Operating Systems

- **Review Syllabus**
  - read the warning about the size of the project
  - make sure you get the 6th edition (or later) of the book
- **Class Grades Server**
  - Grades.cs.umd.edu
- **Program #0 Handout**
  - its due in just over one week
  - purpose is to get familiar with the simulator
- **Discussion Sections**
  - will focus on the project and meet only once a week (W)
- **Reading**
  - Chapter 1
  - Chapter 2 (for Thursday)

What is an Operating System?

- **Resource Manager**
  - Resources include: CPU, memory, disk, network
  - OS allocates and de-allocates these resources
- **Virtualizer**
  - provides an abstraction of a larger (or just different machine)
  - Examples:
    - Virtual memory - looks like more memory
    - Java - pseudo machine that looks like a stack machine
    - VM - a complete virtual machine (can boot multiple copies of an OS on it)
- **Multiplexor**
  - allows sharing of resources and protection
  - motivation is cost: consider a $40M supercomputer

What is an OS (cont)?

- **Provider of Services**
  - includes most of the things in the above definition
  - provide "common" subroutines for the programmer
    - windowing systems
    - memory management

- **The software that is always loaded/running**
  - generally refers to the Os *kernel.*
    - small protected piece of software

- **All of these definitions are correct**
  - **but** not all operating have all of these features

Closely Related to an Operating System

- **Hardware**
  - OS is managing hardware resources so needs to know about the ugly details of the hardware
    - interrupt vectors
    - page tables
    - I/O registers
  - some features can be implemented either in hardware or the OS
    - Example: page tables on MIPS
- **Languages**
  - can you write an OS in any language?
    - No: need to be able to explicitly layout data structures to match hardware

OS Related Topics (cont)

- **Language Runtime systems**
  - memory management requirements
    - explicit heap management
    - garbage collection
    - stack layout
  - concurrency and synchronization
  - calling convention (how are parameters passed)
- **Data Structure and Algorithms**
  - efficient access to information in an OS
    - for most things need linear time and space
    - for many things want log or constant time

Usability Goals

- **Robustness**
  - accept all valid input
  - detect and gracefully handle all invalid input
  - should not be possible to crash the OS
- **Consistency**
  - same operation should mean the same thing
    - read from a file or a network should look the same
    - a "-" flag should be the same in different commands
  - conventions
    - define the convention
    - **follow the convention when adding new items**

Usability Goals (cont)

- Proportionality
  - simple, common cases are easy and fast
    - good default values
  - complex, rare cases are possible but more complex and slower
    - "rm *" should give a warning
    - formatting the disk should not be on the desktop next to the trash can

Cost Goals

- Good Algorithms
  - time/space tradeoff are important
  - use special hardware where needed
    - smart disk controllers, memory protection

- Low maintenance cost
  - should not require constant attention

- Maintainability
  - most of cost in OS is in maintenance so make it easy to maintain the software base

Adaptability Goals

- **Tailored to the environment**
  - server vs. workstation
  - multi-media vs. data entry

- **Changes over time**
  - added memory
  - new devices

- **Extensible**
  - third parties can add new features
    - database vendors often need custom features
  - end customers can extend the system
    - new devices
    - new policies

Why Study Operating Systems?

- **They are large and complex programs**
  - good software engineering examples
- **There is no perfect OS**
  - too many types of users
    - real-time, desktop, server, etc...
  - many different models and abstractions are possible
    - OS researchers have been termed abstraction merchants
- **Many levels of abstraction**
  - hardware details: where the bits really go and when
  - high level concepts: deadlock, synchronization

Why Study Operating Systems (cont.)

- **Necessity**
  - reliability: when the OS is down, computer is down
  - recovery: when the OS goes down it should not take all of your files with it.

- **It's fun**
  - the details are interesting (at least I think so :)
  - thinking about concurrency makes you better at writing software for other areas