CS & IT
ENGINEERING

OPERATING SYSTEMS

CPU Scheduling

Lecture No. 4

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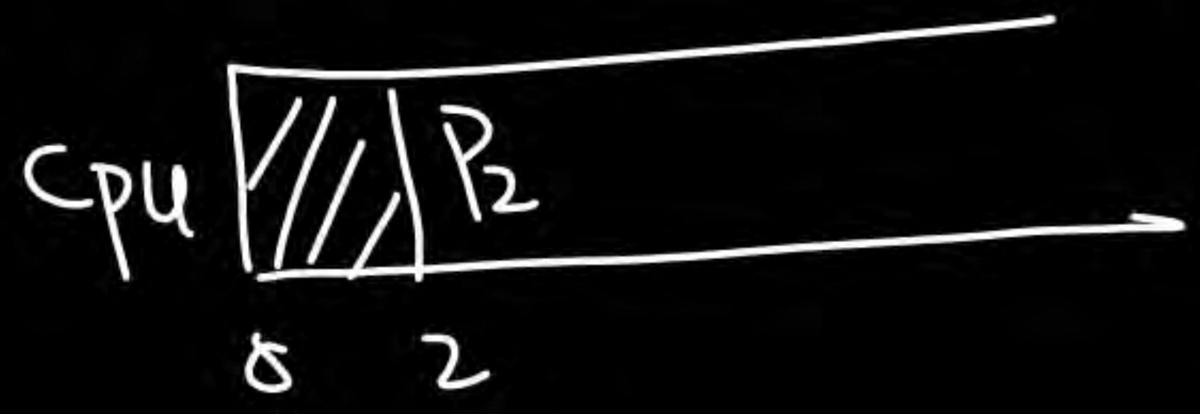
TOPICS TO BE COVERED

- CPU Scheduling Techniques
- Predicting Burst Times
- HRRN ; LRTF ; Priority Scheduling

S.J.F : Tie breaking Rule :
SRTF

Galvin → use FCFS | "Lower Pid"

P.No	A.T	B.T
1	8	10
✓ 2	2	6
✓ 3	2	6
4	4	4



Prediction Techniques

Static

→ Total B.T of Process

Process Size (Bytes)

Type

$P_{old} = 101KB$ ✓

20s

$P_{new} = 100KB$

20s

Type	Av.
- OS	5 s
- Interactive	10 s
- FGND	15 s
- BGND	30 s

P_{ri}

Dynamic ⊛

→ Partial (Next cpu Burst)

Initial Guess

B.T

$\tilde{\tau}_1$ ① t_1 $\tilde{\tau}_2$ ② t_2 $n+1 = 3$

$W.T_1$	$B.T_1$	IOBT	WT_2	BT_2	$\tilde{\tau}_3$	?
R.Q	cpu	IOD	R.Q	cpu	R.Q	cpu

AT

P_r t'

$\tilde{\tau}_{n+1}$

Next cpu Burst'

Exponential Averaging Technique/Aging Algo: (To Predict Next CPU B.T)

→ Let P_i : Process

→ Let t_i : Completed B.T

→ Let $\tilde{T}_i$: Predicted B.T

→ Let $\tilde{T}_{n+1}$ denote Next Predicted B.T

$$\tilde{T}_{n+1} = \alpha t_n + (1-\alpha)\tilde{T}_n \quad — ①$$

$0 < \alpha < 1$: Constant

Recurrence Relation

$$\tilde{T}_{n+1} = \alpha t_n + (1-\alpha)\tilde{T}_n \quad — ①$$

$$\tilde{T}_n = (\alpha t_{n-1} + (1-\alpha)\tilde{T}_{n-1}) \quad — ②$$

Back Substitution

$$\tilde{T}_{n+1} = \alpha t_n + (1-\alpha)\left[\alpha t_{n-1} + (1-\alpha)\tilde{T}_{n-1}\right]$$

$$= \alpha t_n + \alpha(1-\alpha)t_{n-1} + (1-\alpha)^2\tilde{T}_{n-1} \quad — ③$$

$$= \alpha t_n + \alpha(1-\alpha)t_{n-1} + \alpha(1-\alpha)^2 t_{n-2} + (1-\alpha)^3\tilde{T}_{n-2} \quad — ④$$

$$\vdots$$

$$\tilde{T}_1$$

($\tilde{T}_1$ = Initial Guess)

$$\boxed{F(n) = F(n-1) * n}$$

$$F(0) = 1$$

Given the value of 'α' & $\tilde{T}_1$; one can Predict any Next-cpu B.T

Q) Consider a System using Expo. Avg. Tech. To predict Next cpu B.T ; Given $\alpha = 0.5$; & $\tilde{T}_1 = 10$

