Operating Systems: CPU Scheduling

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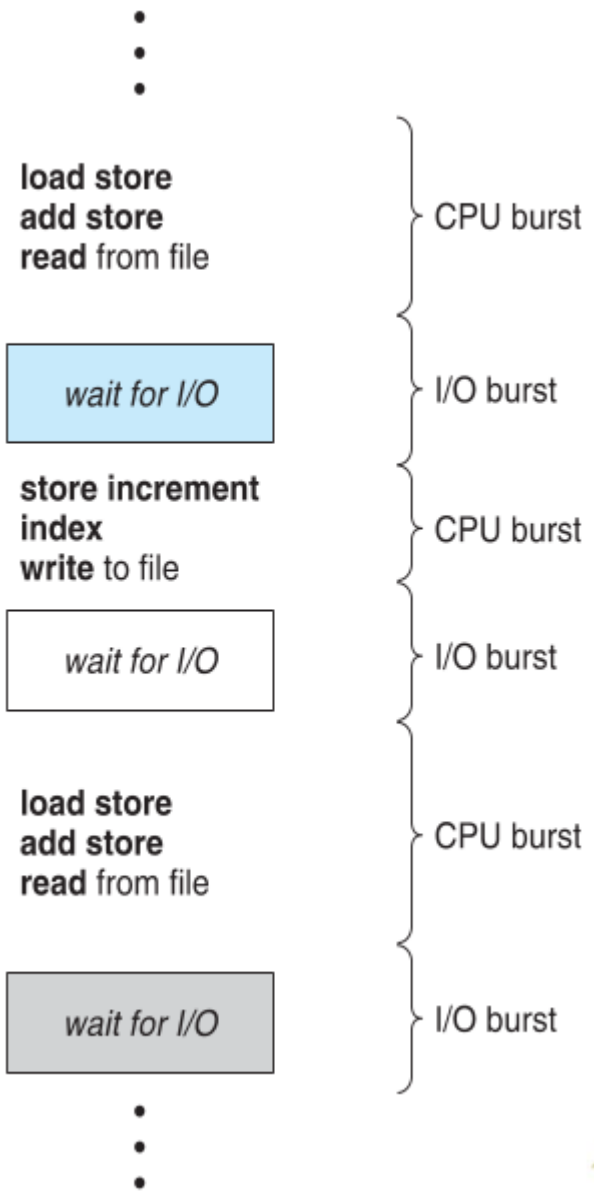
CPU Burst / Service Time

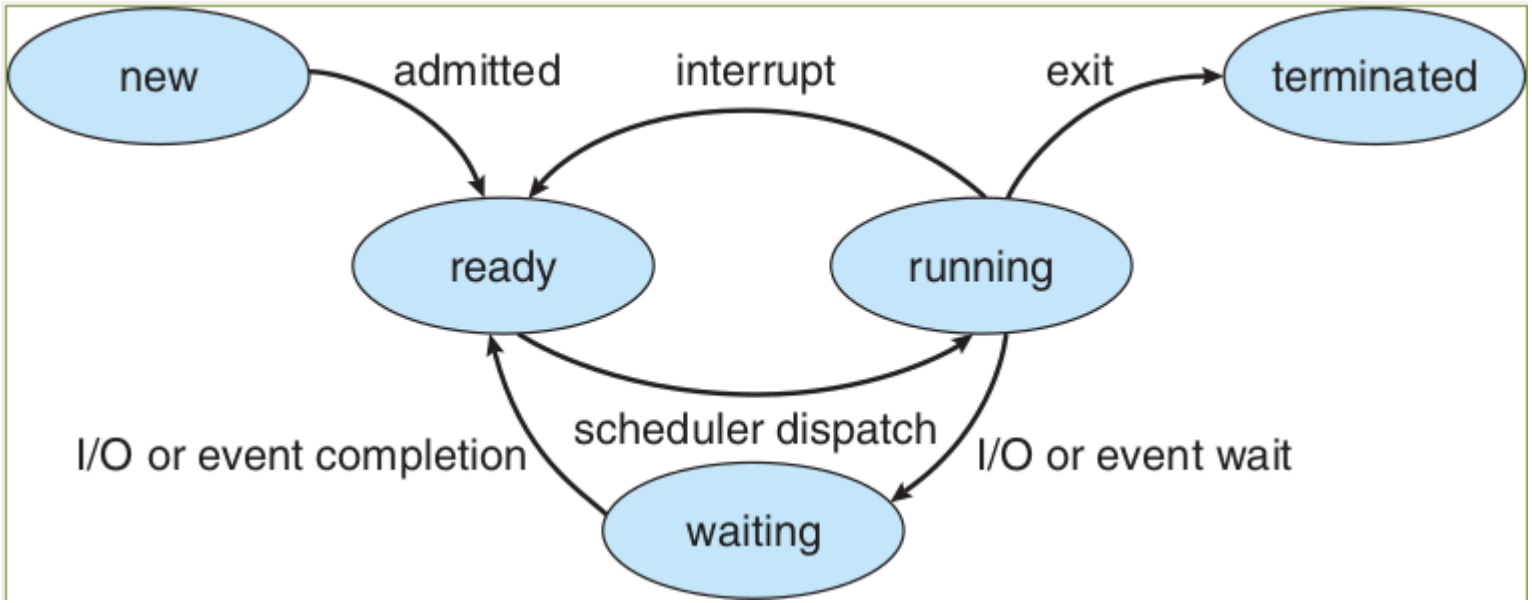
- cpu utilization by multiprogramming
- cpu - I/O cycle of a process
- cpu : burst time, service time
- I/O : or other blocking events like memory request



