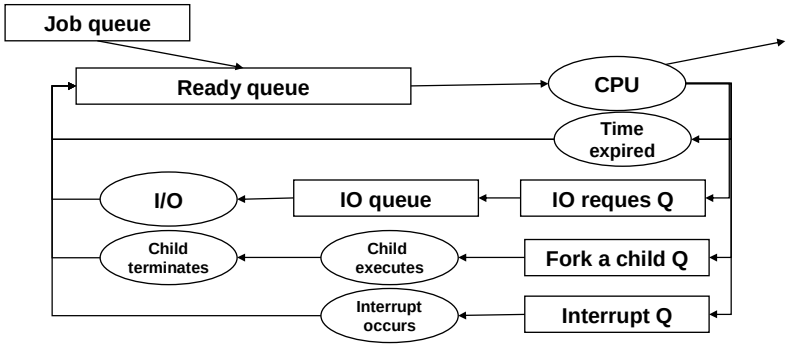
CPU Scheduling



Concepts

- **Scheduler:**
  - ♦ **OS entity which decides in which order and how long a process in the ready list will execute on the CPU.**
- **CPU I/O Burst Cycle:**
  - ♦ **processes execution generally cycles through CPU execution and IO wait.**
- **Preemptive Scheduling:**
  - ♦ **a process already in the CPU may be suspended dynamically, even when it did not finish or did not voluntary request wait.**

Concepts (contd..)

- **Dispatcher**
  - ♦ **the specific module which gives control of CPU to the process selected by the short-term scheduler**
- **Dispatch Latency**
  - ♦ **the time it takes to dispatch; that is: switching context+switching to user mode+jump to the correct location of the new user process**
- **Starvation**
  - ♦ **A situation when a process is deprived of any CPU time for indefinite period.**

Scheduling Performance Criteria

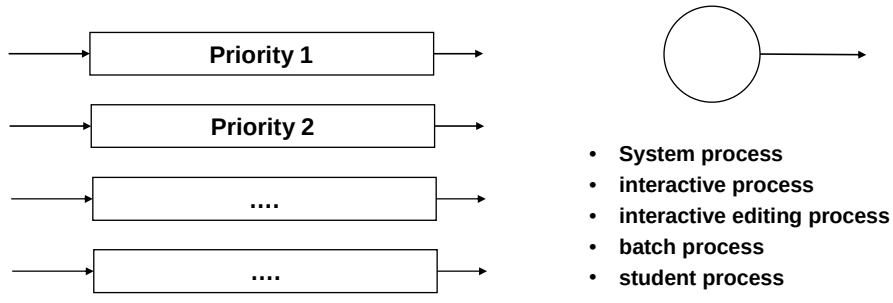
- **CPU utilization:**
  - ♦ **time CPU executed user process/ total time**
- **Throughput**
  - ♦ **# of completed process/ total time**
- **Turn-around time**
  - ♦ **total waiting time+total execution time= time submitted-time completed**
- **Waiting time**
  - ♦ **total time spent waiting in the ready queue**
- **Response time**
  - ♦ **the initial time in the waiting queue**

Desirable Goals?

Scheduling Policies

- **First-In-First-Out (FIFO)**
- **Shortest-Job-First (SJF)**
- **Preemptive Shortest-Job-First (pSJF)**
- **Priority Scheduling**
- **Round Robin (RR)**
- **Multilevel Queue**
- **Multilevel Feedback Queue**

Multilevel Queue



- **System process**
- **interactive process**
- **interactive editing process**
- **batch process**
- **student process**

- **High Priority First or CPU time slice**
- **Processes are permanently assigned**
- **Each Queue can have its own scheduling algorithm**
- **Starvation possible**

Thread Scheduling

- **Load Sharing**
  - ♦ **Very effective on multiprocessor system**
  - ♦ **First Come First Served**
  - ♦ **Smallest number of threads first**
  - ♦ **Preemptive smallest number of threads first**
- **Gang Scheduling**
  - ♦ **Less number of blocks**
  - ♦ **Less context switching**
- **Dedicated Processor Assignment**
  - ♦ **Absolutely no context switching**
  - ♦ **Suitable for massively multiprocessor system**
- **Dynamic Scheduling**
  - ♦ **Compiler+OS controls the number of threads**

Real Time Scheduling

- **Hard realtime vs. soft realtime.**
- **Periodic vs. aperiodic realtime jobs.**
- **Preemption points**

Multiprocessor Scheduling

- **Heterogenenous vs. Homogeneous**
- **Self Scheduling vs. Master-Slave**
  - ♦ **queue access**
  - ♦ **master bottleneck**

Example UNIX 4.3 BSD

- **Multilevel Feedback with Round Robin in each group.**
- **Bands:**
  - **Swapper**
  - **Block I/O device control**
  - **File manipulation**
  - **Character I/O device control**
  - **User Processes**
- **Priority Computation:**

$$CPU_j(t) = \tfrac{1}{2}U_j(t) + \tfrac{1}{2}CPU_j(t-1)$$

$$p_j(t) = Base_j + CPU_j(t-1) + nice_j$$

WINDOWS NT Scheduling

Design Objective: Maximum Responsiveness

- **Priority Driven Preemptive Scheduler**
- **Two priority bands**
  - **real-time (31-16)**
  - **variable (15-0)**
- **Real time processed have fixed priority**
- **Other processes have dynamic priority**
  - **P=process-base (0-15) +thread-base (-2 to +2)**
  - **for preempted threads --thread -base**
  - **for on I/O, interrupt threads ++thread-base;**
  - **for wait on keyboard/display I/O thread ++++thread-base;**
- **On N-multiprocessor system**
  - **(N-1) processors gets (N-1) top priority threads.**
  - **Remaining 1 processor runs remaining threads.**
- **Allows processor affinity**
  - **bound thread blocks until the affined processor is free.**