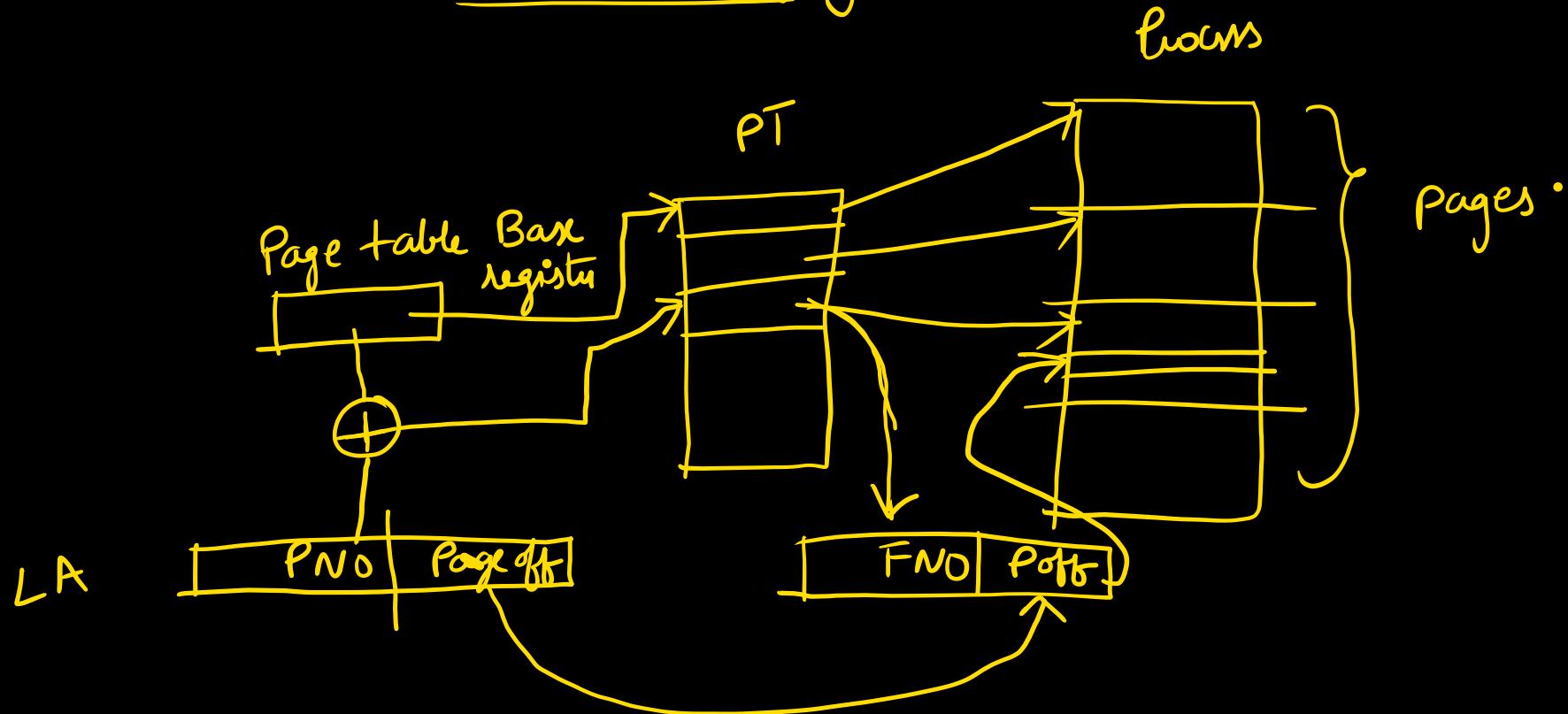
- a) 2
- b) 10
- c) 12
- d) 14

