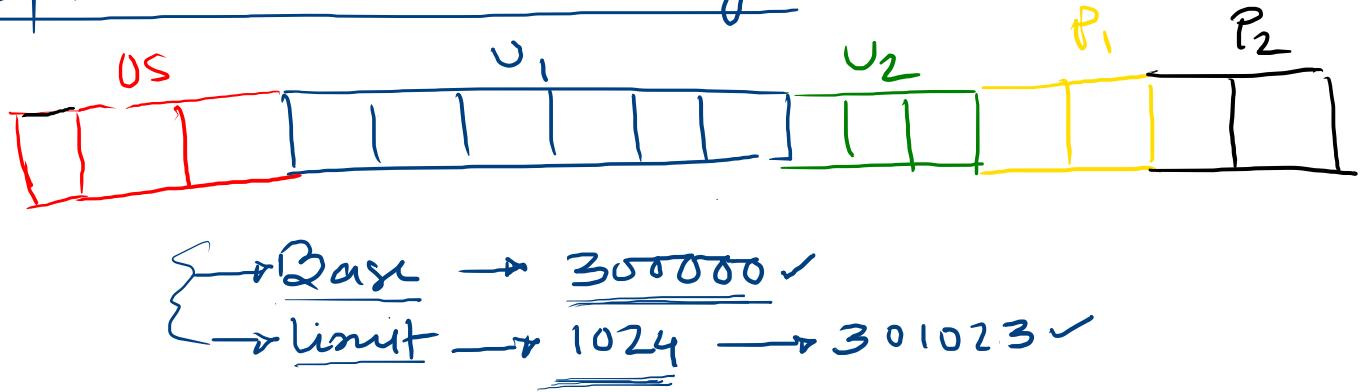


## Chapter 8 Main Memory

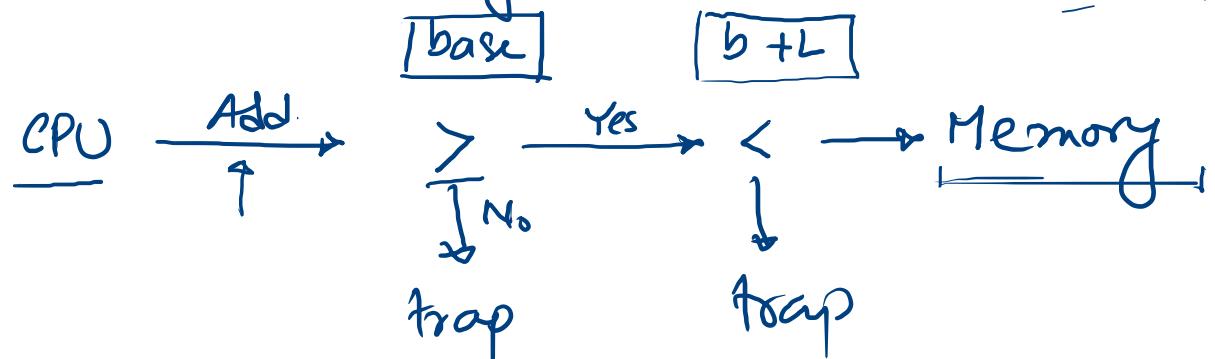
### ① Basic H/W



### ② Clock cycle.

{ Decode instructions }  
 { Simple operations. }  $\xrightarrow[Clock]{1 \text{ or more per}} \rightarrow$  Registers contents.

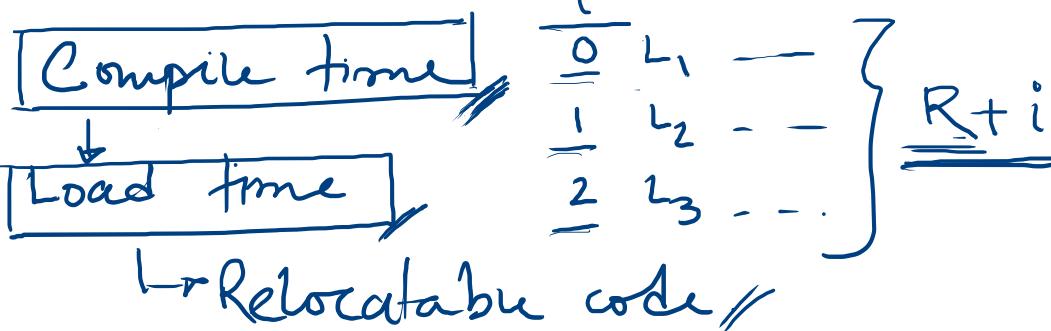
### ③ Cache Memory $\rightarrow$ 3 level ( $L_1 \sim L_3$ )



## ① Address binding

- Symbolic Addresses.