The process B.T's in previous Runs are : 4, 8, 12, 10

$t_1 \quad t_2 \quad t_3 \quad t_4$

Predict the next cpu B.T of Process;

$$\tilde{T}_{n+1} = \alpha t_n + (1-\alpha)\tilde{T}_n \quad - ①$$

Pr_i :

$$\tilde{T}_5 = 0.5 * t_4 + 0.5 * \underset{9.75}{\tilde{T}_4}$$

$$= \frac{1}{2}(t_4 + \tilde{T}_4) = \frac{1}{2}(10 + \tilde{T}_4)$$

$$\tilde{T}_4 = \frac{1}{2}(t_3 + \tilde{T}_3) = \frac{1}{2}(12 + \overset{7.5}{\tilde{T}_3})$$

$$= \frac{19.5}{2} = \boxed{9.75}$$

$$\tilde{T}_3 = \frac{1}{2}(t_2 + \tilde{T}_2) = \frac{1}{2}(8 + \overset{7}{\tilde{T}_2}) = 7.5 \quad \therefore \tilde{T}_3 = 7.5$$

$$\tilde{T}_2 = \frac{1}{2}(t_1 + \tilde{T}_1) = \frac{1}{2}(4 + 10)$$

$$\boxed{\tilde{T}_2 = 7}$$

$$\tilde{T}_5 = \frac{1}{2}(10 + 9.75)$$

$$= \frac{19.75}{2} = \underline{\underline{9.875}}$$

✓

④ Highest Response Ratio Next (HRRN)

Sel. Criteria : Response Ratio = $\left(\frac{w+s}{s}\right)$

W = waiting Time

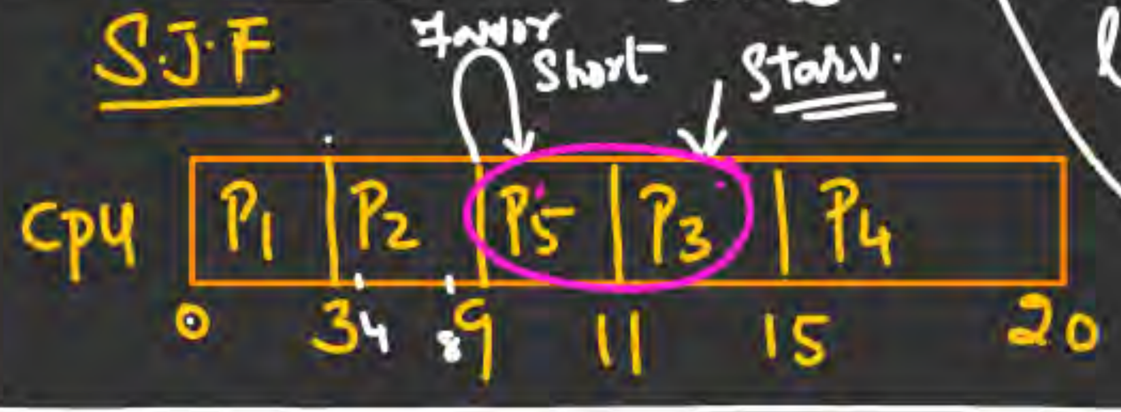
S = Service Time

Mode of opn : Non-Pre :

