Topic 8: CPU Scheduling

- Readings for this topic: Chapter 5.
- OS typically consists of two parts: 1) Process coordination, and 2) Resource Management
- Resources fall into two classes:
  - Preemptible vs Non-preemptible

  - Is this distinction absolute? Real issue?

- OS makes two related kinds of decisions about resources. What is the goal?
  - Allocation: who gets what. Implication?

  - Scheduling: how long can they keep it. Implication?

- Resource #1:
- Processes may be in any one of three general scheduling states:
  - Running.
  - Ready.
  - Blocked.

- Goals for scheduling disciplines:
  - Efficiency of resource utilization. *(keep CPU and disks busy)*
  - Minimize overhead. *(context switching)*
  - Distribute cycles equitably. What does this mean?
• FIFO (also called FCFS): run until finished.
  • Usually, “finished” means “blocked”.
  • Problem?

• Solution: limit maximum amount of time that a process can run without a context switch. This time is called a time slice.

• Round Robin: run process for one time slice, then move to back of queue. Each process gets equal share of the CPU. What if the slice isn’t chosen carefully?
  • Too long:
  • Too small:

• Originally, Unix had 1 sec. time slices. Right size?
  Most systems today use time slices of 10,000 - 100,000 instructions.

• How to implement priorities in RR?

• Is RR always better than FIFO?

• What is the best we can do? Is there “perfect” scheduling algorithm? STCF: shortest time to completion first with preemption. In what sense is it the best?

• Example: two processes, one doing 1 ms computation followed by 10 ms I/O, one doing all computation. Suppose we use 100 ms time slice: I/O process only runs at 1/10th speed, I/O devices are only utilized 10% of time. Suppose we use 1 ms time slice: then compute-bound process gets interrupted 9 times unnecessarily for each valid interrupt. STCF works well.

• Why not using STCF?

• Rule of thumb: Give the most to those who need the least. What’s the idea here?

• The strategy?
• Exponential Queue (or Multi-Level Feedback Queues):
  • Give newly runnable process a high priority and a very short time slice. If process uses
    up the time slice without blocking then decrease priority by 1 and double time slice for
    next time.
  • Go through the above example, where the initial values are 1ms and priority 100.
  • Techniques like this one are called adaptive. They are common in interactive systems.
  • The CTSS system (MIT, early 1960’s) was the first to use exponential queues.

• Fair-share scheduling:
  • Keep history of recent CPU usage for each process.
  • Give highest priority to process that has used the least CPU time recently. Highly in-
    teractive jobs, like vi, will use little CPU time and get high priority. CPU-bound jobs,
    like compiles, will get lower priority.
  • Can adjust priorities by changing “billing factors” for processes. E.g. to make high-
    priority process, only use half its recent CPU usage in computing history.

• Performance evaluation of scheduling algorithms:
  • Analytic methods:
    • deterministic modeling
    • queueing model
  • simulation
  • implementation

• Summary:
  • In principle, scheduling algorithms can be arbitrary, since the system should produce the
    same results in any event.
  • Scheduling algorithms have strong effects on the system’s overhead, efficiency, and
    response time.
  • The best schemes are adaptive. To do absolutely best, we need to predict the future.