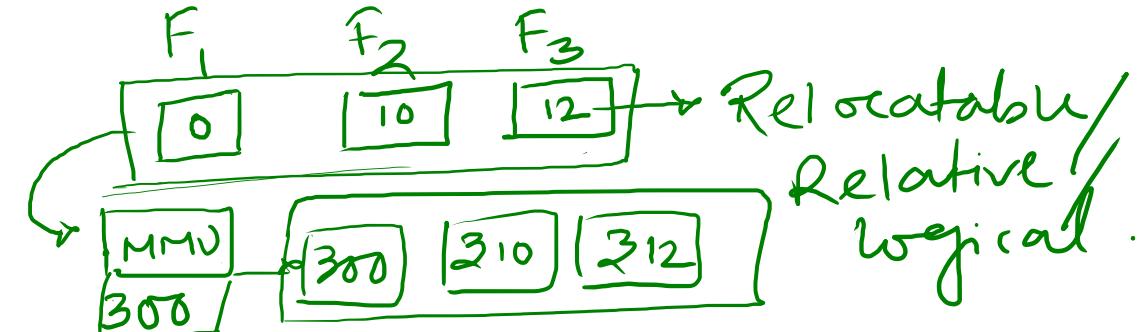
$$0 \rightarrow n-1 \rightarrow \\ 5000 \rightarrow n-1 \rightarrow \left. \right\} \text{Relative}$$



Execution / Run time

\* logical Address Space → CPU

\* Physical Address Space //



Relocation Register

# —

# —

→ exec. time

→ Dy. Loading &  
Dy. Linking }  
Sh. Libraries }

## ⑥ Swapping

CPU → ready queue.

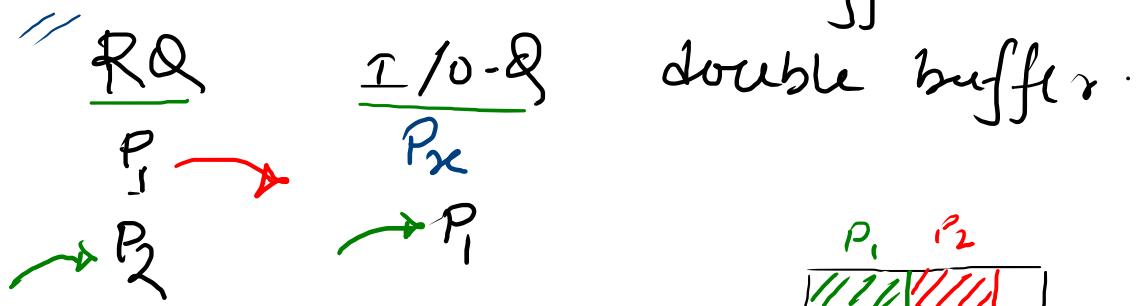
→  $P_1$  → ✓; I/O (Swapped out)

$P_2$  → ✓ (Swapped in)

