Systems 3

Scheduling

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B10 11:05am On Time
DELTA 2106 D01 11:15am Boarding
DELTA 4547 B12 1:30pm On Time
DELTA 780 C03 11:05am Boarding
DELTA 4649 E83 3:00pm On Time
5296 E83 2:00pm On Time
6729 D09 11:00am Boarding
DELTA 7383 E70 11:10am On Time
B7 11:09am On Time
Boarding

Photo by Matthew Smith on Unsplash

How many active processes are running?

1. The program in foreground
2. Mail daemon
3. Update checker
4. SSH client
5. Antivirus program
6. …

Chapter Goals

- How do processes (and threads) use the CPU?
- Why do we need scheduling?
- What are the different scheduling options? What are their pros and cons?
- Can we achieve fairness?
- What is the difference between a thread and a process?
- What are the advantages of threads?

Different process behavior

- **compute-bound**
  spend most of their time computing
- **I/O-bound**
  spend most of their time waiting for I/O

When to Schedule

When scheduling is absolutely required:

1. When a process exits.
2. When a process blocks on I/O or a mutual exclusion mechanism.

When scheduling usually done (though not absolutely required)

1. When a new process is created.
2. When an I/O interrupt occurs.
3. When a clock interrupt occurs.

Why? When?

Goals of scheduling algorithms

- All systems
  - Fairness
  - Policy enforcement
  - Balance
- Batch systems
  - Throughput
  - Turnaround time
  - CPU utilization
- Interactive systems
  - Response time
  - Proportionality
  - User happiness
- Real-time systems
  - Avoiding event loss
  - Avoiding data loss
  - Predictability

Basic algorithms for batch systems

FCFS First-Come First-Serve (nonpreemptive)

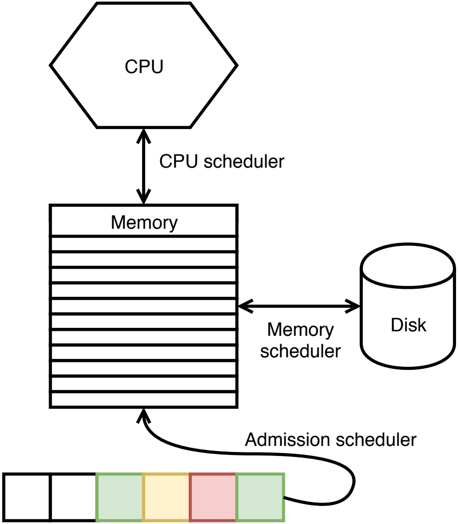
SJF Shortest Job First (nonpreemptive)

SRT Shortest Remaining Time Next (preemptive)

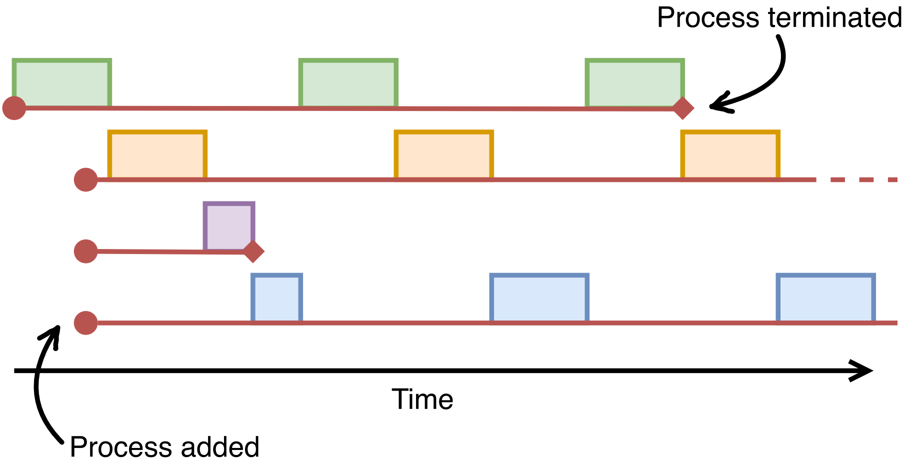
Three Level Scheduling

Criteria for deciding which process to choose:

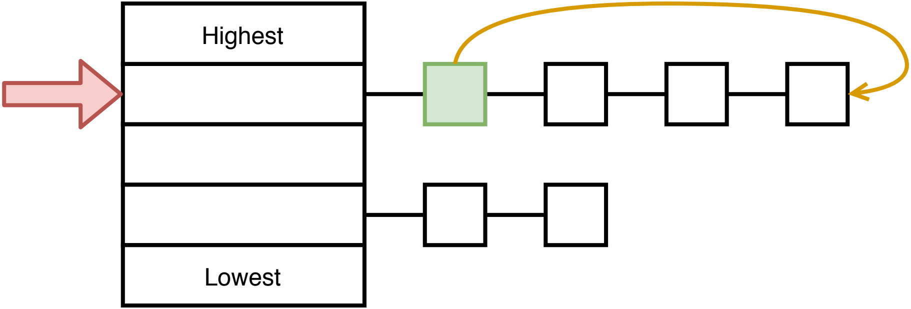
- How long has it been since the process was swapped in or out?
- How much CPU time has the process had recently?
- How big is the process? (Small ones do not get in the way.)
- How important is the process? How determined?



RR: Round-Robin Scheduling

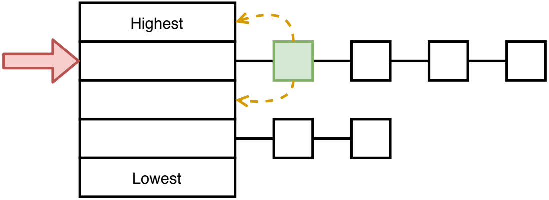


Priority Scheduling



Starvation!

Dynamic Priorities



- Processes are associated with priorities
- Scheduling as in Priority Scheduling
- Additionally:
    - When a process uses up its quantum, it's priority is reduced
    - When a process does not use up its quantum, it's priority is increased

What does this achieve?

Real-time Systems

- time limit
- hard[1] vs. soft[2] real time
- processes with predictable behavior
- processes (or actions) are generally short lived

[1] Something bad is going to happen (e.g., brake system)

[2] The value of the result to be computed is reduced or zero (e.g., video playout)

What is used?

System	Goals	Scheduler
Real-time	React to events in time	Strict Priority
Server	Fast reaction to many requests	Dynamic priority
HPC	Finish simulations fast	Don't care/Admission
Desktop	Fast reaction to user inputs	Dynamic priority