Scheduling

Scheduling

- scheduling: share CPU among processes
- scheduling should:
  - be fair
    - all processes must be similarly affected
    - no indefinite postponement
      - "aging" as a possible solution
        - adjust priorities based on waiting time for resource
  - max. possible no of processes per unit time
  - reduce response time for interactive users

Scheduling

- priorities should be used
- if critical resources exist: run processes using those first so that the resources become available quickly
- not fail even under very heavy load
  - e.g. accept no new processes to system
  - e.g. lower quantum

Scheduling Criteria

- I/O bound
- CPU bound
- interactive / batch
- importance of quick response
- priority
- real execution time
- time to completion

Scheduling

- preemptive x non-preemptive scheduling
- preemptive
  - high cost of context switching
  - to be effective, there must be a sufficient amount of processes ready to run in memory

Priorities

- static x dynamic priorities
- static priorities
  - fixed during execution
  - easy to implement
  - not efficient
- dynamic priorities
  - change based on environment changes
  - harder to implement + more CPU time
  - enhances response times

Scheduling Example

Process	Time of Arrival	Service Time
1	0	3
2	2	6
3	4	4
4	6	5
5	8	2

Scheduling Techniques

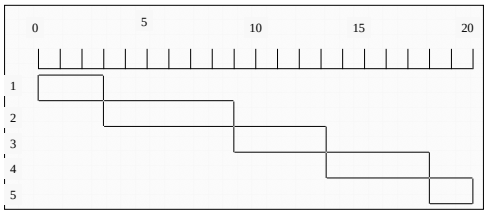
- Deadline scheduling
  - order processes based on their ending times
    - useless if process is not completed on time
  - process must declare all resource requests beforehend
    - may not be posible
  - plan resource allocation based on ending times
    - new resources may become available

Scheduling Techniques

- FIFO scheduling
  - simplest technique
  - order based on arrival times
  - non-preemptive
  - processes with short service times wait unnecessarily because of processes requring long service times
    - ineffective for interactive processes
    - response times may be too long
  - ineffective for I/O bound proceses
    - I/O ports may be available while the process waits for a CPU bound process to complete

  $\Rightarrow$ FIFO usually used together with other techniques

Example: FIFO Scheduling



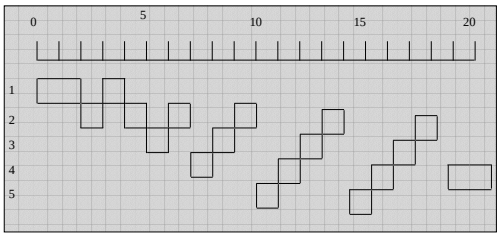
Scheduling Techniques

- Round-Robin schedulling
  - FIFO-like
  - assign CPU to processes for fixed time units in turn
  - preemptive
  - quantum = time slice
  - if not completed within quantum: move to end of queue
  - effective for interactive processes
  - has context switching

Scheduling Techniques

- selection of quantum is critical
  - has effect on performance of system
    - short x long
    - fixed x variable
    - same x different for each user
  - if too long quantum $\Rightarrow$ becomes FIFO
  - if too short quantum $\Rightarrow$ too much time for context switches
  - correct quantum sizes different for different types of systems

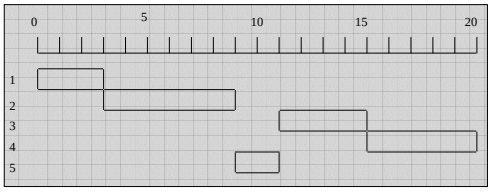
Example: Round-Robin Scheduling



Scheduling Techniques

- shortest-job-first scheduling
  - non-preemptive
  - order based on shortest time to completion
  - decreased average waiting times compared to FIFO
  - better service for short jobs
  - not suitable for interactive processes
  - total running time must be known beforehand
    - user provides estimate
      - if requires more than estimate, stop process and run later
    - if jobs repeat, may know running time

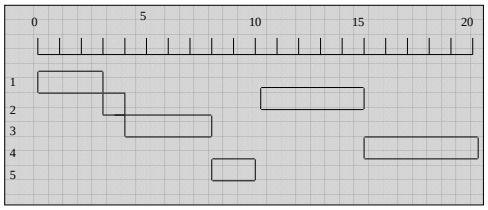
Example: Shortest-Job-First Schedulling



Scheduling Techniques

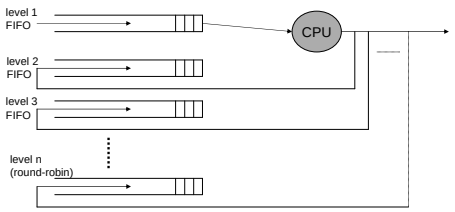
- shortest time remaining
  - preemptive version of previous technique
    - good performance for time-sharing systems
  - run process with least time remaining to completion
    - consider new arrivals too
    - a running process may be preempted by a new, short process
  - total running time must be known beforehand
  - more time wasted
    - used / remaining time calculations
    - context switching

Example: shortest time remaining



Scheduling Techniques

- Multilevel queues



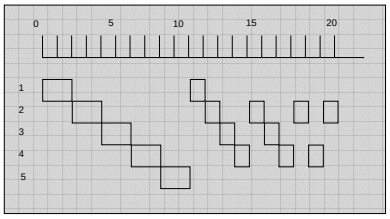
Scheduling Techniques

- new process to end of level 1
- FIFO within levels
- if not completed within quantum, go to end of lower level
- limited no of levels
- in last level, round-robin instead of FIFO
- short, new jobs completed in a short time
- in some systems, longer quantum at lower levels

Scheduling Techniques

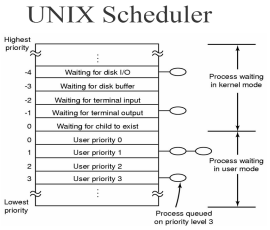
- processes at higher level queues finished before those in lower levels can be run
- a running process may be preempted by a process arriving to a higher level
- in some systems stay in same queue for a few rounds
  - e.g. at lower level queues

Example: Multilevel Queues



Assumption: Max 3 levels in system.

Scheduling in UNIX Systems



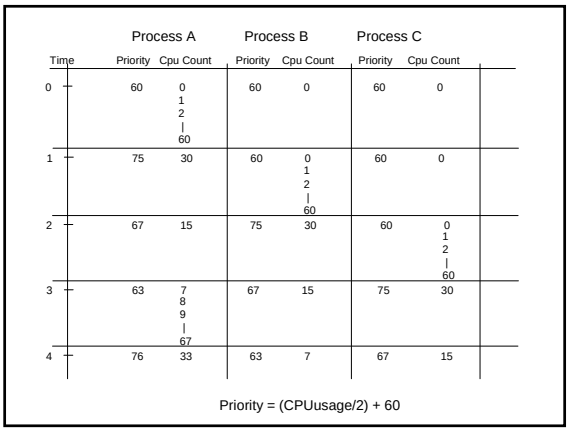
Scheduling in UNIX Systems

Priority = CPU_usage + nice + base

CPU_usage = ΔT/2

Example:

- Assume only 3 processes
- base=60
- no nice value
- clock interrupts system 60 times per quantum
- start with the order Process A, B and C



Priority = (CPUusage/2) + 60