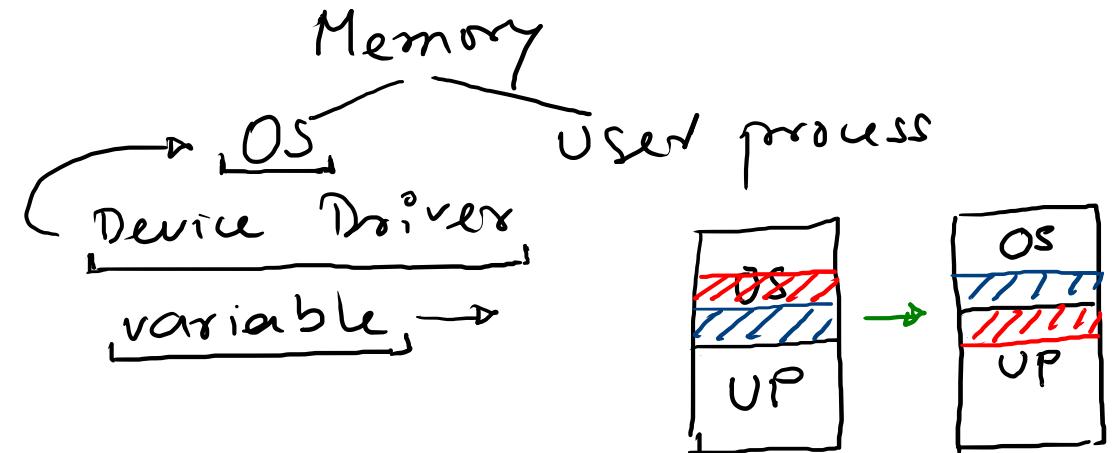
I/O operation → I/O queue

$P_x$ ,  $P_1$

OS-buffer



## ⑦ Contiguous memory allocation



## ⑧ Memory Allocation

- Variable partition scheme
- Available memory → hole

$P_1 \rightarrow 100$  bytes.

$P_2 \rightarrow 200$  bytes

$P_3 \rightarrow 150$  bytes.

500 byte

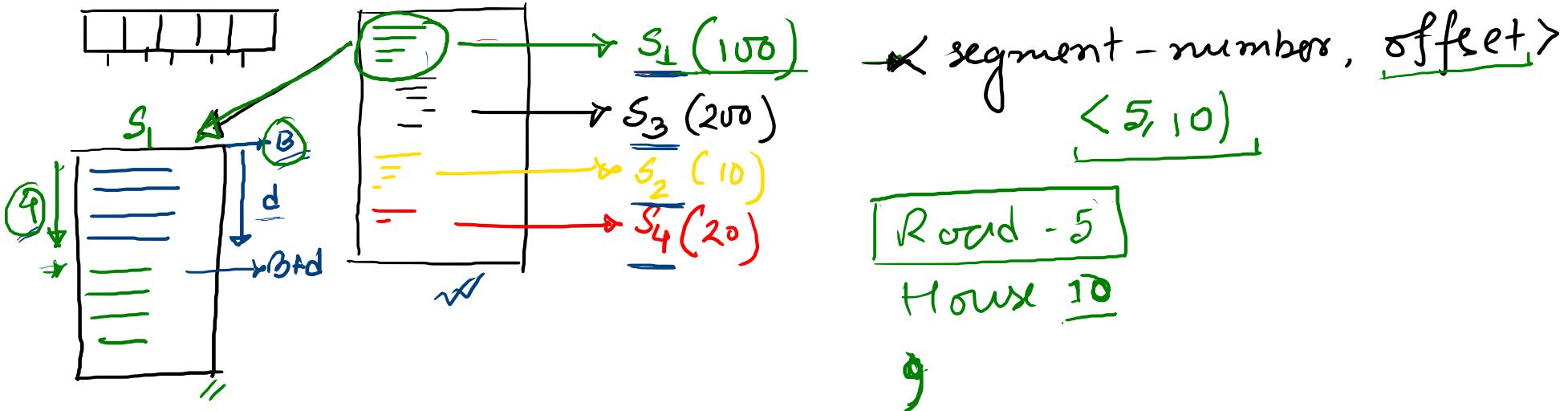
✓ 100 bytes →  $P_1$

300

✓ 200 bytes →  $P_2$

100 bytes

- ① First-fit
  - ② Best-fit    200 100 120 105 → 102
  - ③ Worst-fit
  - ④ External fragmentation.
  - ⑤ Internal fragmentation.
- 
- $P_2 \rightarrow 17 \text{ bytes.}$

