5118020-03 Operating Systems

Scheduling

OSTEP Chapter 7

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Scheduling Policy

- scheduling policy
  - In which order processes would be dispatched
  - How much amount of time would be given to a process when it’s dispatched
- workload
  - characteristics of the running processes in a system
  - derived from the program properties or captured by runtime monitoring

Workload Assumption for Discussion

1. Each job runs for the same amount of time.
2. All jobs arrive at the same time.
3. Once started, each job runs to completion.
4. All jobs only use the CPU (i.e., they perform no I/O)
5. The running time of each job is known before execution

Scheduling Metrics

- scheduling metric: a measurement of *goodness* of a scheduling policy

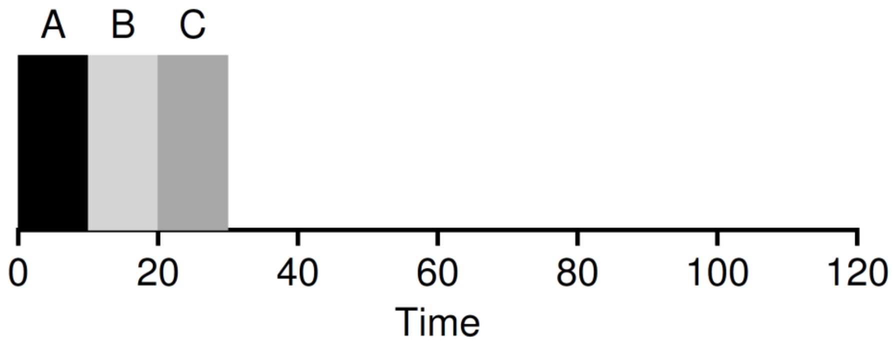
- **turnaround time**: the difference between the time at which the job completes and the time at which the job arrived
  - performance metric
  - upon the assumptions, it’s the same as the time to complete a process

- **response time**: the difference between the time when a job arrives and the first time it is scheduled
  - fairness metric

First In First Out (FIFO) Scheduling Policy

- First come, first served
- Pros: clear, simple, easy to implement, lightweight
- Cons: convoy effect

- Process A
  - arrives at 0
  - requires 10
- Process B
  - arrives at 0
  - requires 10
- Process C
  - arrives at 0
  - requires 10

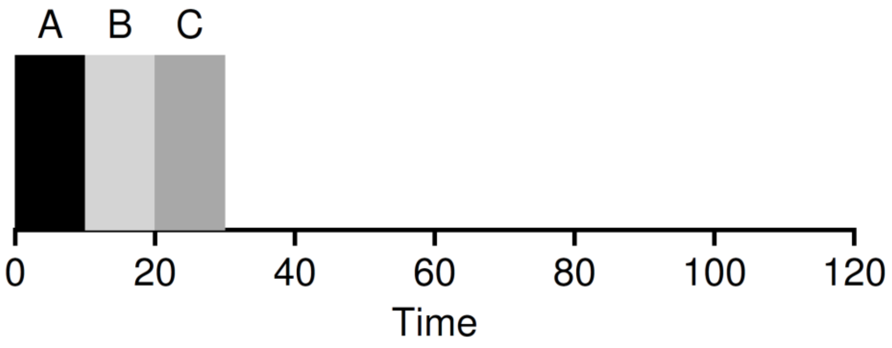


average turnaround time:
20 = (10 + 20 + 30) /3

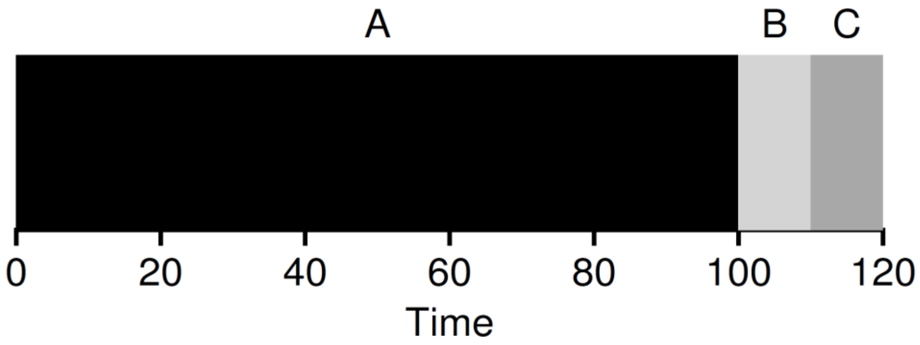
First In First Out (FIFO) Scheduling Policy

