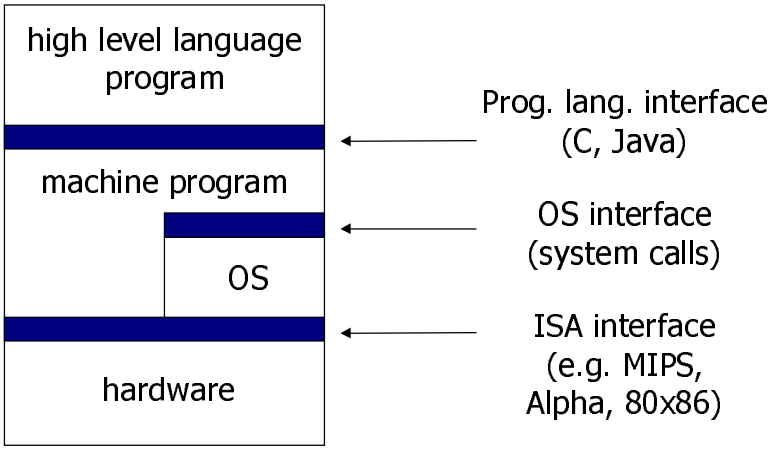
Lecture Topics: 10/25

- Introduction to Operating Systems
  - What is an OS?
  - Issues in operating systems
  - A little history
- Applications, Address Spaces, and Processes

What is an Operating System?

- Low-level software
- Makes using the computer convenient
  - does a lot of the dirty work for you
  - hides details about the system behind a clean interface
- Makes using the computer efficient
  - expertly manages and allocates resources
- These goals are often contradictory

The Bigger Picture (Again)



Views of the OS

- The OS is like a government
  - Provides no useful service on its own
  - Instead, provides an environment in which to do useful work
  - Other programs have to abide by its decrees
- The OS is a controller
  - Controls the I/O devices and user programs
  - Prevents and handles errors

Views of the OS, cont.

- The OS is a resource allocator
  - A system has many resources: CPU time, memory, disk space, access to I/O devices
  - The OS is in charge of allocating these resources
  - Many possible *policies*:
    - allocate fairly; give more to those who pay more; give it all to me
  - A well-designed OS is merely the *mechanism* for allocation; policy is configurable

What makes up the OS?

- "All the code you didn't write"
  - this view includes all system libraries, compilers, assemblers
  - all the software shipped with the machine (and maybe more)
- Just the *kernel*
  - the program that starts running at boot time, manages all user programs, and runs until shutdown
- This issue goes to court; controversial

Issues in Operating Systems

- structure - how is the OS organized?
- sharing - how are resources shared among users?
- naming - how are resources named by users or programs?
- protection - how is one user/program protected from another?
- security - how is the flow of information restricted?

More Issues in OS

- performance - why is it so slow?
- reliability and fault tolerance - how are failures prevented and dealt with?
- extensibility - how are new features added?
- communication - how is information exchanged?
- concurrency - how are parallel activities created and controlled?

Yet More Issues in OS

- scale and growth - what happens as demands or resources increase?
- persistence - how to make data last longer than programs
- compatibility - can we ever do anything new?
- distribution - can the components of the system be geographically separated?
- accounting - who pays the bills? how do we control resource usage?

In Olden Times...

- The first operating systems were called *batch systems*
  - OS was stored in part of memory
  - Programs were "written" on punch cards
  - One at a time, programs were loaded from cards into memory and run
  - Each program came with *control cards* telling the OS what to do
- An optimization: read the next program into memory while this one runs

Multiprogramming

- Goal: increase utilization of the processor
- Motivation: decrease in memory prices
- Keep multiple jobs loaded in memory
- While one program waits for I/O, run another one for a while

Timesharing

- Goal: allow multiple users/programs to share a single system concurrently
- Optimize *response time*
- Based on time-slicing - divide the CPU equally among the users
- For the first time, users could actively view, edit, and debug
- MIT Multics system (mid 1960's) was the first large timesharing system

Operating Systems Topics

- Allow multiple users, each running multiple programs
  - Friday & next week: processes
- Each program can have multiple *threads* of control
  - Next week: multithreading
- Programs can make requests of the operating system
  - Friday: system calls

Topics, cont.

- With multiple threads, new issues arise
  - Week 7: synchronization
  - Week 7 & 8: deadlock
  - Week 8: scheduling
- Making 128MB of memory look like 4GB
  - Week 9 & 10: virtual memory
- Storing and managing your files
  - Week 10 & 11: file systems

Which OS?

- The OS subsystems we'll study are common to all modern OSs
  - Windows NT, MacOS, Linux, Solaris, you name it (not DOS)
- Sometimes I'll present details
- These details will probably be based on some flavor of UNIX
  - No real advantage to studying NT structure
  - Advantages to UNIX: your textbook's foundation, source code available

Real-Time Operating Systems

- Specialized operations: subway systems, flight control, factories, nuclear power plants, lots more
- OS must guarantee response to physical events in a fixed time interval
- Problem is to schedule all activities in order to meet all of the critical requirements
- Basic approach: over-capacitize

Parallel Operating Systems

- Support parallel applications wishing to get speedup of computationally complex tasks
- Needs basic primitives for dividing one task into multiple parallel activities
- Supports efficient communication between those activities
- Supports synchronization of activities to coordinate sharing of information

Distributed Operating Systems

- Distributed systems facilitate use of geographically distributed resources
- Supports communication between parts of a job or different jobs
- Sharing of distributed resources, hardware, and software to improve utilization
  - speedup through parallelism
  - improve reliability