Operating Systems

Evaluation of CPU Scheduling Algorithms

- Which one is best?
- It depends:
  - ✓on the system workload (extremely variable)
  - ✓hardware support for the dispatcher
  - ✓relative weighting of performance criteria (response time, CPU utilization, throughput...)
  - ✓The evaluation method used
  - ✓Management priorities
    - ❑Machine efficiency vs. user service..

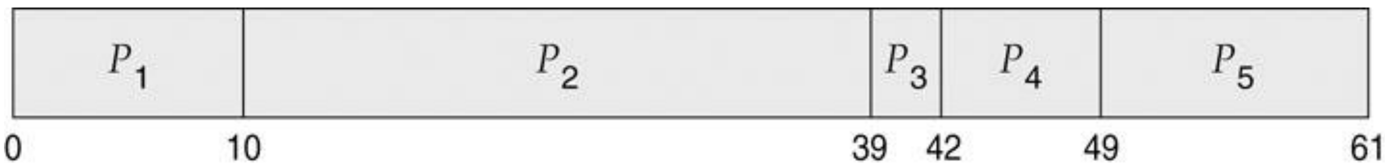
	Selection Function	Decision Mode	Throughput	Response Time	Overhead	Effect on Processes	Starvation
FCFS	max[*w*]	Non-preemptive	Not emphasized	May be high, especially if there is a large variance in process execution times	Minimum	Penalizes short processes; penalizes I/O bound processes	NO
Round Robin (RR)	constant	Preemptive (at time quantum)	May be low if quantum is too small	Provides good response time for short processes	Minimum	Fair treatment; although it penalized I/O bound processes	NO
Shortest Job First (SJF)	min[*s*]	Non-preemptive	High	Provides good response time for short processes	Can be high	Penalizes long processes	Possible
Shortest Remaining Time First (SRTF)	min[*s* – *e*]	Preemptive (at arrival)	High	Provides good response time	Can be high	Penalizes long processes	Possible
Highest Response Ratio Next (HRRN)	max((w + s) / s)	Non-preemptive	High	Provides good response time	Can be high	Good balance	NO
Feedback	Adjustable	Preemptive (at time quantum)	Not emphasized	Not emphasized	Can be high	May favor I/O bound processes	Possible

- How do we pick an algorithm?
  - ✓Many algorithms
  - ✓Many parameters
- Maximize or Minimize some criteria.
  - ✓Utilization, throughput, etc.
- What do we base our choice on?
  - ✓A single example?

- Given a predetermined workload, simulate
  - ✓ run the workload through different schedulers
  - ✓ calculate statistics

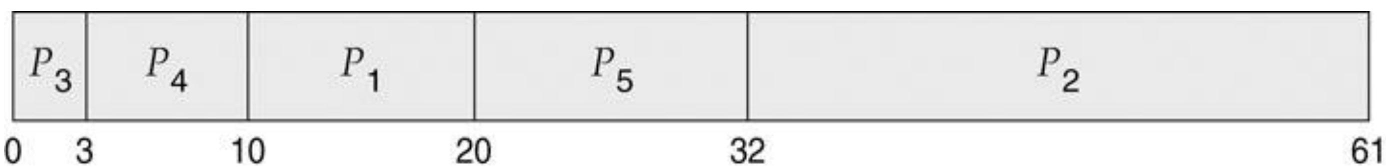
Process	Burst Time
P1	10
P2	29
P3	3
P4	7
P5	12

- **Deterministic modeling**
  - takes a particular predetermined workload and defines the performance of each algorithm for that workload
- FCFS