- First come, first served
- Pros: clear, simple, easy to implement, lightweight
- Cons: convoy effect

- Process A
  - arrives at 0
  - requires 100
- Process B
  - arrives at 0
  - requires 10
- Process C
  - arrives at 0
  - requires 10



average turnaround time:
20 = (10 + 20 + 30) /3

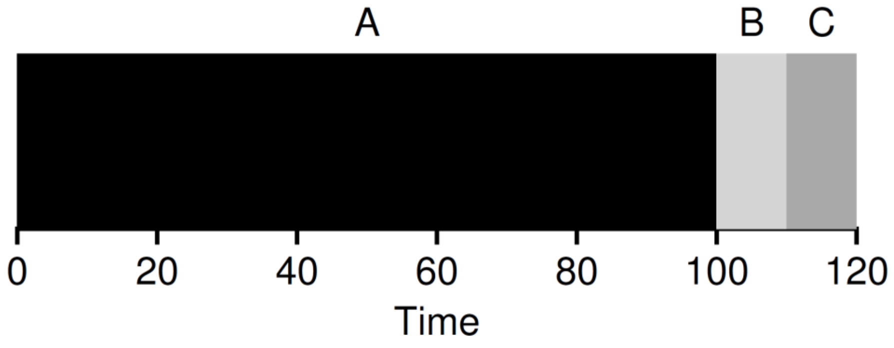


average turnaround time:
110 = (100 + 110 + 120) /3

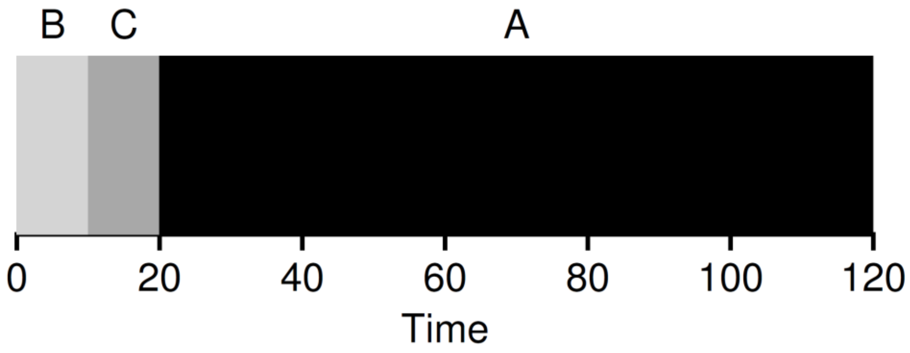
Shortest Job First (SJF) Scheduling Policy

- runs the shortest job first, then the next shortest, and so on
- optimal with respect to the average turnaround time

- Process A
  - arrives at 0
  - requires 100
- Process B
  - arrives at 0
  - requires 10
- Process C
  - arrives at 0
  - requires 10



