UNIVERSITY of WISCONSIN-MADISON
Computer Sciences Department

CS 537
Introduction to Operating Systems

Andrea C. Arpaci-Dusseau
Remzi H. Arpaci-Dusseau

INTRODUCTION

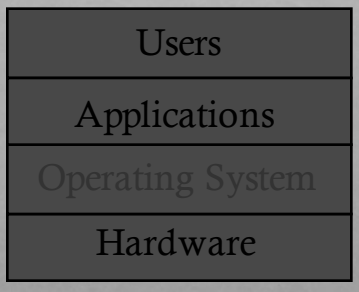
Questions answered in this lecture:

- **What is an OS and why do you want one?**
- **Why study operating systems?**
- **What will you do in this course?**

To do:

- **Take a look at course web page and first programming project**
- **Bring laptop to first discussion section (Wednesday)**

WHAT IS AN OPERATING SYSTEM?



Operating System (OS):
Software that converts hardware into a useful form for applications

What does an OS provide?

WHAT DOES OS PROVIDE?

Role #1: Abstraction - Provide standard library for hardware resources

What is a resource?
- Anything valuable
- e.g., CPU, memory, persistent storage (disk)

What abstraction does modern OS typically provide for each resource?
- CPU:
  - process and/or thread
- Memory:
  - address space
- Disk:
  - directories and files

Advantages of OS providing abstraction?
- Allow applications to reuse common facilities
- Make different devices look the same
- Provide higher-level or more useful functionality

Challenges
- What are the correct abstractions?
- How much of hardware should be exposed?

WHAT DOES OS PROVIDE?

Role #2: Resource management – Share resources well

Advantages of OS providing resource management?
- Protect applications from one another
- Provide efficient access to resources (cost, time, energy)
- Provide fair access to resources

Challenges
- What are the correct mechanisms?
- What are the correct policies for different workloads?

COURSE ORGANIZATION

How to cover all the topics relevant to operating systems?

THREE PIECES: FIRST

Virtualization

- Make each application believe it has each resource to itself
- Both mechanisms and policies

Demo

- Virtualize CPU
  - More processes than processors (or cores) can be running concurrently
- Virtualize memory
  - Each process has its own separate address space
  - Accessing the same virtual address in two different address spaces gives different contents

THREE PIECES: SECOND

Concurrency:
Events occur simultaneously and may interact with one another

- OS must be able to handle concurrent events

Easier case

- Hide concurrency from **independent** processes

Trickier case

- Manage concurrency with **interacting** processes (or threads)
- Provide abstractions (**locks, semaphores, condition variables, shared memory, critical sections**) to processes
- Ensure processes do not **deadlock**

Demo

- Interacting threads must coordinate access to shared data

THREE PIECES: THIRD

Persistence: Access information permanently

- Lifetime of information is longer than lifetime of any one process
- Machine may be rebooted, machine may lose power or crash unexpectedly

Issues

- Provide abstraction so applications do not know how data is stored
  - Files, directories (folders), links
- Correctness with unexpected **failures**
- **Performance**: disks are very slow; many optimizations needed!

Demo

File system does substantial work to ensure data updated correctly

ADVANCED TOPICS

Last week or two: Networked and distributed systems

WHY STUDY OPERATING SYSTEMS?

Build, modify, or administer an operating system

Understand system performance

- Behavior of OS impacts entire machine
- Tune workload performance

Apply knowledge across many layers

- Computer architecture, programming languages, data structures and algorithms, and performance modeling

Fun and challenging to understand large, complex systems

TO DO

Look over course web page

Take a look at first programming project

- Refresh knowledge of C
- If needed: Watch video about programming in C

Attend discussion section tomorrow to meet TA

- Bring laptop for C review