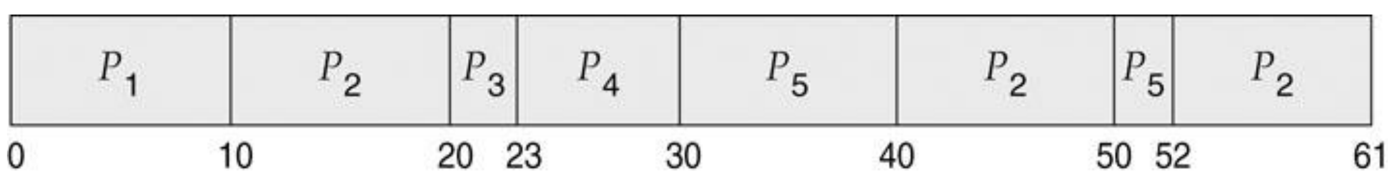
Average wait = 28

- SJF



-Average wait = 13

- RR



-Average wait = 23

Advantages

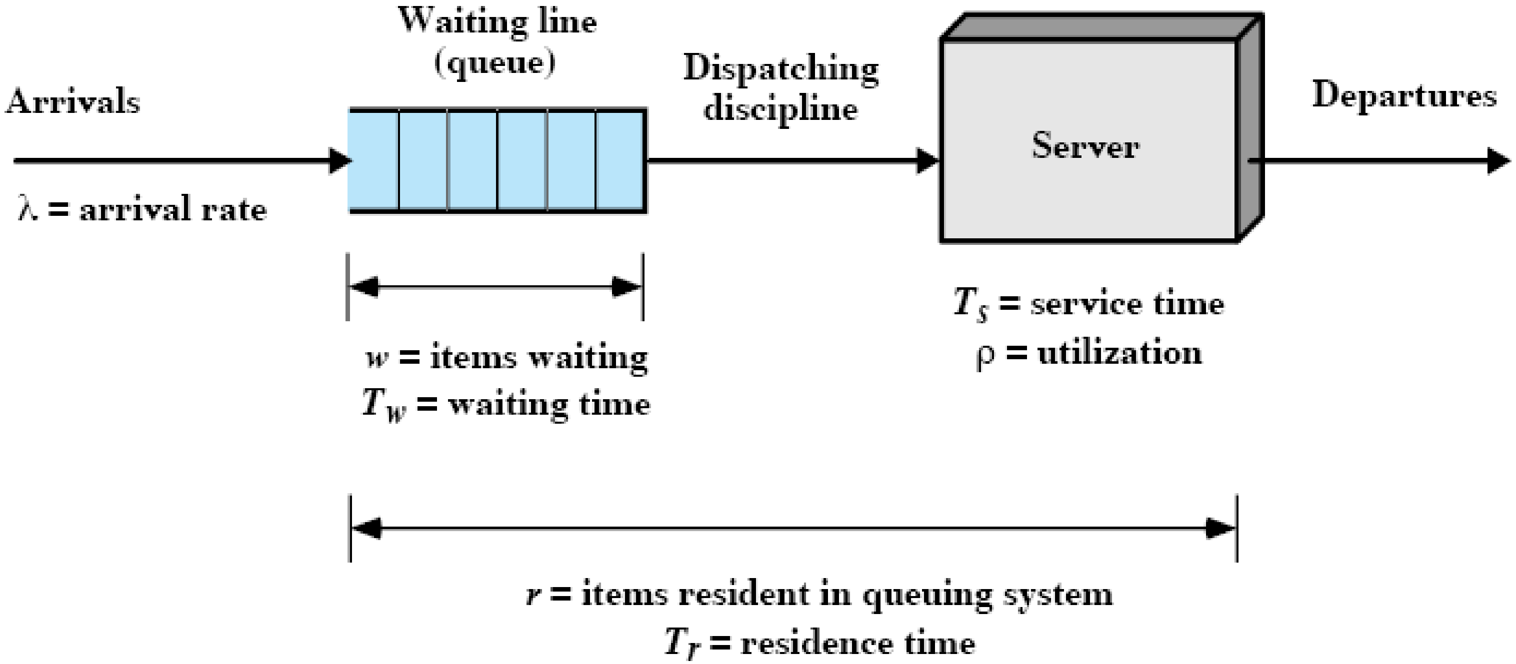
- ✓ Simple
- ✓ Fast
- ✓ Exact Results

Disadvantages

- ✓ too specific
- ✓ too much exact knowledge is required
- ✓ tied to example data

- Using statistics, we can determine the distribution of CPU and I/O bursts.
    - ✓Probability distribution function
- The result is a mathematical formula which describes the probability of a particular burst
- Mathematics can then tell us performance
- A computer system can be described as a network of servers
    - ✓each server has a queue of waiting processes
- Simply add an imaginary server to each queue.
- Now, we can compute statistics

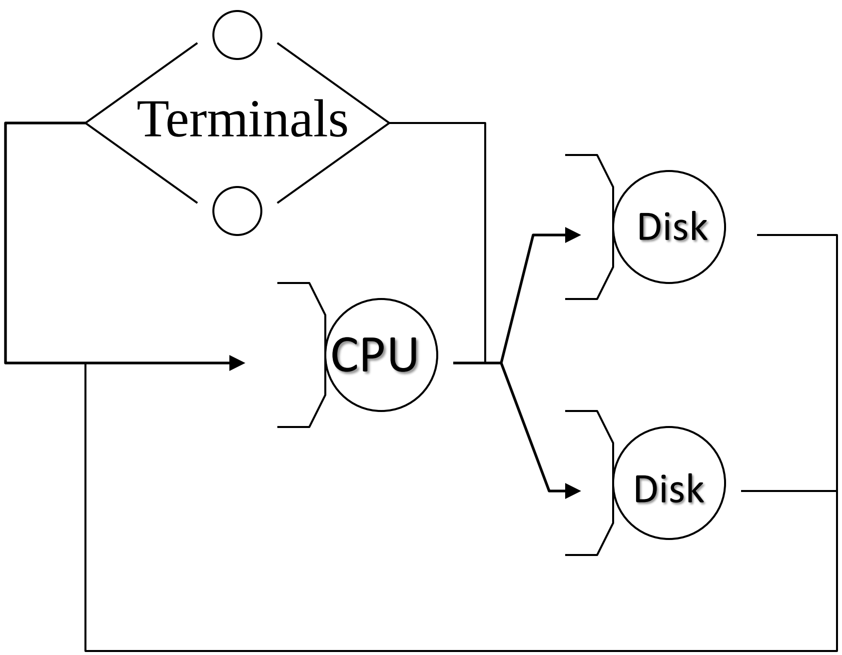
- **Queuing models**
  - ✓ Distribution of CPU and I/O bursts
  - ✓ Distribution of arrival times
- Little's formula: n = λ x W
  - ✓ In steady-state, number of departures must be equal to the number of arrivals