CPU Schedular

Short Term Schedular

- ready queue
- Dispatcher



Time Unit Concept

- Millisecond
- Nanosecond
- ?

Scheduling type

- nonpreemptive
- preemptive

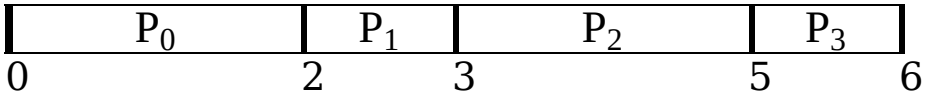
Processes Table

process	service(Burst) time
p_0	3
p_1	2
p_2	1
p_3	2

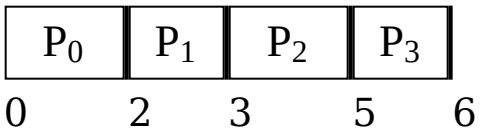
process	service time	arrival time
p_0	3	0
p_1	2	0
p_2	1	3
p_3	2	5

First-Come, First-Served (FCFS)

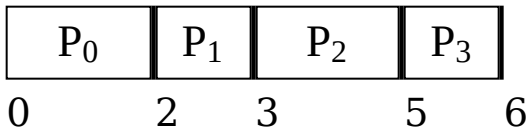
process	service time	arrival time
p_0	2	0
p_1	1	0
p_2	2	3
p_3	1	4



- t = 0: ready queue(q) = [p_0, p_1]
- t = 2: q = [p_1]
- t = 3: q = [p_2]
- t = 5: q = [p_3]

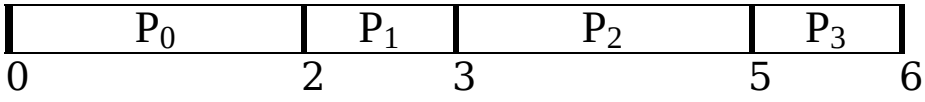


P_0	P_1	P_2	P_3	
0	2	3	5	6



Average Waiting Time

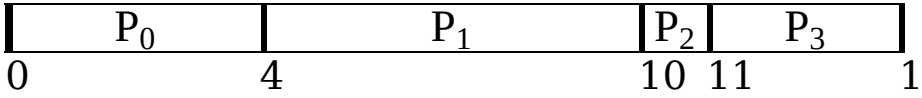
process	service time	arrival time
p_0	2	0
p_1	1	0
p_2	2	3
p_3	1	4



- P_0 waiting time: 0
- P_1 waiting time: 2
- P_2 waiting time: (3-3) = 0
- P_3 waiting time: (5-4) = 1
- *Average Waiting Time*: $\frac{0+2+0+1}{4} = \frac{3}{4} = 0.75$

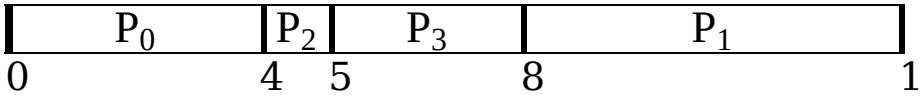
FCFS - Convoy effect

process	service time	arrival time
p_0	4	0
p_1	6	0
p_2	1	3
p_3	3	4



Average Waiting Time 1: $\frac{0+(4-0)+(10-3)+(11-4)}{4} = \frac{18}{4} = 4\frac{2}{4} = 4.5$

Rearange

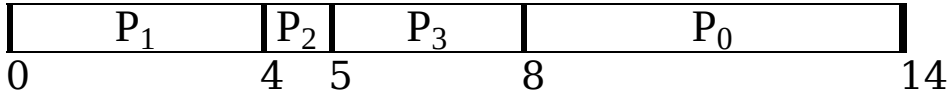


Average Waiting Time 2: $\frac{0+(4-3)+(5-4)+8}{4} = \frac{10}{4} = 2\frac{2}{4} = 2.5$

