CSE451 Scheduling
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Lecture #6

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Today

- Finish comparing user and kernel threads
- Whether it be processes or threads that are the basic execution unit the OS needs to some way of scheduling each process time on the CPU
- Why?
  - To make better utilization of the system

Goals for Multiprogramming

- In a multiprogramming system, we try to increase utilization and throughput by overlapping I/O and CPU activities.
- This requires several os *policy* decisions:
  - Determine the *multiprogramming level* -- the number of jobs loaded in primary memory
  - Decide what job is to run next to guarantee good service
- These decisions are long-term and short-term scheduling decisions, respectively.
- Short-term scheduling executes more frequently, changes of multiprogramming level are more costly.

Scheduling

- The *scheduler* is a main component in the OS kernel
- It chooses processes/threads to run from the ready queue.
- The *scheduling algorithm* determines how jobs are scheduled.
- In general, the scheduler runs:
  - When a process/thread switches from running to waiting
  - When an interrupt occurs
  - When a process/thread is created or terminated
- In a *preemptive* system, the scheduler can interrupt a process/thread that is running.
- In a *non-preemptive* system, the scheduler waits for a running process/thread to explicitly block

Preemptive and Non-preemptive Systems

- In a non-preemptive system the OS will not stop a running jobs until the job either exists or does an explicit wait
- In a preemptive system the OS can potentially stop a job midstream in its execution in order to run another job
  - Quite often a timer going off and the current jobs time-slice or quantum being exhausted will cause preemption

Preemptive and Non-preemptive System (continued)

- I cannot over emphasize the need to understand the difference between preemptive and non-preemptive systems
- Preemptive systems also come in various degrees
  - Preemptive user but non-preemptive kernel
  - Preemptive user and kernel
- This affects your choice of scheduling algorithm, OS complexity, and system performance

Scheduling Algorithms Criteria

- There are many possible criteria for evaluating a scheduling algorithm:
  - CPU utilization
  - Throughput
  - Turnaround time
  - Waiting time
  - Response time
- In an interactive system, predictability may be more important than a low average but high variance.
- One OS goal is to give applications the illusion they are running unhindered by other jobs sharing the CPU and memory

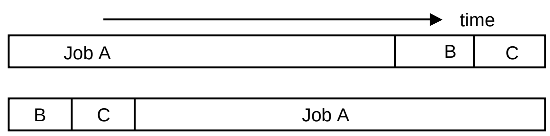
Various Scheduling Algorithms

- First-come First-served
- Shortest Job First
- Priority scheduling
- Round Robin
- Multi-level queue

- We'll examine each in turn

Scheduling Algorithms
First-Come First-Served

- First-come First-served (FCFC) (FIFO)
  - Jobs are scheduled in order of arrival to ready Q
  - Typically non-preemptive
- Problem:
  - Average waiting time can be large if small jobs wait behind long ones



  - May lead to poor overlap of I/O and CPU

Scheduling Algorithms
Shortest Job First

- Shortest Job First (SJF)
  - Choose the job with the smallest (expected) CPU burst
  - Provability optimal min. average waiting time
- Problem:
  - Impossible to know size of CPU burst (but can try to predict from previous activity)
- Can be either preemptive or non-preemptive
- Preemptive SJF is called *shortest remaining time first*

Scheduling Algorithms
Priority Scheduling

- Priority Scheduling
  - Choose next job based on priority
  - For SJF, priority = expected CPU burst
  - Can be either preemptive or non-preemptive
- Problem:
  - Starvation: jobs can wait indefinitely
- Solution to starvation
  - Age processes: increase priority as a function of waiting time

Scheduling Algorithms
Round Robin

- Round Robin
  - Used for timesharing in particular
  - Ready queue is treated as a circular queue (FIFO)
  - Each process is given a time slice called a *quantum*
  - It is run for the quantum or until it blocks
- Problem:
  - Frequent context switch overhead

Scheduling Algorithms
Multi-level Queues

- Multi-level Queues
  - Probably the most common method used
  - Implement multiple ready Queues based on the job priority
  - Multiple queues allow us to rank each job's scheduling priority relative to other jobs in the system
  - Windows NT/2000 has 32 priority levels
    - Each running job is given a time slice or quantum
    - After each time slice the next job of highest priority is given a chance to run
    - Jobs can migrate up and down the priority levels based on various activities

Next time

- With so much potentially going on in the system how do we synchronize all of it?