- Little's Law -- Suppose:
  - n is the average queue length
  - W is the average waiting time in the queue
  - lambda is the average arrival rate

$$n = \lambda * W$$

- So:
  - during the time W that a process waits
  - lambda * W processes will arrive
  - if system is in steady state, same number leave



Average queue length

CPU is 8.88

Disk 1 is 3.19

Disk 2 is 1.4

Suppose arrival rate is:

CPU 5 Ps/sec

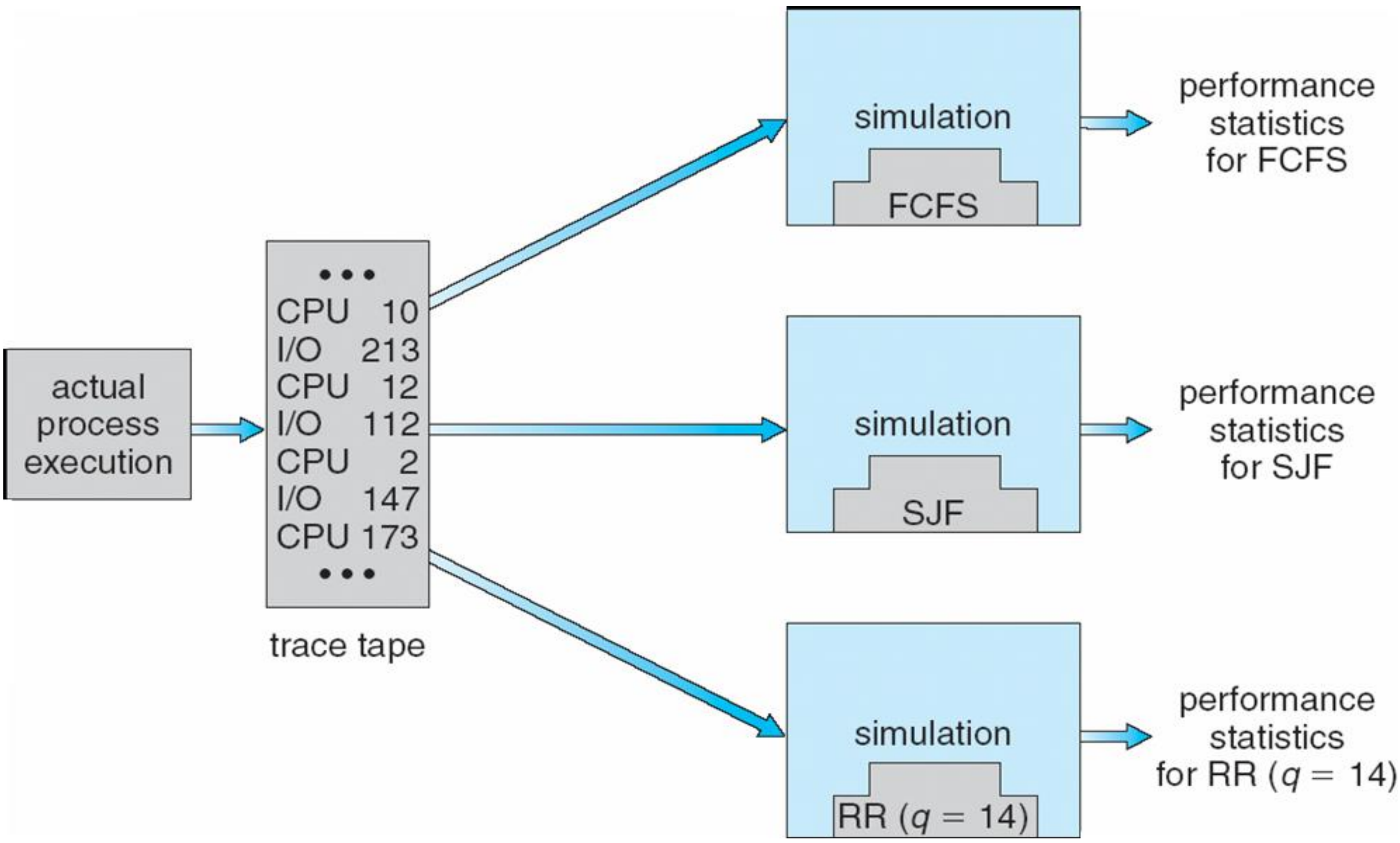
What is waiting time?

W = n/L

W = 8.88/5

W = 1.7 sec

Simulation


actual
process
execution
CPU 10
I/O 213
CPU 12
I/O 112
CPU 2
I/O 147
CPU 173
trace tape
simulation
FCFS
simulation
SJF
simulation
RR (q = 14)
performance
statistics
for FCFS
performance
statistics
for SJF
performance
statistics
for RR (q = 14)

Bibliography

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❖I have drawn materials from various sources such as mentioned in bibliography or freely available on Internet to prepare this presentation.

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Thank You!!

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