average turnaround time with FIFO:
110 = (100 + 110 + 120) /3



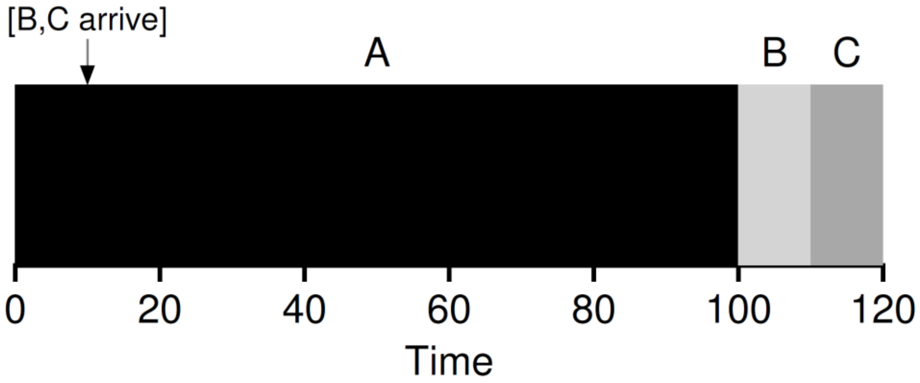
average turnaround time with SJF:
50 = (10 + 20 + 120) /3

Shortest Time-to-completion First (STCF)

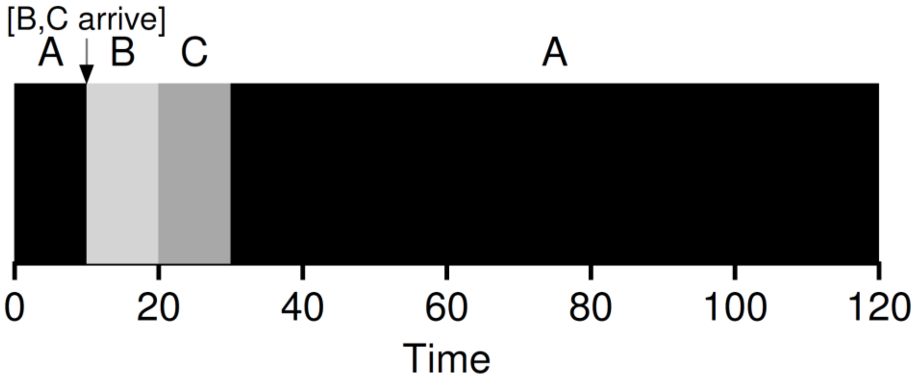
- preemptive version of SJF
  - schedules the one that has the least time left at a new job arrives

- Process A
  - arrives at 0
  - requires 100
- Process B
  - arrives at 10
  - require 10
- Process C
  - arrives at 10
  - require 10