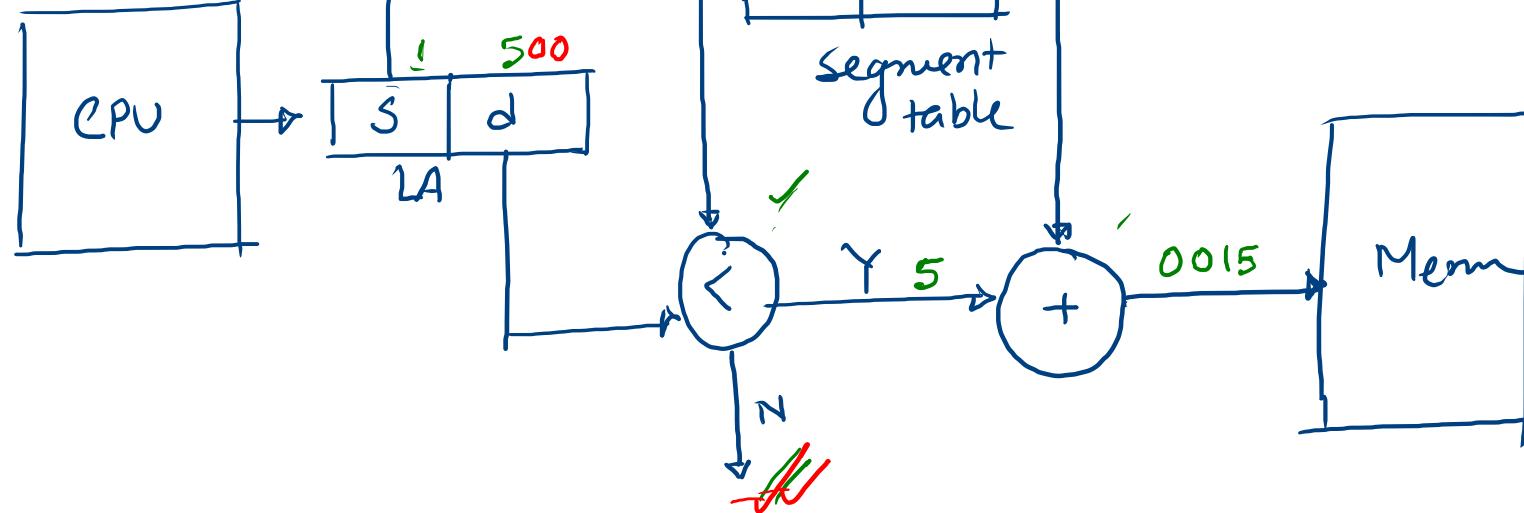


$S \# \rightarrow 1$

$O \# \rightarrow 500 \rightarrow d$

$L \rightarrow 100$

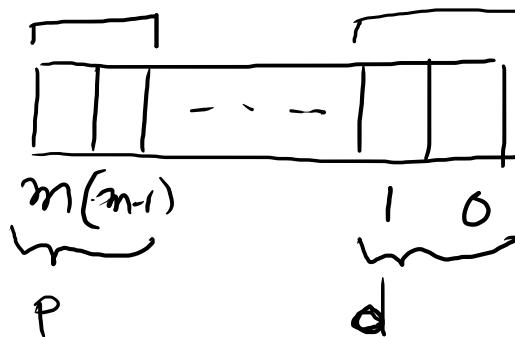
$B \rightarrow 0010$



## \* Paging

- Logical Memory → pages. (page number, offset)
- Physical Memory → frames.
- ↳ page # → page table → base address of each page.
- page size → power of 2

$$\text{LA} \rightarrow \underline{2^m}, \quad \text{PS} \rightarrow \underline{2^n}$$