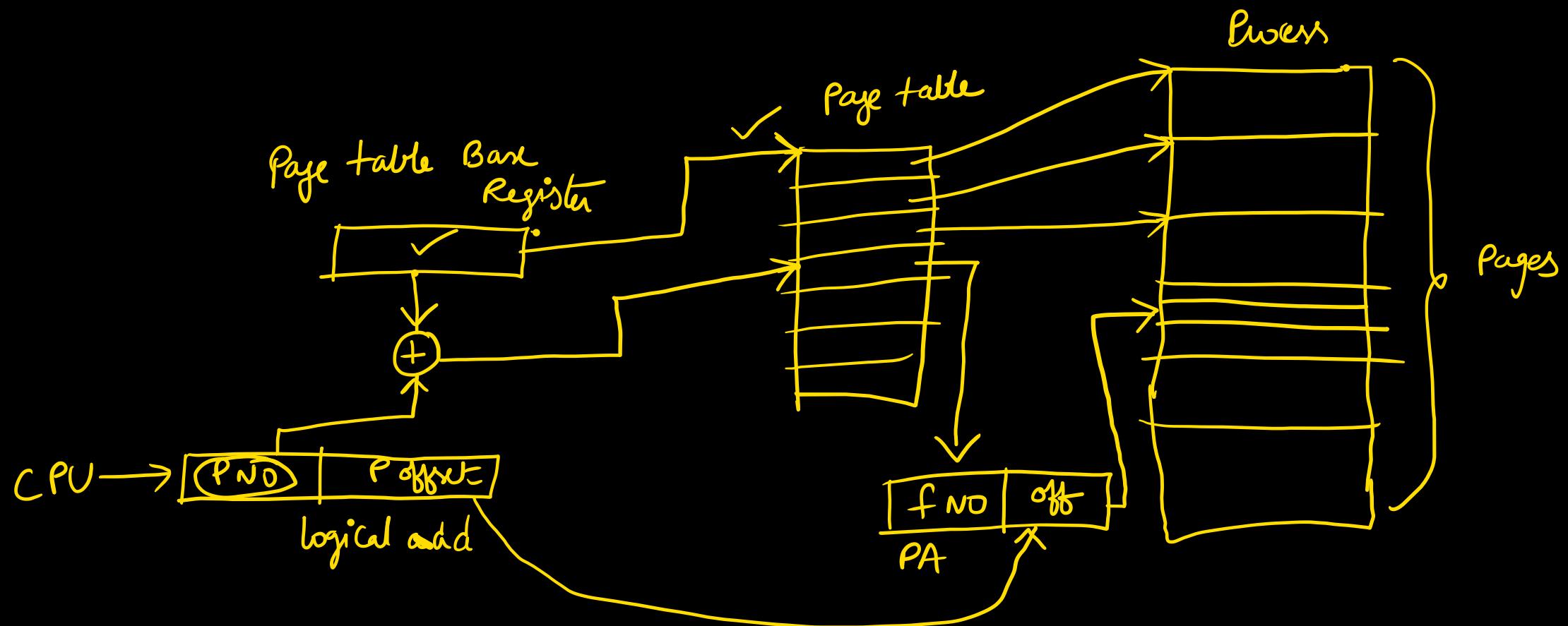


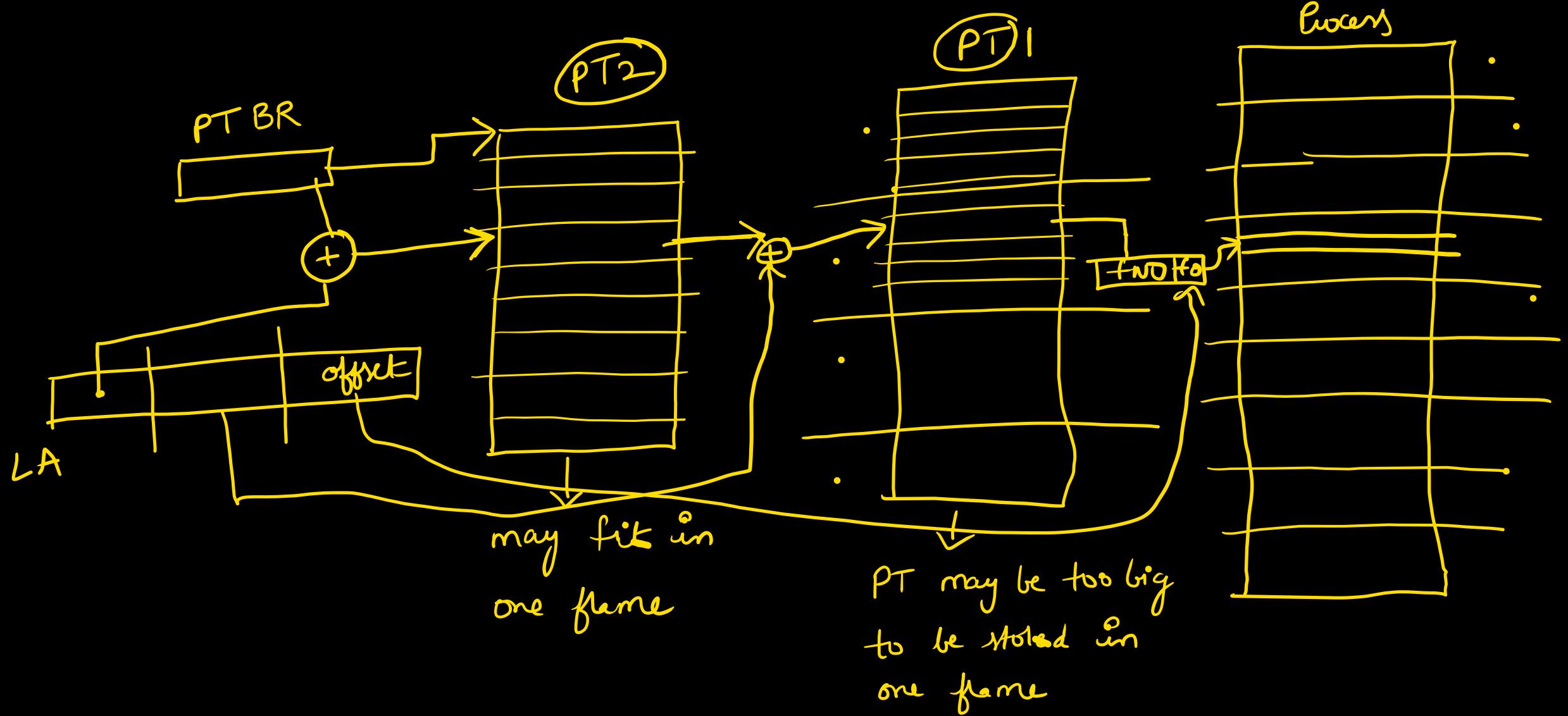
$$\text{PTE} = \text{32 bits}$$