case of SJF



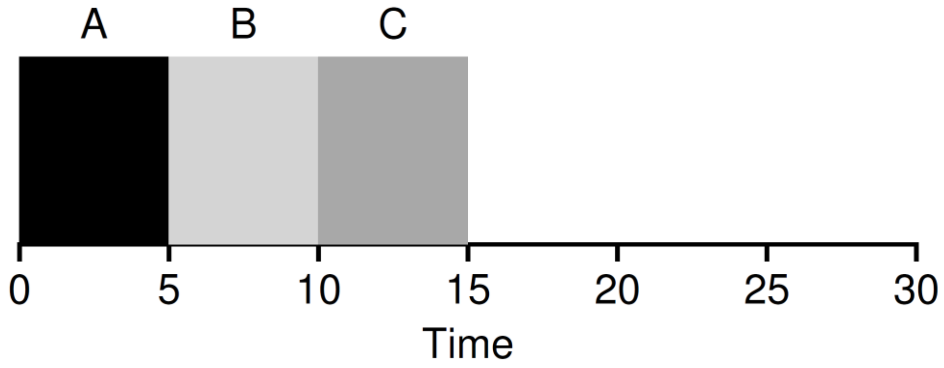
case of STCF



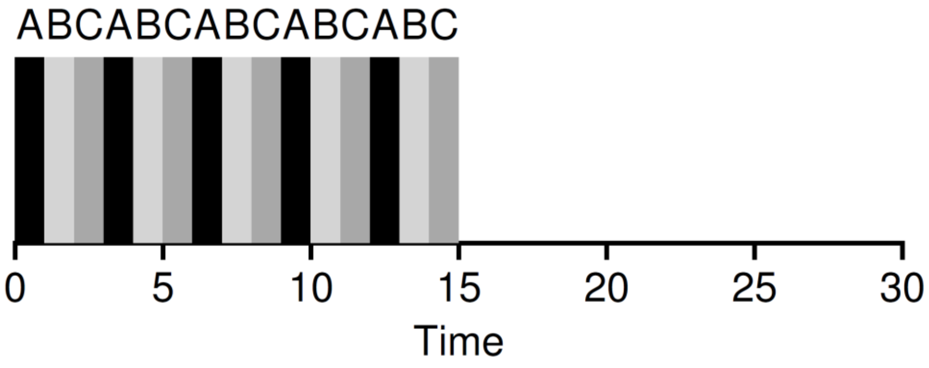
Round Robin (RR) Scheduling Policy

- Response time: the time from when a job arrives to the first time it is scheduled/responed
  - interactive performance measure

- RR runs a job for a time slice (scheduling quantum) and then switches to the next one in the ready queue
  - trace off between responsiveness and context switching overhead