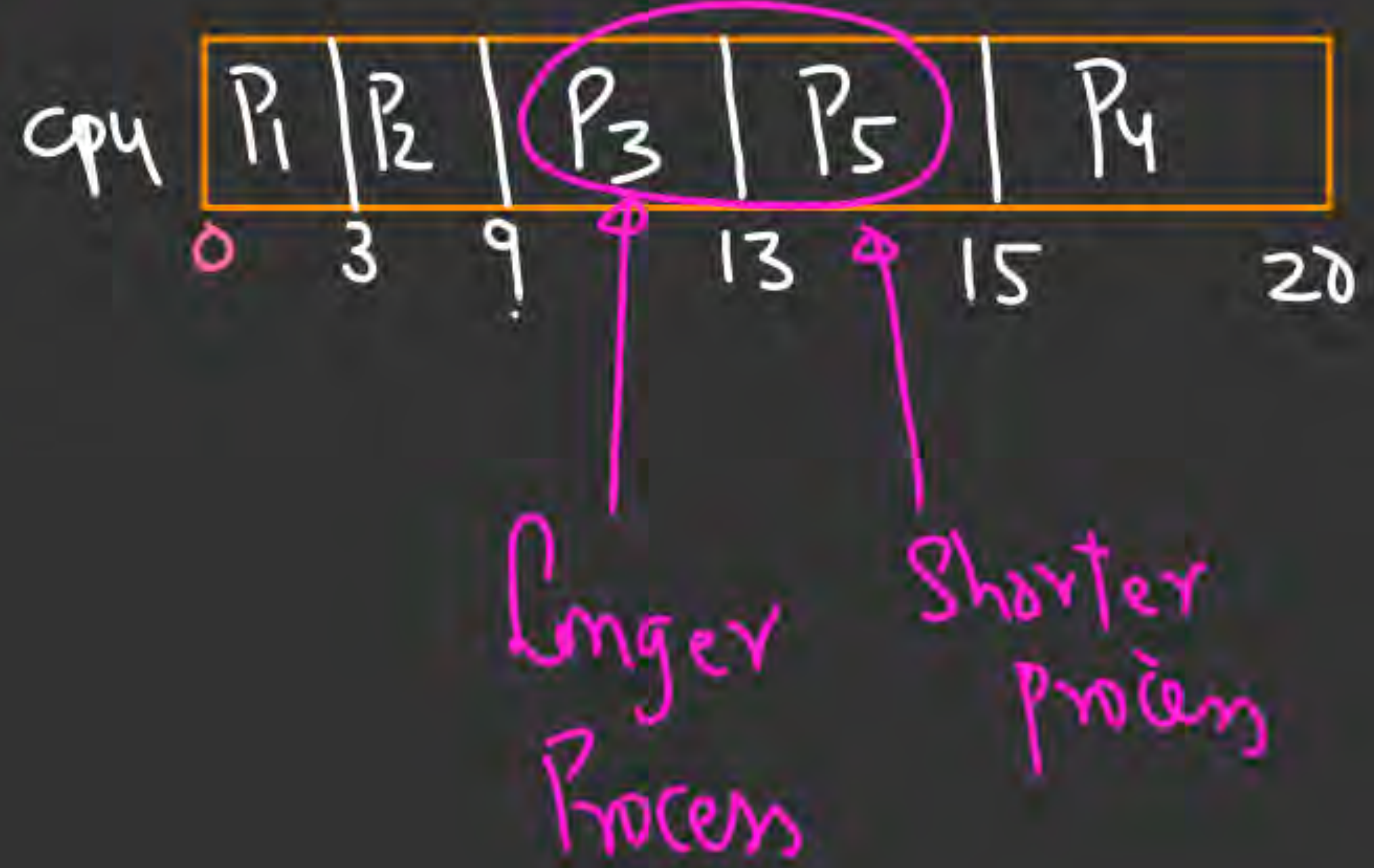
"Not only favors Shorter Process but also limit the waiting Time of Longer Process"

P.No	A.T	B.T
1	0	3
2	2	6
3	4	4
4	6	5
5	8	2

S.J.F



HRRN:



t_9 :

✓ $RR_3 = \frac{5+4}{4} = \frac{9}{4}$

$RR_4 = \frac{3+5}{5} = \frac{8}{5}$

$RR_5 = \frac{1+2}{2} = 3/2$

t_{13} :

$RR_4 = \frac{7+5}{5} = \frac{12}{5}$

$RR_5 = \frac{5+2}{2} = 7/2$ ✓

5) Longest Remaining Time First (LRTF) (opposite of SRTF)