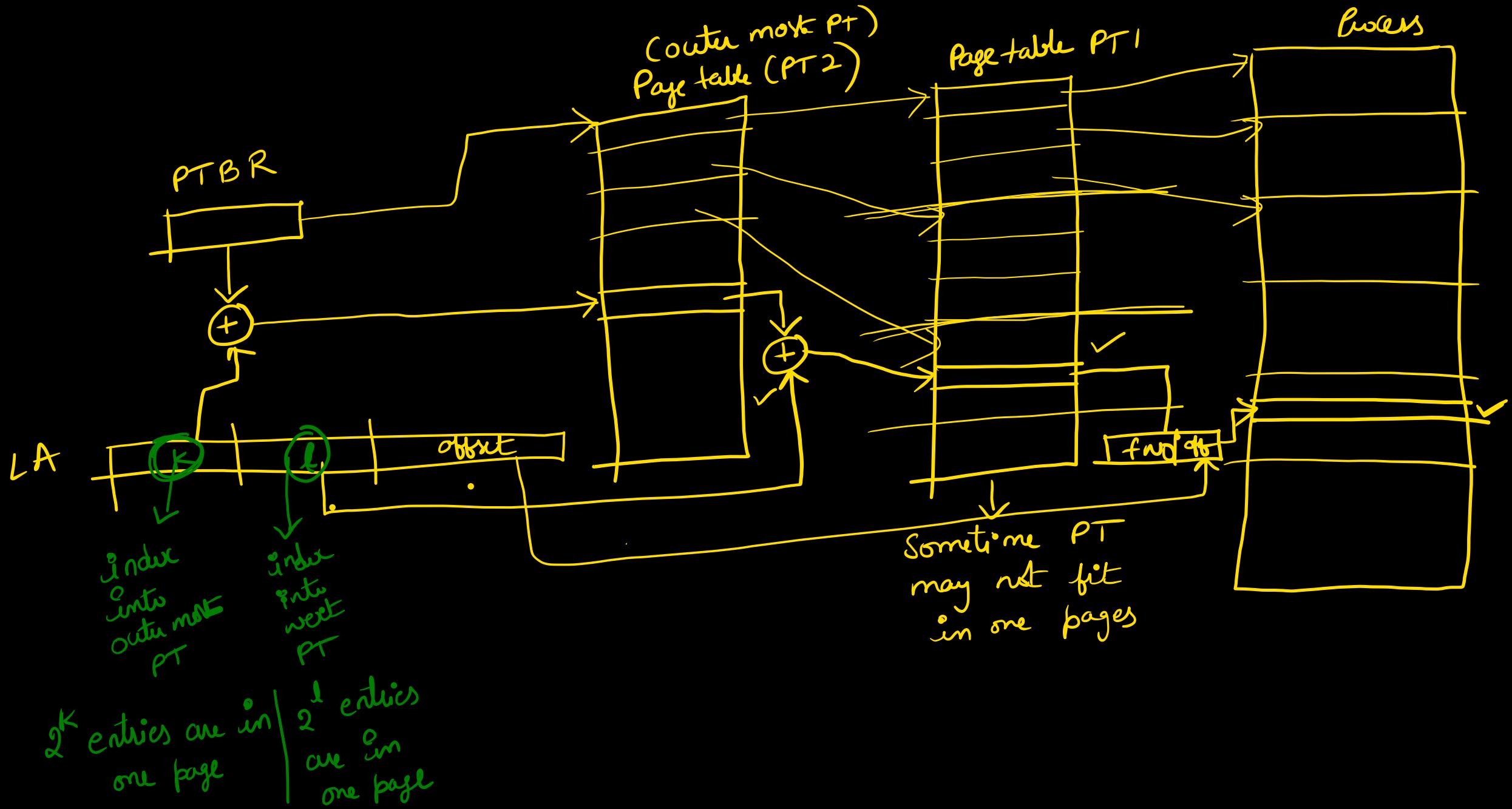
$$\begin{aligned}\text{extra} &= 32 - 18 \\ &= 