- *Average Waiting Time* 1: 4.5
- *Average Waiting Time* 2: 2.5
- 1: FCFS
- 2: Shortest Job First(SJF) or Shortest Process Next(SPN)

SJF/SPN

process	service time	arrival time
p_0	6	0
p_1	4	0
p_2	1	3
p_3	3	4

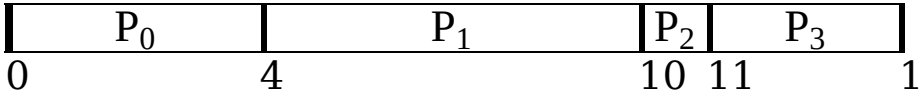


Average Waiting Time: $\frac{0+(4-3)+(5-4)+8}{4} = \frac{10}{4} = 2\frac{2}{4} = 2.5$

- Starvation
- Nonpreemptive

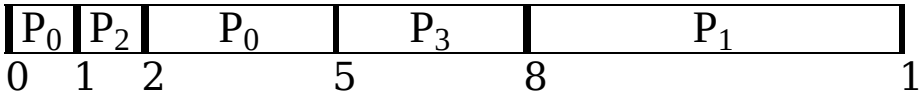
Shortest Remaining Time(SRT), preemptive SJF

process	service time	arrival time
p_0	4	0
p_1	6	0
p_2	1	1
p_3	3	2



Average Waiting Time 1: $\frac{0+(4-0)+(10-1)+(11-2)}{4} = \frac{22}{4} = 5\frac{2}{4} = 5.5$

Rearange



Average Waiting Time 2: $\frac{(0+(2-1))+(8-0)+(1-1)+(5-2)}{4} = \frac{12}{4} = 3$

- *Average Waiting Time* 1: 5.5
- *Average Waiting Time* 2: 3
- 1: FCFS
- 2: Shortest Job First(SJF) or Shortest Process Next(SPN)

Estimating Service Time(I)

- $$\tau_n = \frac{t_0 + t_1 + t_2 + \ldots + t_{n-1}}{n}$$
- $$n * \tau_n = t_0 + t_1 + t_2 + \ldots + t_{n-1}$$
- $$\tau_{n+1} = \frac{t_0 + t_1 + t_2 + \ldots + t_{n-1} + t_n}{n+1}$$
- $$= \frac{t_0 + t_1 + t_2 + \ldots + t_{n-1}}{n+1} + \frac{t_n}{n+1}$$
- $$\tau_{n+1} = \frac{n * \tau_n}{n+1} + \frac{t_n}{n+1}$$
- $$\tau_{n+1} = \frac{n}{n+1} * \tau_n + \frac{1}{n+1} * t_n$$

Estimating Service Time(II)

- $$\tau_{n+1} = \frac{n}{n+1} * \tau_n + \frac{1}{n+1} * t_n$$
- $$\tau_{n+1} = \frac{n+1-1}{n+1} * \tau_n + \frac{1}{n+1} * t_n$$
- $$\tau_{n+1} = (\frac{n+1}{n+1} - \frac{1}{n+1}) * \tau_n + \frac{1}{n+1} * t_n$$
- $$\tau_{n+1} = (1 - \frac{1}{n+1}) * \tau_n + \frac{1}{n+1} * t_n$$
- $$\alpha = \frac{1}{n+1}$$

$$\tau_{n+1} = (1 - \alpha) * \tau_n + \alpha * t_n$$

Estimating Service Time(III)

- $\alpha = \frac{1}{n+1}$, $\tau_{n+1} = (1-\alpha) * \tau_n + \alpha * t_n$
- t_n = actual length of n^{th} service time
- τ_{n+1} = predicted value for the next service time
- $0 \leqslant \alpha \leqslant 1$, $\tau_{n+1} = (1-\alpha) * \tau_n + \alpha * t_n$
- $\alpha \rightarrow 0$

- Scheduling Criteria
  - *CPU utilization* : keep the CPU as busy as possible
  - *Throughput* : number of processes that complete their execution per time unit
  - *Turnaround time* : amount of time to execute a particular process
  - *Waiting time* : amount of time a process has been waiting in the ready queue
  - *Response time* : amount of time it takes from when a request was submitted until the first response is produced, not output (for time-sharing environment)
- Optimization Criteria
  - Max CPU utilization
  - Max throughput
  - Min turnaround time
  - Min waiting time
  - Min response time