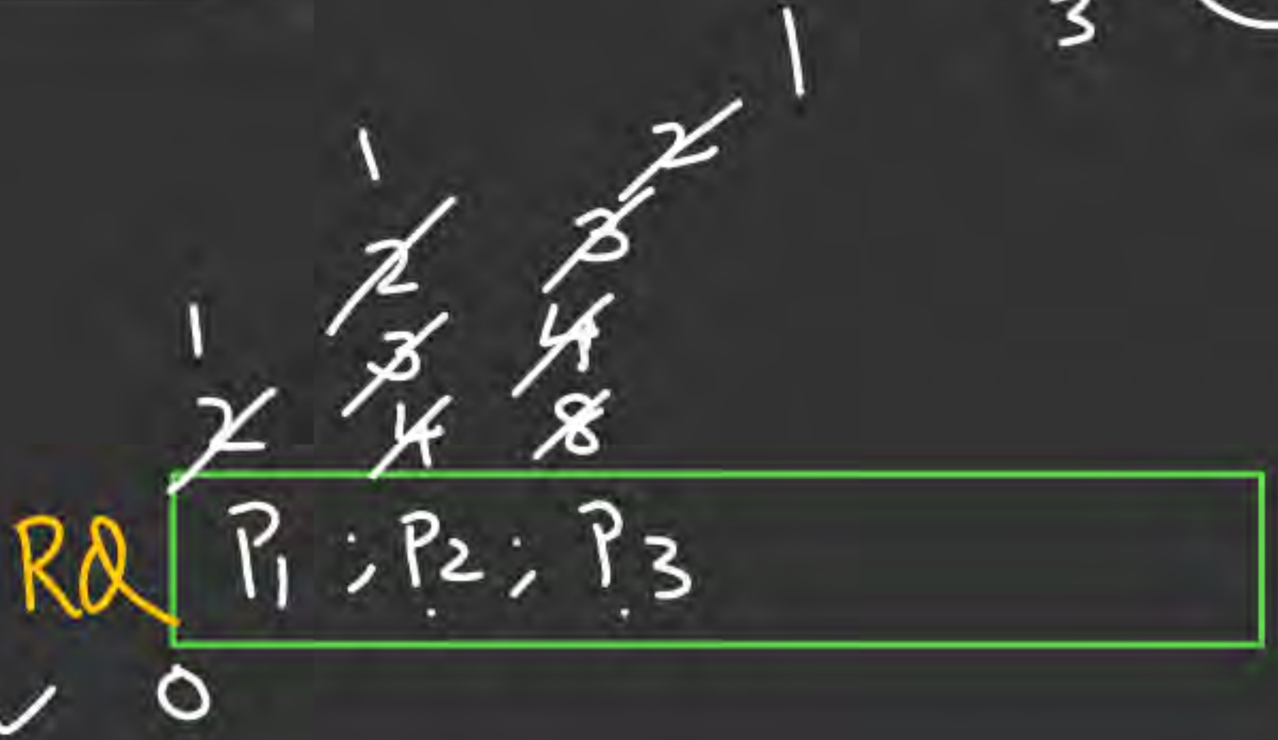
Sel. Criteria: B.T

Mode of opn: PreEmptive

Av. TAT = $\frac{12+13+14}{3}$ = $\frac{39}{3}$ = $\boxed{13}$

"In Case of a tie b/w Processes then Favor the Process having Lower Process id;" ✓

P.No	A.T	B.T
1	0	2
2	0	4 ✓
3	0	~~8~~ 4 ✓



CPU

P3	P2	P3	P2	P3	P1	P2	P3	P1	P2	P3

0 4 5 6 7 8 9 10 11 12 13 14

Pr Pr Pr Pr Pr Pr Pr Pr

Using LRTF, the Avg. TAT = ______

(NAT)

(2m)

Q.

Consider 3 processes A, B, C with compute burst times are 4, 6, 9 units. All processes arrive at time zero. Consider the longest remaining time first (LRTF) scheduling algorithm. In LRTF ties are broken by giving priority to the process with lowest process id. Find the average of completion times of A, B?

- (A) 14.5
- (B) 15.5
- (C) 17.5 ✓
- (D) 18.0

P.No	A.T	B.T
A 1	0	~~4~~ ~~3~~ ~~2~~ 1
B 2	0	~~6~~ ~~5~~ ~~4~~ ~~3~~ ~~2~~ 1
C 3	0	~~9~~ ~~8~~ ~~6~~ ~~5~~ ~~4~~ ~~3~~ ~~2~~ 1

RQ

4	6	9
P1	P2	P3

CPU

P3	P2	P3	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3

0 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Pr Pr

A	B	
P1	P2	P3

16 17 18 19

$$\frac{17+18}{2} = \boxed{17.5}$$

Process

Q.

