Operating System
Process Scheduling

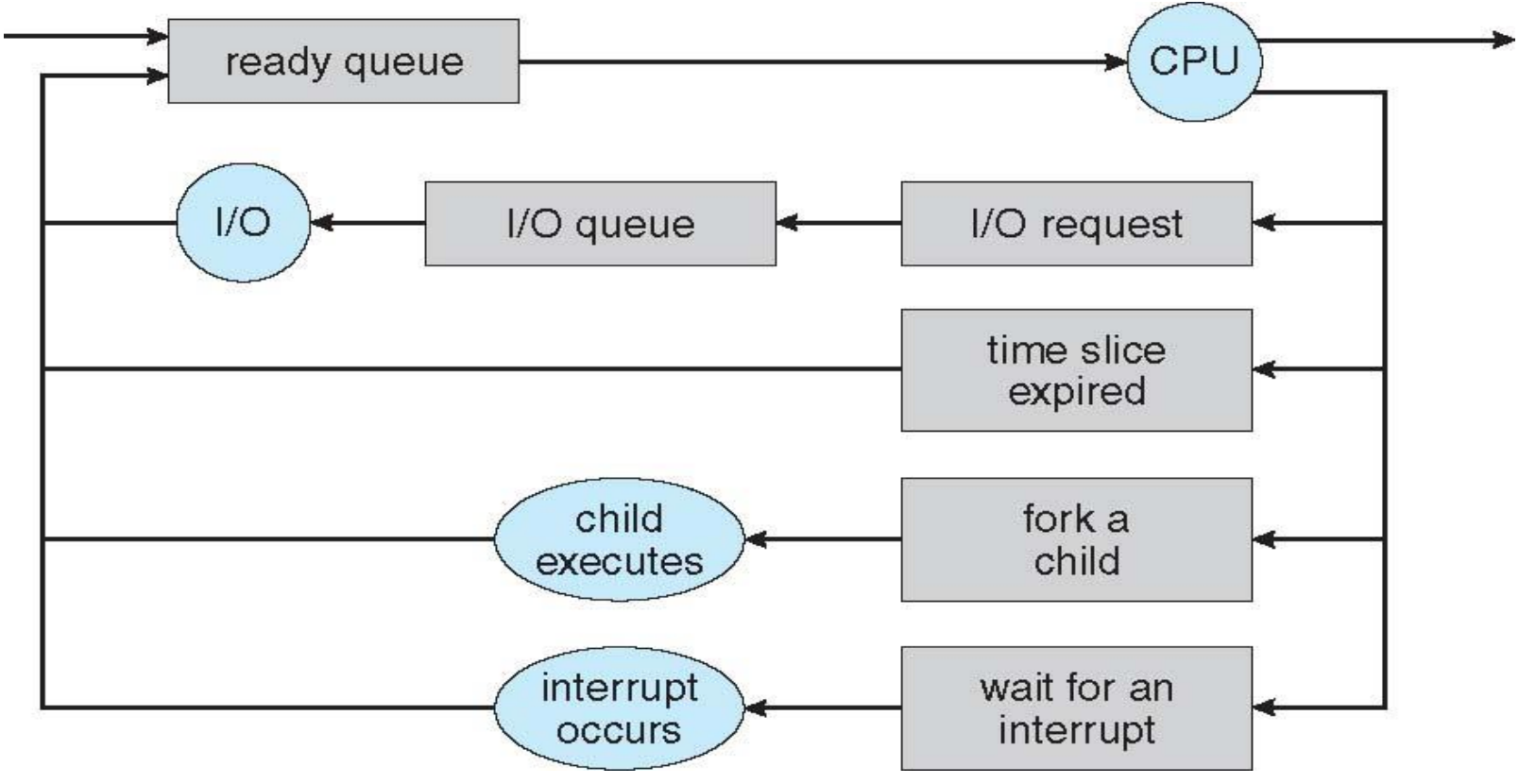
Tahira Alam
University of Asia Pacific

CPU Switches from Process to Process

Process Scheduling Queues

- **Job queue** – set of all processes in the system
- **Ready queue** – set of all processes residing in main memory, ready and waiting to execute
- **Device queues** – set of processes waiting for an I/O device
- Processes migrate among the various queues