④  $m=2$ ,  $n=4$        $1101$

→ 0	5
→ 1	6
→ 2	1
→ 3	2

$\text{PS} = \underline{4 \text{ bytes}} \rightarrow 2^2$

$\text{PM} = \boxed{32 \text{ bytes}} \text{ (8 pages)}$

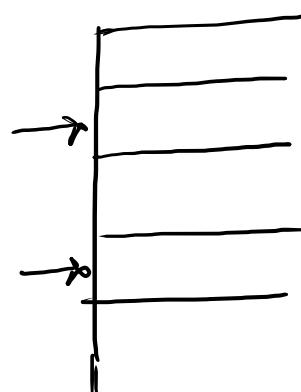
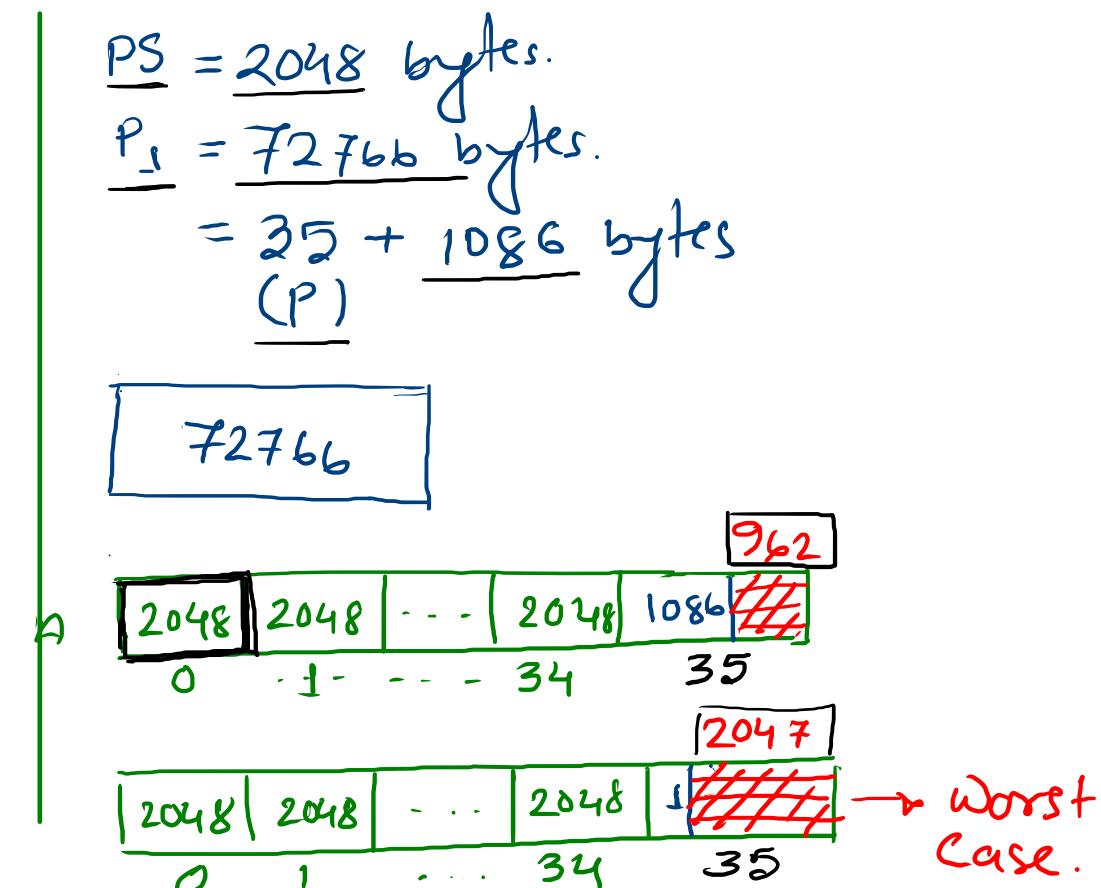
PT  $\begin{array}{|c|c|} \hline p & d \\ \hline \end{array}$        $\frac{F_i * PS + d}{}$

