Today’s Plan

Upcoming:
- Quiz #2
- Assignment 1

Last time:
- Quiz #1 recap
- OS services
- System calls

Today’s topics:
- From last time:
  - Operating System Design and Implementation
  - Operating System Structure
  - Virtual Machines
  - Chapter 3
    - Introducing the Process Concept

Quiz #2
Assignment 1
What is a Process?

- Fundamental building block of modern operating systems is the notion of a process
- A process is a running program (a program in execution). This includes:
  - All programs running on behalf of users (application programs)
  - Some operating system functions are also implemented using processes
Much of the functionality of a modern OS is the work required to manage processes.

OS may have hundreds of processes active at the same time.

Processes are not found in the operating system kernel.
What is **not** a Process?

- A program by itself is not a process
- There is no one-to-one correspondence between programs and processes
  - E.g. there may be 10 people using emacs at the same time, i.e. 10 processes running emacs, but only one copy of the emacs program on disk
  - E.g. there may be many programs on disk that are not executing at the present time
A Process in Memory

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<table>
<thead>
<tr>
<th>max</th>
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<tbody>
<tr>
<td>stack</td>
</tr>
<tr>
<td>heap</td>
</tr>
<tr>
<td>data</td>
</tr>
<tr>
<td>text</td>
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</tbody>
</table>

- **text:**
- **data:**
- **heap:**
- **stack:**
Modern OSes allow for more than one process to exist at the same time, and since there is usually only one processor, processes must assume different states during their lifetime:

- Running:
- Blocked:
- Ready:
- Deadlocked:
  - OS must recognize this and deal with it
Process State Diagram

READY

RUNNING

BLOCKED

DEADLOCKED
Process Control Block (PCB)

Information associated with each process

- Process state
- Program counter
- CPU registers
- CPU scheduling information
- Memory-management information
- Accounting information
- I/O status information
Process Control Block (PCB)

- process state
- process number
- program counter
- registers
- memory limits
- list of open files
  
  ...
Process Model of an OS

- Modern OSes are a collection of cooperating processes that run on top of (and are supported by) an OS kernel.
- The kernel is responsible for the following services:
  - Creation and destruction of processes
  - CPU scheduling, memory management, device management
  - Process synchronization tools
  - Process communication tools
- OS services provided by the kernel are invoked using *system calls*.