

Prerequisites for successful scheduling:

1.) CPU-I/O-Burst Cycle

Experience shows: I/O occurs after **fixed amount of time** in $\geq 90\%$

⇒ appropriate time for re-scheduling

2.) **Preemptive Scheduling**: Processes can be forced to relinquish processor

20

Have various, often conflicting criteria to measure success of scheduling:

- **CPU utilisation**
- **Throughput**: Number of processes completed within a given time
- **Turnaround time**: Time it takes for each process to be executed
- **Waiting time**: Amount of time spent in the ready-queue
- **Response time**: time between submission of request and production of first response

21

1.) First-Come, First-Served (**FCFS**)

Jobs are put in a queue, and **served according to arrival time**

Easy to implement **but** CPU-intensive processes can cause long waiting time.

FCFS with preemption is called **Round-Robin** standard method in time sharing systems

Problem: get the **time quantum (time before preemption) right**.

- **too short**: too many context switches
- **too long**: Process can monopolise CPU

22

Next job is one with **shortest CPU-burst time** (shortest CPU-time before next I/O-operation)

Not implementable, but this is algorithm with the **smallest average waiting time**
⇒ Strategy against which to **measure other ones**

Approximation: Can we **predict the burst-time?**

Only hope is extrapolation from previous behaviour
done by weighting recent times more than older ones.

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

23

Priority Scheduling

Assumption: A priority is associated with each process

CPU is allocated to **process with highest priority**

Equal-priority processes scheduled according to FCFS

Two variations:

- **With preemption**: newly-arrived process with higher priority may gain processor immediately if process with lower priority is running
- **Without preemption**: newly arrived process always waits

Preemption good for ensuring quick response time for high-priority processes

Disadvantage: **Starvation** of low-priority processes **possible**

Solution: Increase priority of processes after a while (**Aging**)

24

Multilevel Queue Scheduling

Applicable when processes can be **partitioned into groups** (e.g., interactive and batch processes):

Split ready-queue into several separate queues, with separate scheduling algorithm

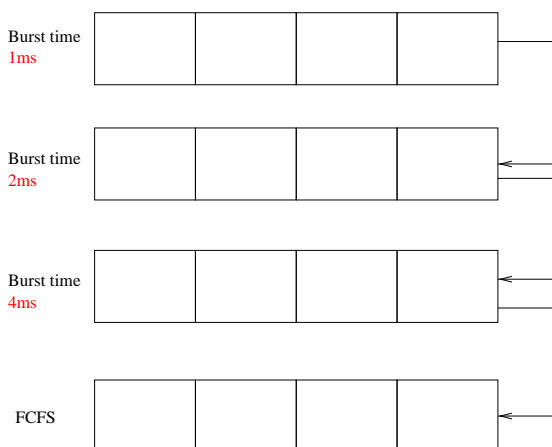
Scheduling between queues usually implemented as pre-emptive priority scheduling

Possible setup of queues:

- System processes
- Interactive processes
- Interactive editing processes
- Batch processes

25

Other way of organising queues: **according to length of CPU-burst**



26