H/W

Six jobs are waiting to be run. The expected running times are 9, 7, 5, 2, 1 and x respectively. Where $5 < x < 7$ and the average completion time is 13. Find the value of x using SJF algorithm? (Assume all jobs arrive at same time = 0)

- Ⓐ 3.33
- Ⓑ 4.33
- Ⓒ 5.33
- Ⓓ 6.33

Q.

In a system using single processor, a new process arrives at the rate of 10 processes per minute and each such process requires 5 seconds of service time. What is the %CPU utili~~zat~~ion?

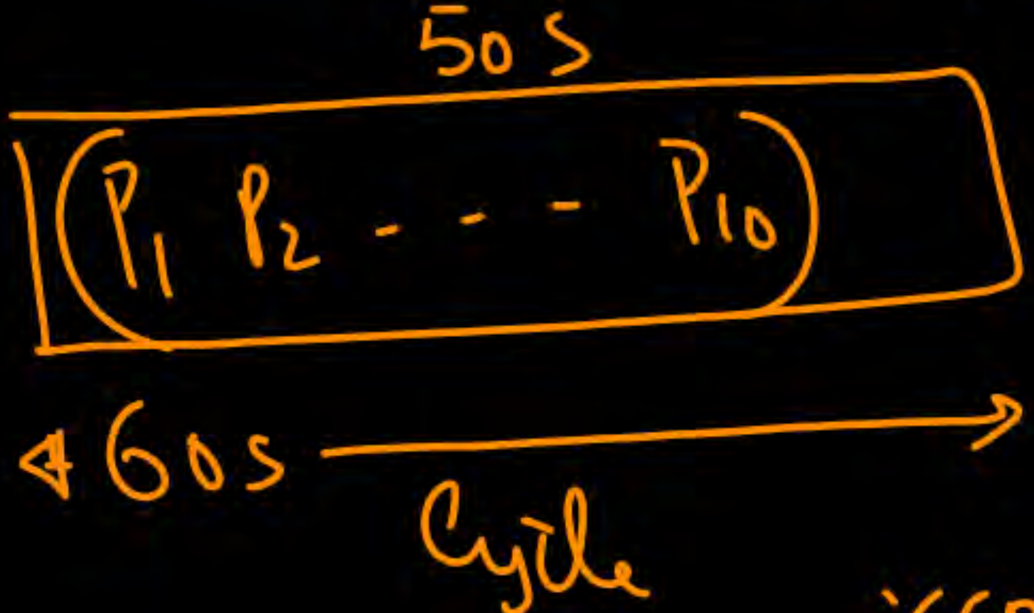
B.T

Idleness.

(General)

- (A) 81.33
- (B) 82.33
- (C) 84.33
- (D) 83.33 ✓

$60\text{ S} \longrightarrow 10\text{ Process} \rightarrow (5\text{ sec})$



$\%\text{cpu utiliz} = \left(\frac{50\text{ s}}{60}\right) * 100$

6) Priority Based Scheduling

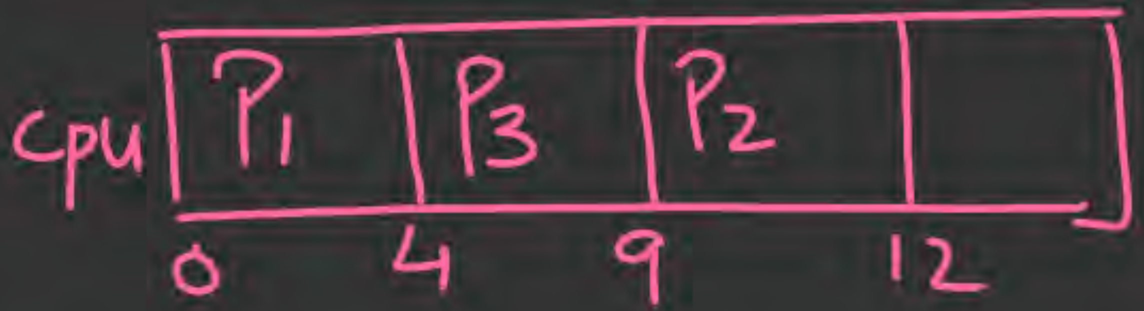
Sel. Criteria: Priority : f(Type, Size, Resources..) = integer-value