14 \text{ bits}\end{aligned}$$

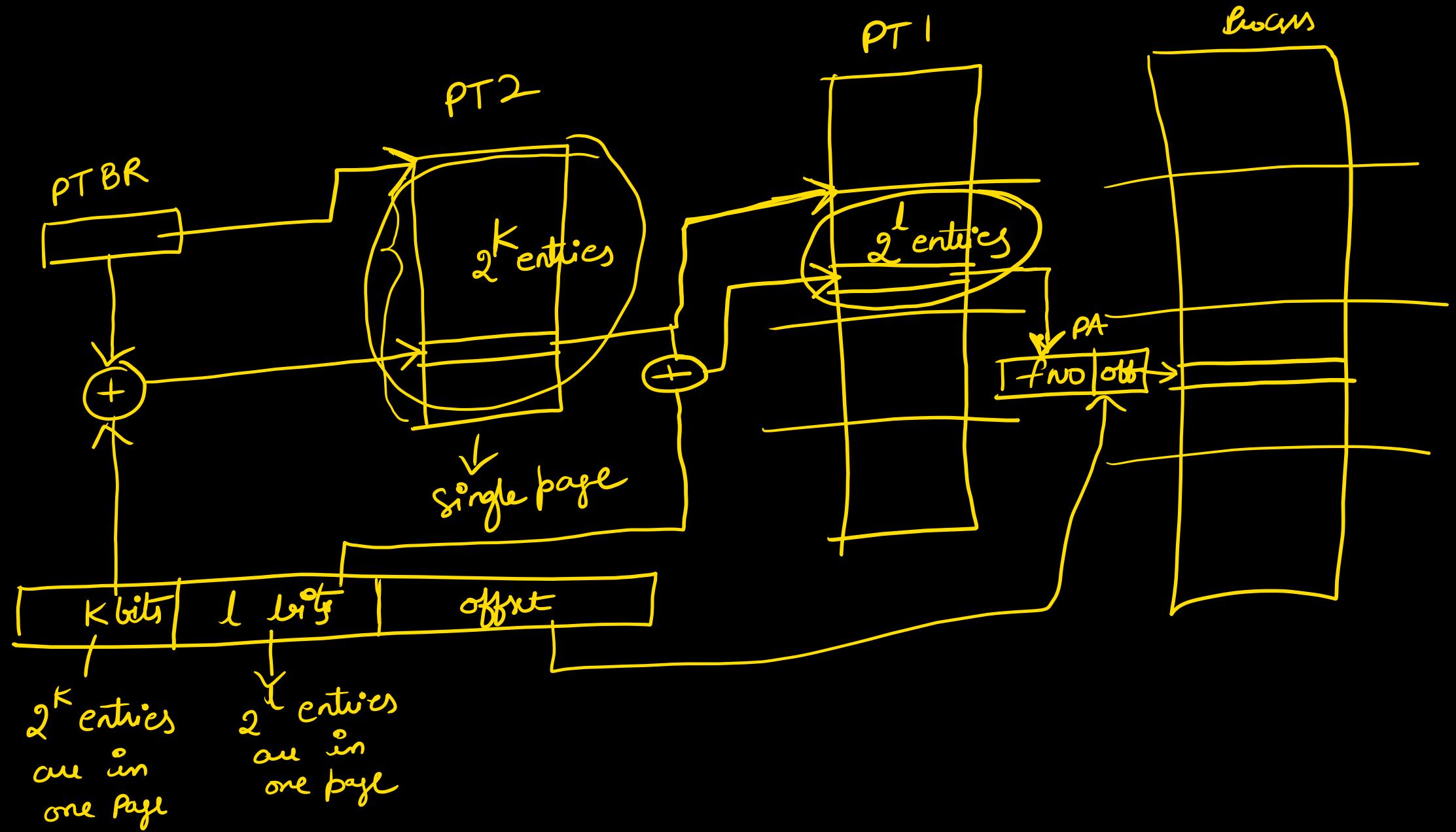
Multi-level paging:

