

# CSc 360

## Operating Systems

### More on Scheduling

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## Review: scheduling

- Scheduling algorithm
  - FCFS
    - “convey effect”
  - SJF
    - optimal in terms of ...
    - “starvation”
  - priority
  - RR

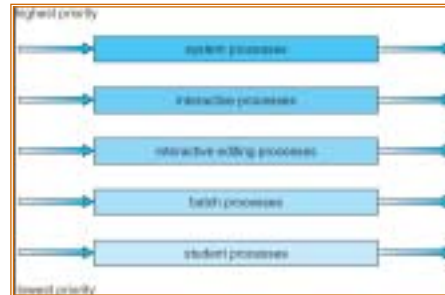
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## Multi-queue scheduling

- “No one fits all”
- Multi-queue approach
  - foreground queue
    - e.g., RR; better fairness
  - background queue
    - e.g., FCFS; more efficient
- Inter-queue scheduling
  - priority, time sharing (e.g., “80% rule”)



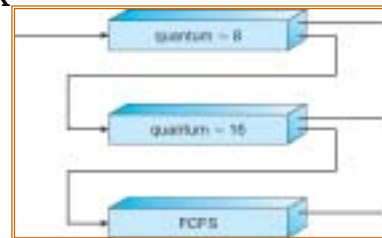
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## Multi-queue with feedback

- Multi-queue
  - number of queues
  - queuing algorithm for each queue
- Multi-queue with feedback
  - promote jobs
  - demote jobs
  - example



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## Multi-processor queuing

- Load balance between processors
  - cooperation and communication
- Asymmetric multiprocessing
  - one master scheduler
- Symmetric multiprocessing
  - cooperative schedulers
    - processor affinity: try to stick with one
    - load balancing: push or poll migration

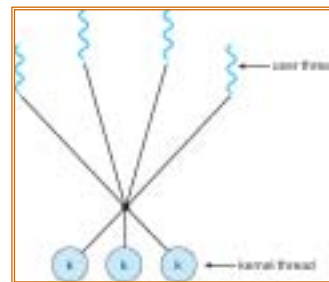
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## More on scheduling

- Thread scheduling
  - local: user  $\rightarrow$  kernel thread
    - e.g., within a process
  - global: kernel thread  $\rightarrow$  CPU
    - e.g., across the system
- Algorithm evaluation
  - queuing analysis
    - Little's law:  $n = \lambda * W$
  - simulation



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# Linux scheduling

- Scheduler
  - $O(n)$ : global run queue (Linux 2.4)
    - $n$ : number of processes
  - $O(1)$ : double linked list (Linux 2.6)
    - active/expired set
- 140 priority levels
  - realtime (0-99), user (100-139)
- Interactive vs CPU-bound: interactivity

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# Pthread scheduling

- `pthread_attr_setschedpolicy ();`
  - regular, non-realtime (nice-able)
  - realtime, round-robin (preemptive, privileged)
  - realtime, FCFS (non-preemptive, privileged)
- `pthread_attr_setschedparam ();`
- `pthread_attr_setscope ();`
  - scheduling within a process
  - scheduling for the entire system

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## This lecture

- More on scheduling
  - multi-queue scheduling
  - multi-processor scheduling
  - scheduling evaluation
    - Little's law
- Explore further
  - list process priority: `/usr/bin/top`
  - change priority: `/bin/nice`

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## Next lecture

- Midterm
  - topics: “This lecture”

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