Mode of op'n : N.Pr / Pr

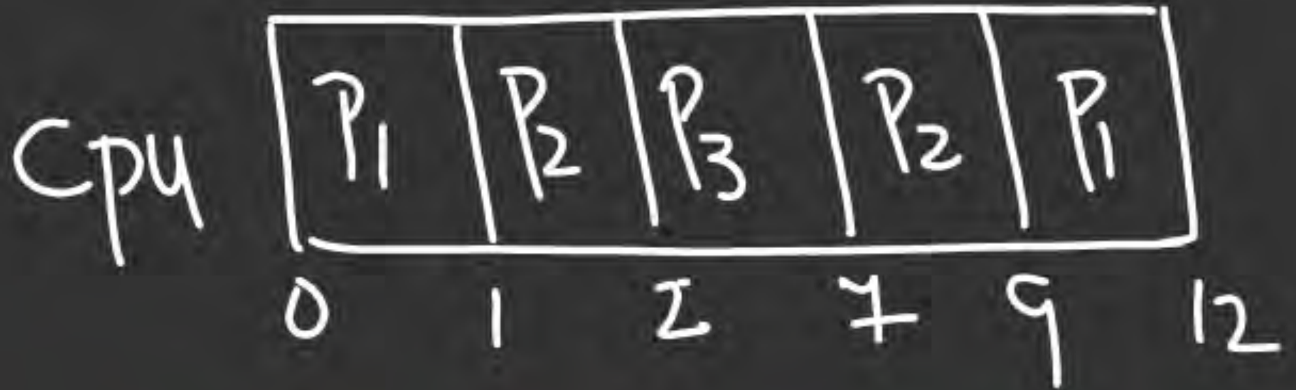
Tie : (Whatever given) (Lower-Pid)

Prio	P.No	A.T	B.T
4	1	0	4
5	2	1	3
8	3	2	5

N.Pr Prio



Pr - Prio

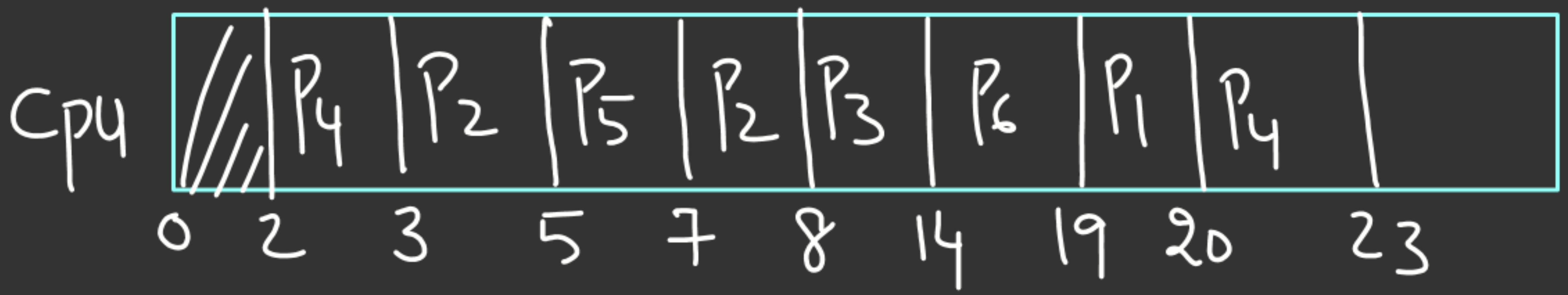


Note: (Priority based Scheduling works exactly like SJF/SRTF; Except that it looks @ Priority, instead of B.T

Prio	P.No	A.T	B.T
x 4	1	4	1
x 6	2	3	3
x 8	3	8	6
3	4	2	4
x 7	5	5	2 x
x 5	6	3	5

Pre - Prio:

$\mathcal{L} = 23 - 2 = 21$



THANK YOU
GW
SOLDIERS !