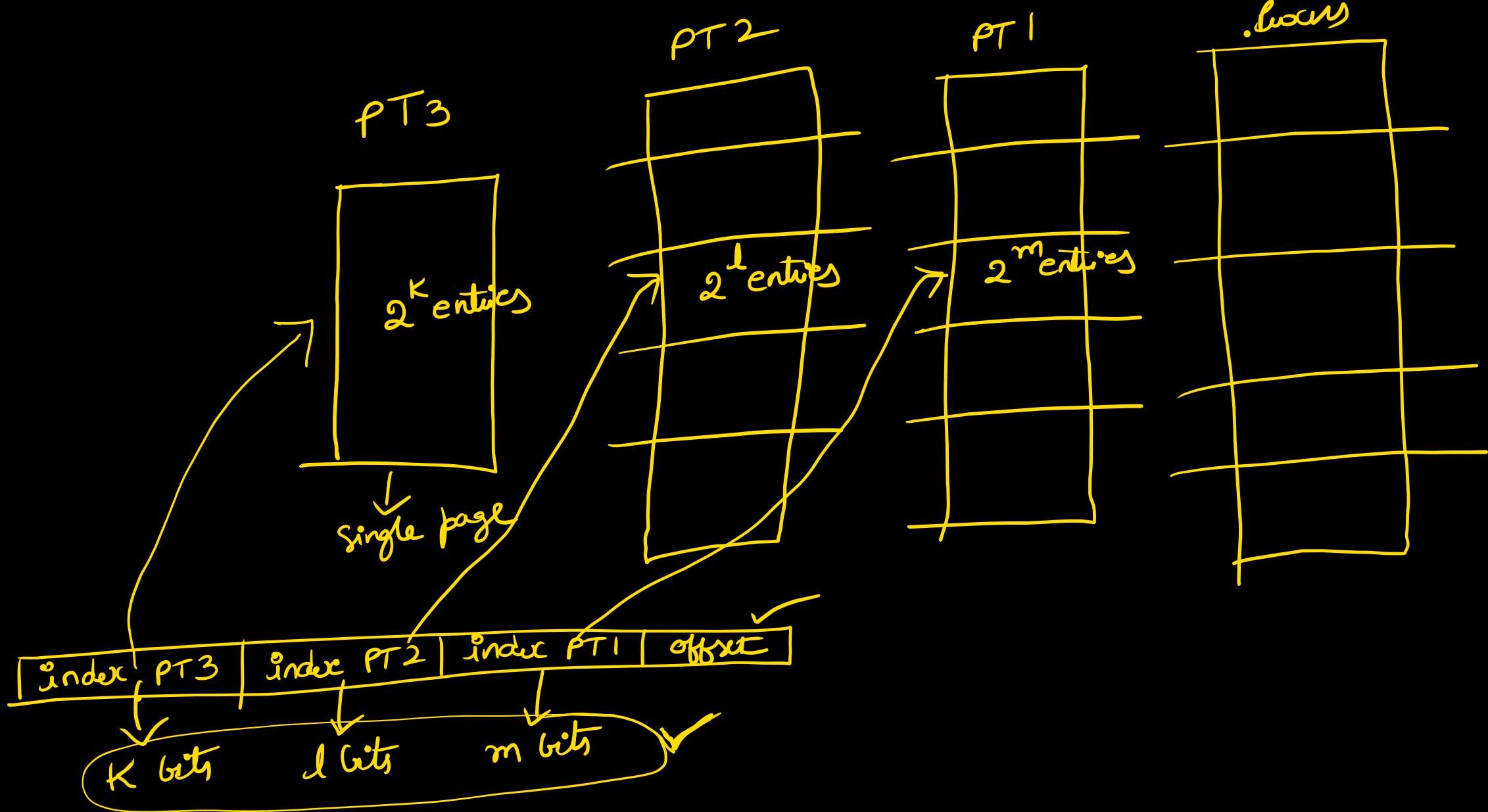