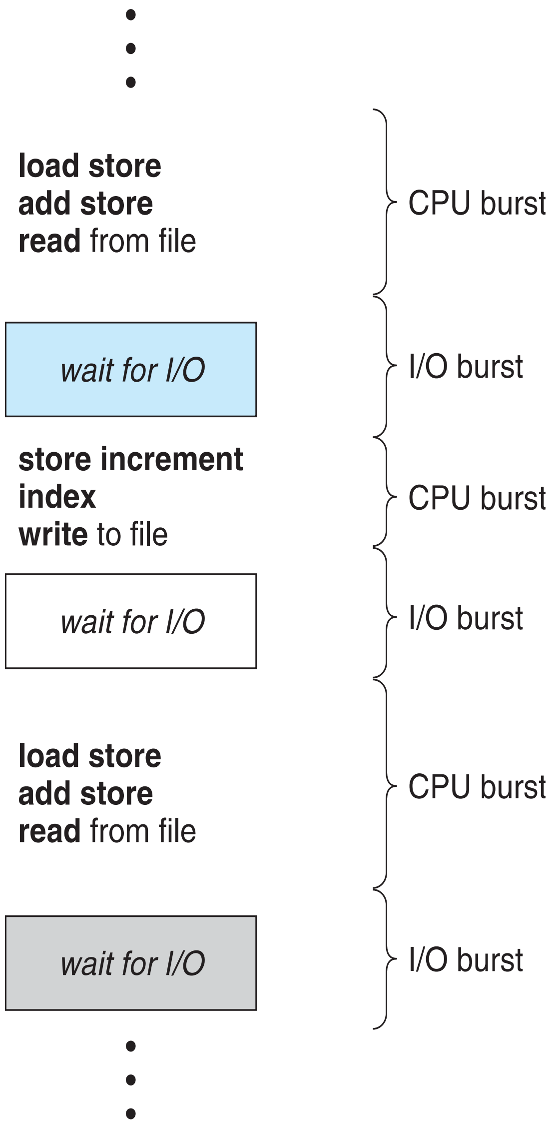


SJF –
response time: 5

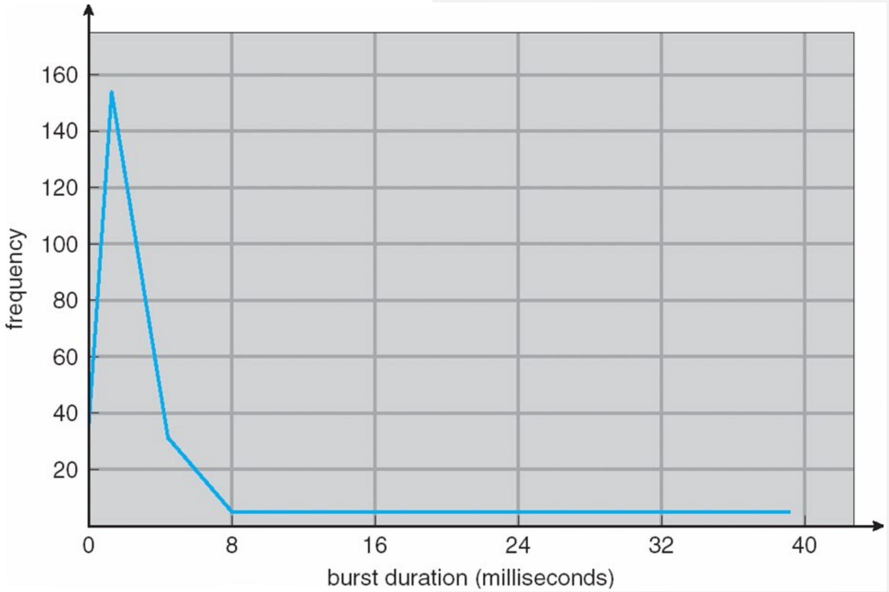


Round Robin –
response tme: 1

CPU Burst and I/O Burst Cycle

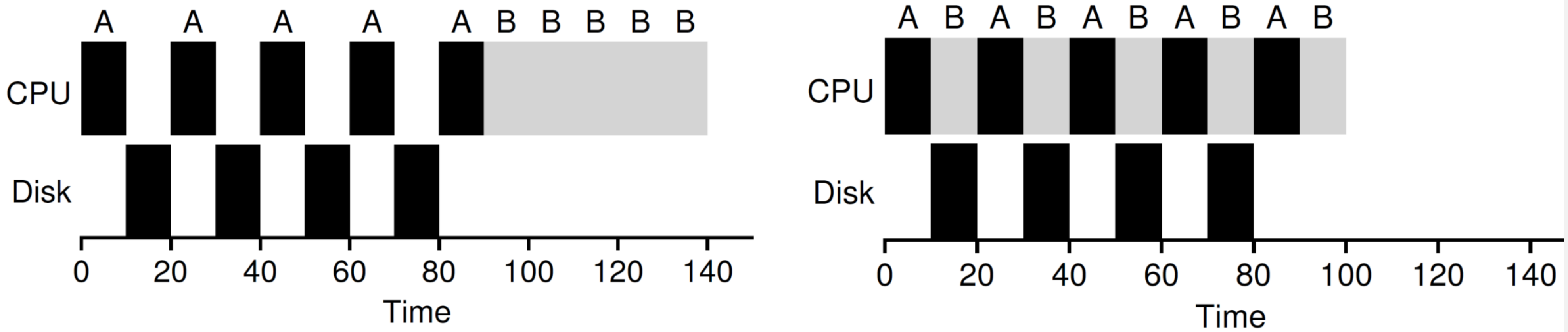


- process execution consists of a cycle of CPU execution and I/O wait
- CPU burst followed by I/O burst
- CPU burst distribution is of main concern



Incorporating I/O

- The scheduler operates when I/O completes, moves the blocked process back to the ready queue
- First schedule one with a shorter CPU burst, and then one with a longer CPU burst
  - an interactive process tends to have short CPU-burst time, and get scheduled much frequently
  - CPU- and I/O-burst can be overlapped, thus CPU can be utilized better



c.f. Time Scale of System Latencies

Event	Latency	Scaled
1 CPU cycle	0.3 ns	1 s
Level 1 cache access	0.9 ns	3 s
Level 2 cache access	2.8 ns	9 s
Level 3 cache access	12.9 ns	43 s
Main memory access (DRAM, from CPU)	120 ns	6 min
Solid-state disk I/O (flash memory)	50–150 μs	2–6 days
Rotational disk I/O	1–10 ms	1–12 months
Internet: San Francisco to New York	40 ms	4 years
Internet: San Francisco to United Kingdom	81 ms	8 years
Internet: San Francisco to Australia	183 ms	19 years
TCP packet retransmit	1–3 s	105–317 years
OS virtualization system reboot	4 s	423 years
SCSI command time-out	30 s	3 millennia
Hardware (HW) virtualization system reboot	40 s	4 millennia
Physical system reboot	5 m	32 millennia