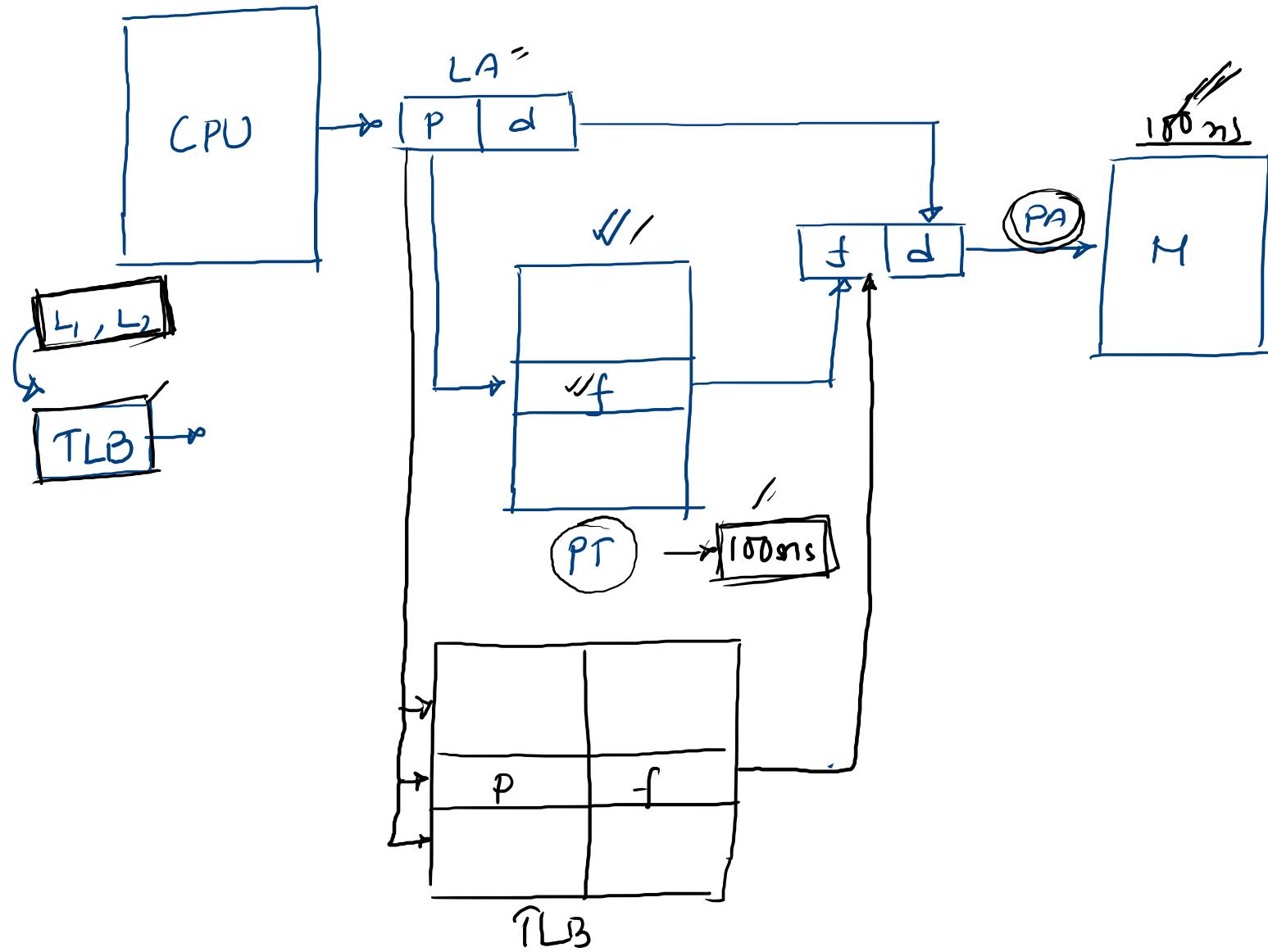
$LA(0)$   $\begin{array}{|c|c|} \hline 00 & 00 \\ \hline \end{array} \rightarrow 5 * 4 + 0 \rightarrow \boxed{20}$

$= LA(3)$   $00 \quad 11 \rightarrow 5 * 4 + 3 \rightarrow 23$

$= LA(4)$   $01 \quad 00 \rightarrow 6 * 4 + 0 \rightarrow \boxed{24}$

$LA(13)$   $11 \quad 01 \rightarrow 2 * 4 + 1 \rightarrow \boxed{9}$



$$\begin{aligned}
 & 100 \text{ ns} * 2 = 200 \text{ ns} \\
 \xrightarrow{\quad \text{HR} \rightarrow 80\% \quad} \\
 & \frac{80 * 100 \text{ ns} + 20 * 200}{120 \text{ ns}} \\
 & \text{HR} \rightarrow 99\% \\
 & \frac{99 * 100 + 1 * 200}{101 \text{ ns.}}
 \end{aligned}$$