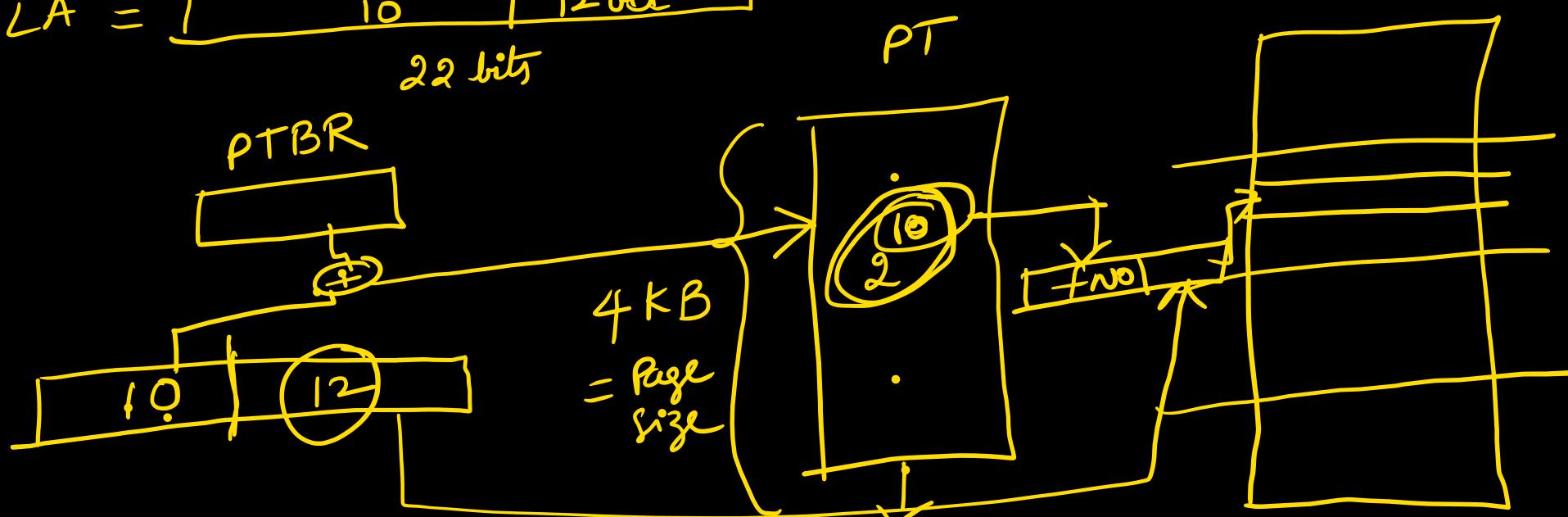
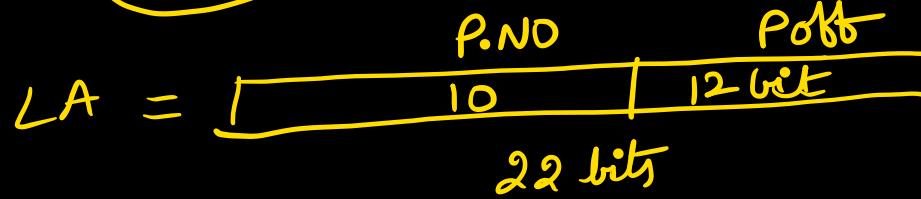