Representation of Process Scheduling

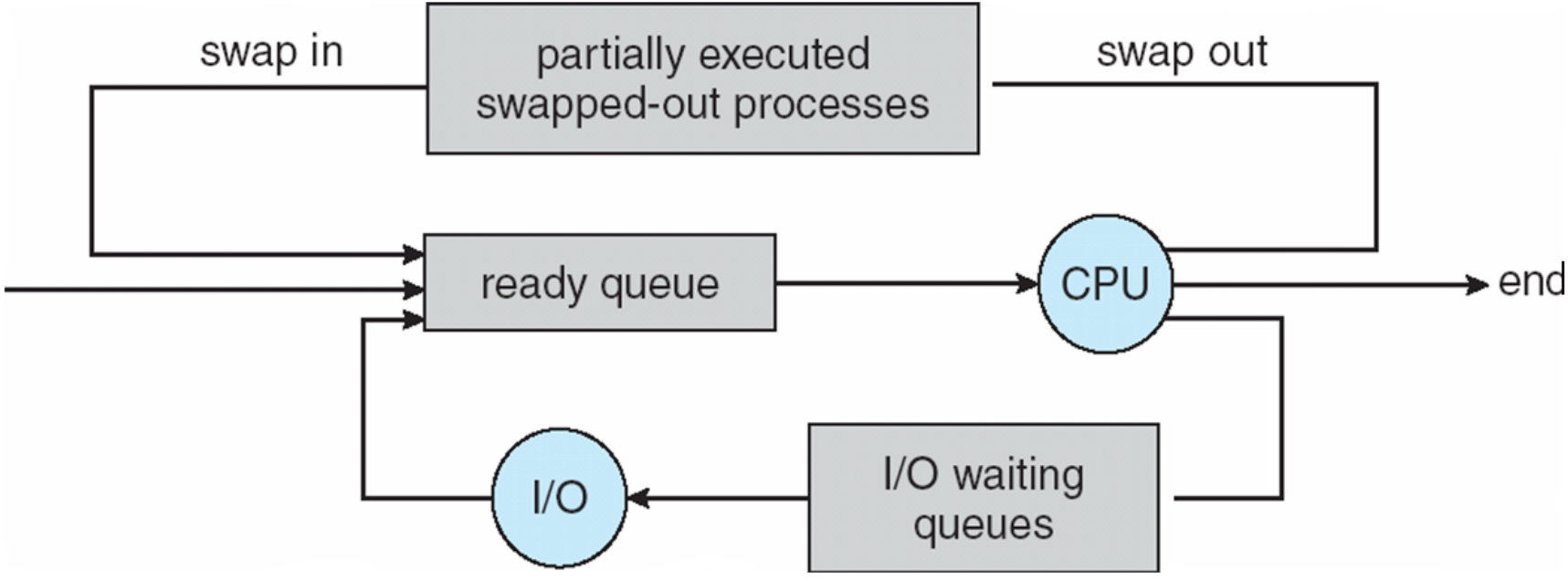


Types of Schedulers

- **Long-term scheduler** (or job scheduler) – selects which processes should be brought into the ready queue
- **Short-term scheduler** (or CPU scheduler) – selects which process should be executed next and allocates CPU

- The **long-term scheduler** controls the *degree of* ***multiprogramming***

Addition of Medium Term Scheduling



Schedulers(cont.)

- Processes can be described as either:
  - **I/O-bound process** – spends more time doing I/O than computations, many short CPU bursts
  - **CPU-bound process** – spends more time doing computations; few very long CPU bursts

Scheduling Algorithms(1)

Policy: which process to run

Mechanism: how to "**context switch**" between processes

Scheduling Algorithms(2)

- The **policy** which process to run next, from set of ready processes?
- OS scheduler schedules the CPU requests (bursts) of processes
  - CPU burst = the CPU time used by a process in a continuous stretch
  - If a process comes back after I/O wait, it counts as a fresh CPU burst

Scheduling Algorithms(3)

Goals:

- Maximize utilization = fraction of time CPU is used
- Minimize average turnaround time = time from process arrival to completion
- Minimize average response time = time from process arrival to first scheduling
- Fairness: all processes must be treated equally
- Minimize overhead: run process long enough to amortize cost of context switch (~1 microsecond)

Scheduling Algorithms(4)

- ***Arrival Time:*** *Time at which the process arrives in the ready queue.*

- ***Burst Time:*** *Time required by a process for CPU execution.*

- ***Waiting Time(W.T):*** *Total time spent by the process in the ready state waiting for CPU.*
  Waiting Time = Turn Around Time – Burst Time

Scheduling Algorithms(5)

- ***Turn Around Time:*** *Total amount of time spent by the process from coming in the ready state for the first time to its completion.*

  Turn Around Time = Completion Time – Arrival Time

  Turnaround time = Waiting time + Burst time

- ***Completion Time:*** *Time at which process completes its execution.*

Scheduling Algorithms(6)

- Types of Algorithms:
  - **Pre-emptive :** allows a running process to be interrupted by a high priority process
  - **Non Pre-emptive:** any new process has to wait until the running process finishes its CPU cycle.

