Processes

Systems II

Process Concept

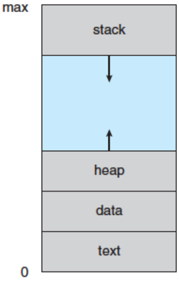
A process is a program in execution.

- Batch systems (early computers) executed jobs.
- Time-shared systems ran user programs, or tasks.
- The modern term is process.

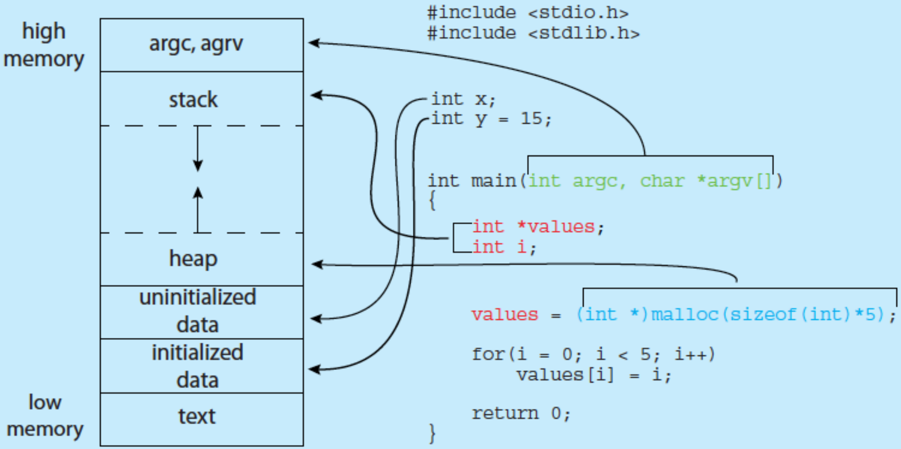
The Process

Status of the current activity:

- processor's registers (program counter)
- memory layout:
  - text section: executable code
  - data section: global variables
  - heap section: dynamically allocated memory during program run time
  - stack section: temporary data storage for functions (parameters, return addresses, local variables – activation record)



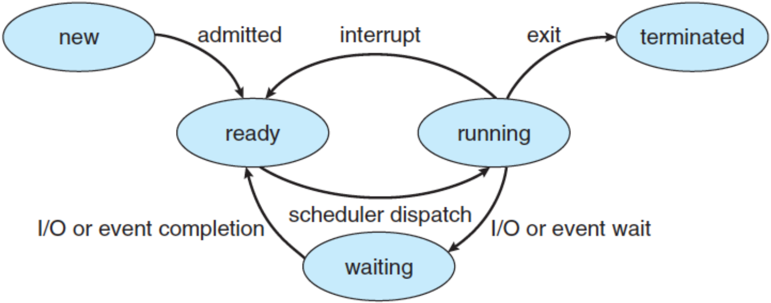
Memory layout of a C program



```
#include <stdio.h>
#include <stdlib.h>

int x;
int y = 15;

int main(int argc, char *argv[])
{
    int *values;
    int i;

    values = (int *)malloc(sizeof(int)*5);

    for(i = 0; i < 5; i++)
        values[i] = i;

    return 0;
}
```

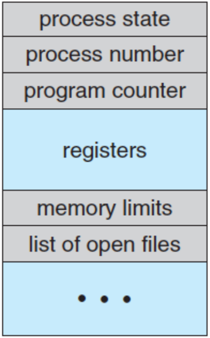
Process State

- new: the process is being created
- running: instructions are being executed
- waiting: the process is waiting for some event to occur
- ready: the process is waiting to be assigned to a processor
- terminated: the process has finished execution



Process Control Block (PCB)

- process state
- CPU registers, program counter
- CPU-scheduling information (process priority, etc.)
- memory-management information (base & limit, or page table)
- accounting information (amount of CPU and real time used, time limits, . . .)
- I/O status information (list of I/O devices allocated to the process, a list of open files)



On systems that support threads, the PCB is expanded to include information for each thread.