LA = 22 bits

Page size = 4 KB ✓ PTE = 4B

PTS = # pages * frame no bits = $2^{10} \times 4B = 4KB$ ✓



$$LAS = 2^{32} B$$

$$PAS = 2^{44} B$$

$$PS = 4 KB$$

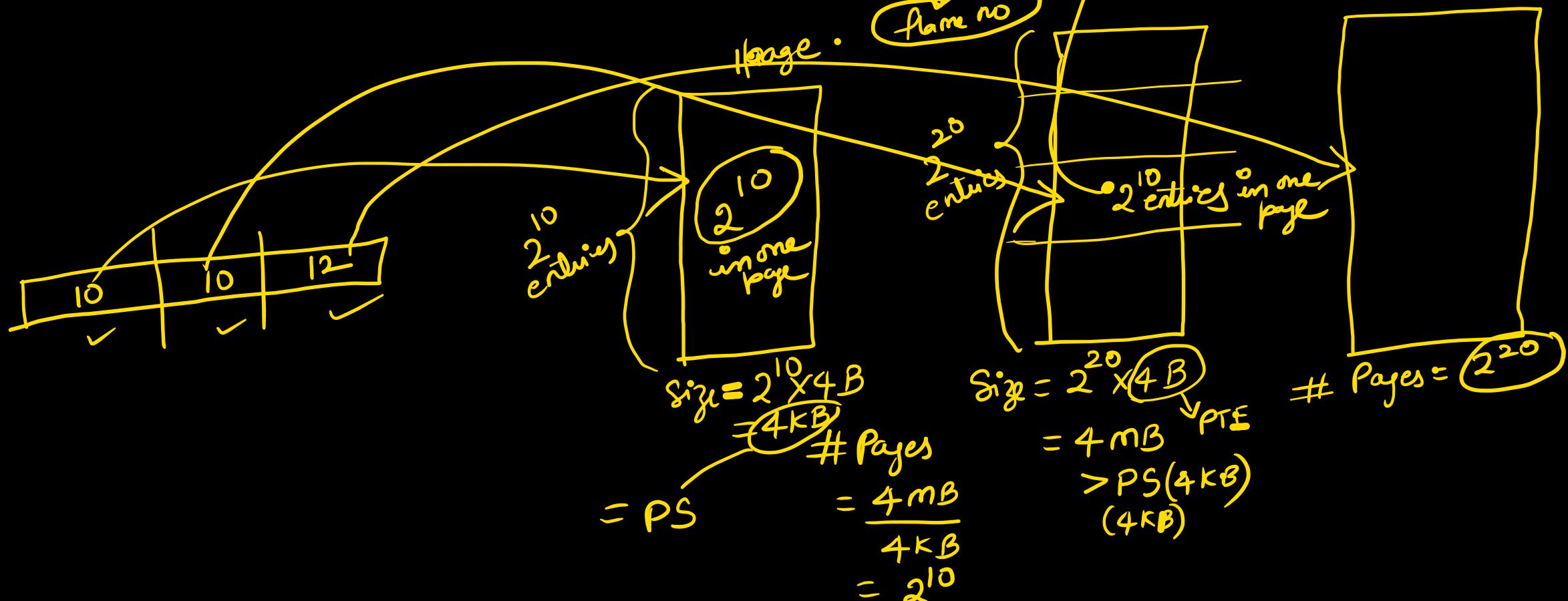


$$PTS = 2^{20} \times 32B = 4 MB$$



$$\frac{\text{entries in one page}}{\text{Page size}} = \frac{2^{12} B}{4 B} = 2^{10}$$