First Come First Serve(1)

- Non Pre-emptive

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2

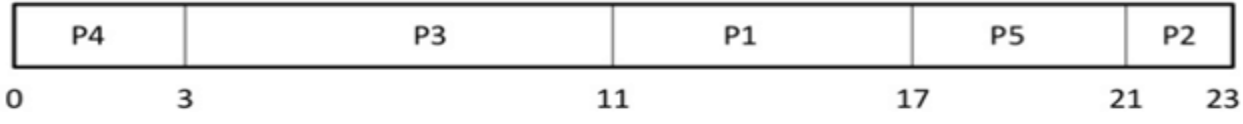
This is the GANTT chart for the above processes

The average waiting time will be = (0 + 21 + 24 + 30)/4 = 18.75 ms

First Come First Serve(1)

Process	Burst time	Arrival time
P1	6	2
P2	3	5
P3	8	1
P4	3	0
P5	4	4

Grantt Chart:



Average waiting time: (0+2+9+13+16)/5 = 8

Shortest Job First(1)

Non Pre-emptive

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2

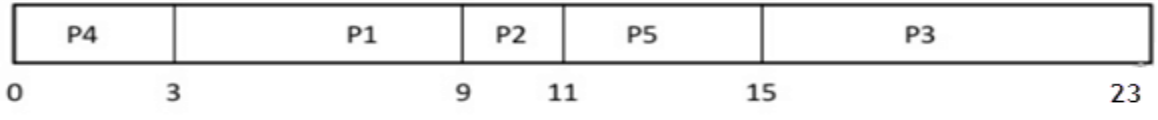
In Shortest Job First Scheduling, the shortest Process is executed first.

Now, the average waiting time will be = (0 + 2 + 5 + 11)/4 = 4.5 ms

Shortest Job First(1)

Ready queue: p1p2p5 p3

Process Queue	Burst time	Arrival time
P1	6	2
P2	2	5
P3	8	1
P4	3	0
P5	4	4



Average Waiting Time= 0+1+4+7+14/5 = 26/5 = 5.2

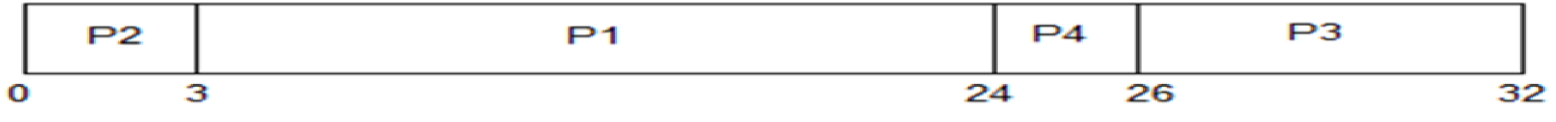
Priority Scheduling(1)

- Process selected based on priority
- The lowest priority gets the CPU first
- **Can be both pre-emptive and non pre-emptive**

Priority Scheduling(Non pre-emptive)

r.q: p2 p1 p4 p3

PROCESS	BURST TIME	PRIORITY
P1	21	2
P2	3	1
P3	6	4
P4	2	3



The average waiting time will be, (0 + 3 + 24 + 26)/4 = 13.25 ms

Priority Scheduling(Pre-emptive)

r.q:

Process	Priority	Burst time	Arrival time
P1	1	4	0
P2	2	3	0
P3	1	7	6
P4	3	4	11
P5	2	2	12


```
P1 = 0 - 0 = 0
P2 =4 - 0 + 7 =11
P3= 6-6=0
P4= 16-11=5
Average Waiting time = (0+11+0+5+2)/5 = 18/5= 3.6
```

p5=14-12=2

Round Robin(1)

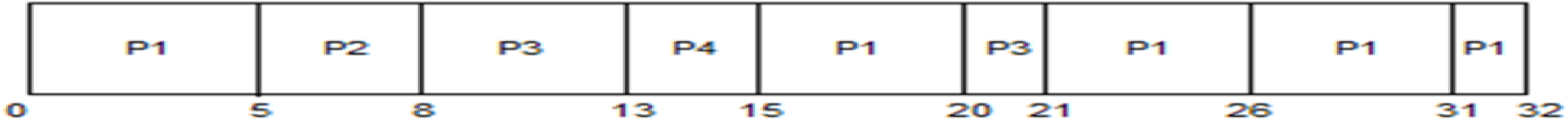
- Pre-emptive
- Each process gets a small unit of CPU time (*time quantum*), usually 10-100 milliseconds. After this time has elapsed, the process is preempted and added to the end of the ready queue.

Round Robin(2)

P1=0+(15-5)+(21-20)
P2=5, p3=8+(20-13)
P4=13

Here, Quantam = 5

PROCESS	BURST TIME
P1	21
P2	3
P3	6
P4	2



The average waiting time will be, 11 ms.

Round Robin(3)

Quantam=2

Readu queue:

P1=0+3+5, p2=1+7, p3=2,p4=4

P5=5+2

Process Id	Arrival time	Burst time
P1	0	5
P2	1	3
P3	2	1
P4	3	2
P5	4	3

- Average waiting time = (8 + 8 + 2 + 4 + 7) / 5 = 29 / 5 = 5.8 unit

Some animation links…

- First come first serve:

https://www.youtube.com/watch?v=iiBij98FtHg

- Shortest job first:

https://www.youtube.com/watch?v=ngHgEqYZeyg

- Priority Scheduling (Pre-emptive)

https://www.youtube.com/watch?v=2NB53crEWn4

- Round Robin Scheduling:

https://www.youtube.com/watch?v=hy5dn9mK36I

Thank you!!!!