Process Scheduler

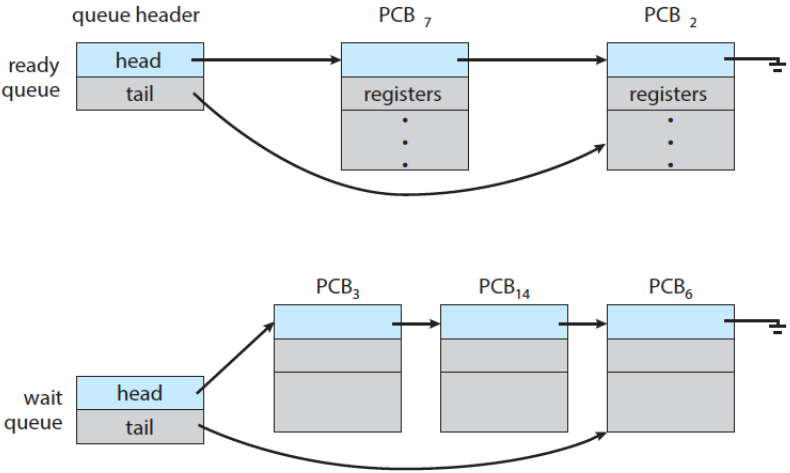
Process scheduler is a part of the kernel that selects an available process for execution on a CPU (core).

Degree of multiprogramming is the number of processes currently in memory.

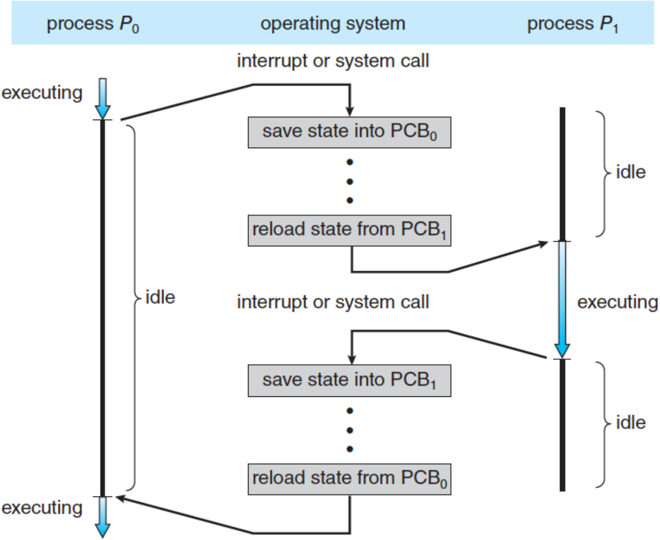
I/O-bound process: spends more of its time doing I/O than it spends doing computations.

CPU-bound process: generates I/O requests infrequently, using more of its time doing computations.

Scheduling Queues



Context Switch

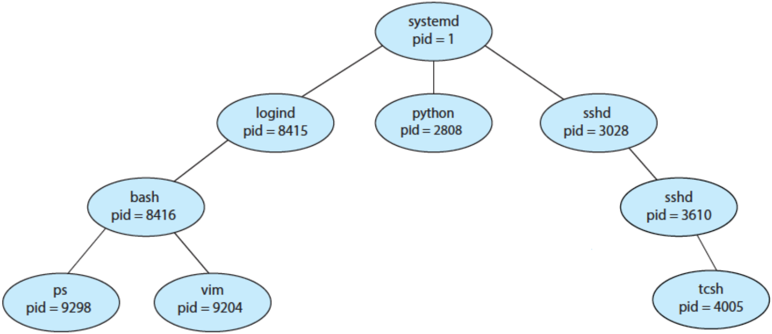


Operations on Processes

Process Creation

In most OS, processes may be created and deleted dynamically.

Process tree (Linux):



Each process has a process identifier (pid).
`ps` and `pstree` commands

Operations on Processes

Process Termination

exit() system call

cascading termination: if a process terminates its children have to be terminated

zombie: process terminated but its parent has not called `wait()` yet

orphan: parent process terminated