processes = $2^{32} B$

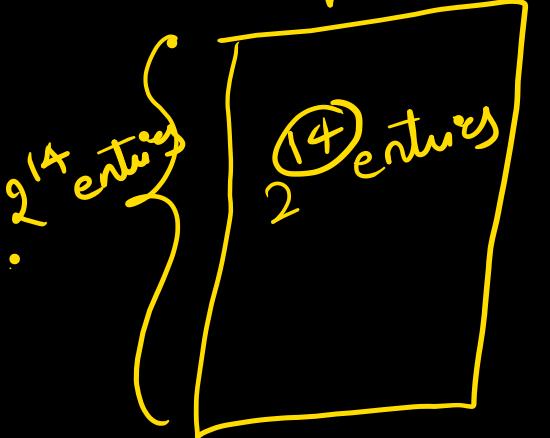


VA = 72 bits

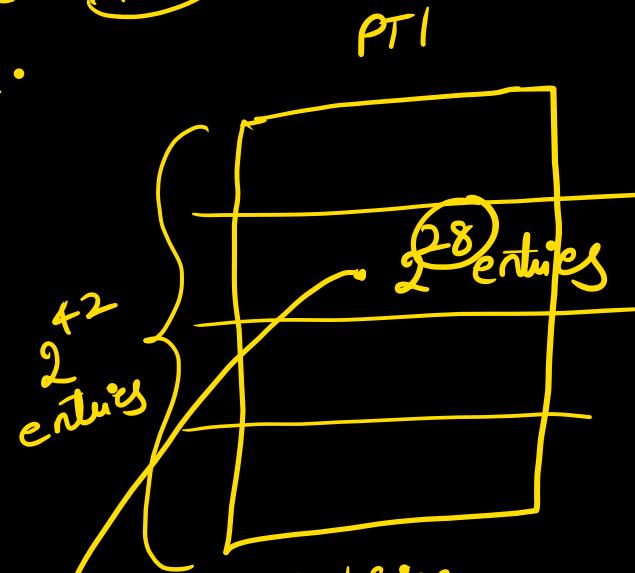
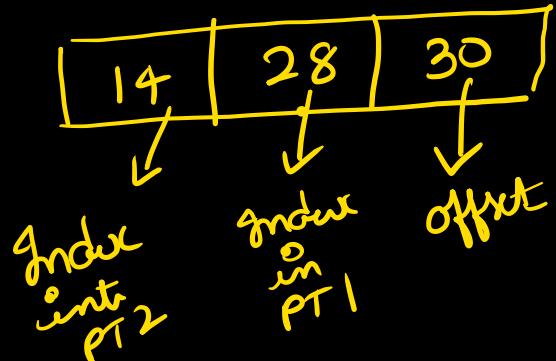
Page size = 1 GB

PTE = 4 B

PT2 → 1 page.



$$\begin{aligned} \text{size PT2} &= 2^{14} * 2^2 \\ &= 2^{16} B \\ &< PS \end{aligned}$$

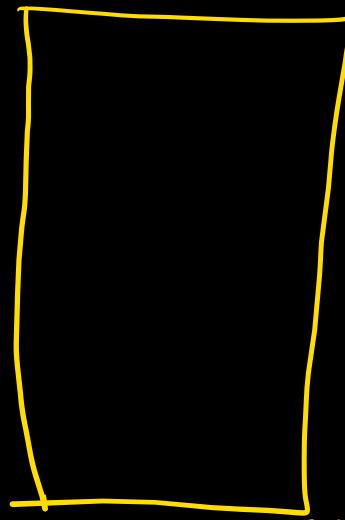


$$\begin{aligned} \text{PT1 size} &= 2^{12} * 4 B \\ &= 2^{14} B > PS \end{aligned}$$

$$\# \text{Pages} = \frac{2^{14}}{2^{30}} = 2^{-16}$$

$$\text{entries} = \frac{\cancel{16B} PS}{PTE} = \frac{2^{30}}{2^2} = 2^{28}$$

Pages = 2^{72} B



$$\# \text{Pages} = \frac{2^{72}}{2^{30}} = 2^{42}$$