Operating System

Introduction

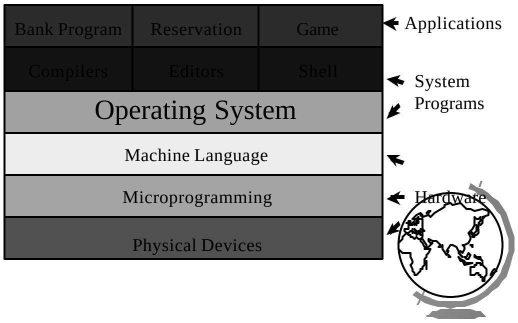
Topics

- What is an OS?
- OS History
- OS Concepts
- OS Structures

Let's Get Started!

- What are some OSes you know?
  - Guess if you are not sure
- Pick an OS you know:
  - What are some things you like about it?
  - What are some things you don't like about it?

What is an Operating System?



Bank Program | Reservation | Game

Compilers | Editors | Shell

Operating System

Machine Language

Microprogramming

Physical Devices

Applications

System Programs

Hardware

What is an Operating System?

- An Extended Machine (Top-down)
  - Transforming - new resource
    - ex: Win98 device manager
- A Resource Manager (Bottom-up)
  - Multiplexing - illusion of several resources
    - ex: browse the web AND read email
  - Scheduling - deciding who gets what when
    - ex: compile fast OR edit fast
- Why have an OS?
  - Convenient and Efficient
    - Programming hardware difficult
    - Idle hardware "wasteful"

Where in the Book are we?

- Ch 1 -2 already
  - Reading details on course Web page
  - Ch 1, brief, alternate viewpoint
  - Ch 2, computer architecture review
- Ch 3 by Today
  - Ch 3, system structure
- Timeline on Web page
  - Proj 1 due by in two weeks

OS History

- Helps understand key requirements
  - Not one brilliant design
    - (despite what Gates or Torvalds might say)
  - Fixed previous problems, added new ones
  - Tradeoffs
- Closely tied to:
  - Hardware history
  - User history

Hardware History

	1981	*1999*	*Factor*
Power	1	250	250
$/Power	$100K	$45	2200
Memory	128K	128M	1000
Disk Capacity	10M	10G	1000
Net Bandwidth	9600b/s	155Mb/s	15K
Users / Mach.	10s	<=1	10

- Comments? Change!

OS History

- Supplement to book
- My version is a brief narrative

Hardware Very Expensive
Humans Cheap

- Single program execution (no OS)
- Hardwire "programming"
- Programming slow, not "offline"!
  - Punch cards

Hardware Very Expensive
Humans Cheap

- Punch cards
- Fortran or assembler
- Waste computer time walking!
  - Batch programs on tape

Hardware Very Expensive
Humans Cheap

- Programs read in from tape
- Two applications:
  - Scientific
  - Data processing
- CPU idle during I/O!
  - Multiprogramming with partitions
  - Spooling as jobs finished

Hardware is Cheap
Humans Expensive

- Turn around time 1/2 day
- Programmer time wasted!
  - "Sigh. In the good old days…."
  - – Time-sharing
  - – Multics (sorta)
  - – New problems
    - + response time
    - + thrashing
    - + file-systems

Hardware Very Cheap
Humans Very Expensive

- Personal computers
  - – Network operating systems
  - – Distributed operating systems
- OSes today
  - – small == 1000K (15 pages, 5 programmer years)
  - – large == 10,000K (150 pages, 500 programmer years) (longer than a semester :-))
  - – need to evolve quickly
    - + hardware upgrades, new user services, bug fixes
  - – efficient and/or modular kernels

Windows NT/2000 History

- 1988, v1
  - – split from joint work with IBM OS/2
  - – Win32 API
- 1990, v3.1
  - – Server and Workstation versions
- 1997(?), v4
  - – Win95 interface
  - – Graphics to kernel
  - – More NT licenses sold than all Unix combined

Windows NT/2000 History

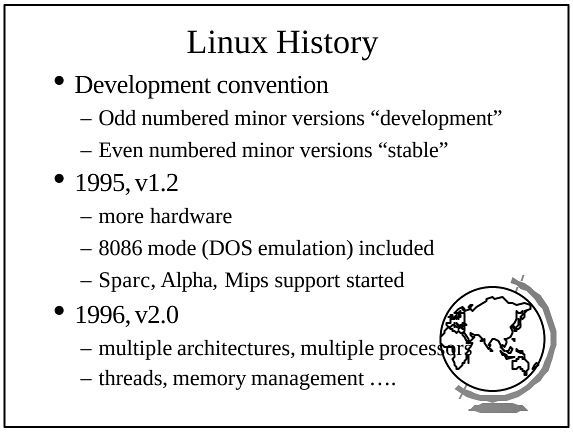
- 2000 v5, called "Windows 2000"
  - – Micro-kernel
  - – Multi-user (with terminal services)
- Four versions (all use same core code)
  - – Professional
    - + desktop
  - – Server and Advanced Server
    - + Client-server application servers
  - – Datacenter Server
    - + Up to 32 processors, 64 GB RAM

Windows NT/2000 Today

- Microsoft has 80% to 90% of OS market
  - – mostly PC's
- 800 MHz Intel Pentium
- NT aiming at robust, server market
  - – network, web and database
- Platforms
  - – Intel 386+ only
- NT is 12,000,000 lines of code
- 2000 is 18,000,000 lines of code

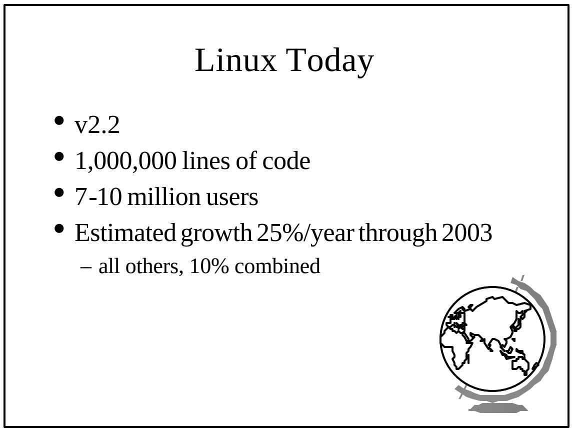
Linux History

- Open Source
  - – Release Early, Release Often, Delegate
  - – "The Cathedral or the Baazar"
- Bday 1991, Linus Torvalds, 80386 processor
  - – v.01, limited devices, no networking,
  - – with proper Unix process support!
- 1994, v1.0
  - – networking (Internet)
  - – enhanced file system (over Minix)
  - – many devices, dynamic kernel modules



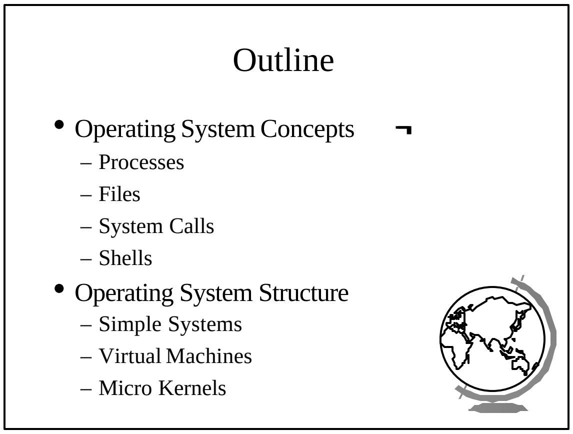
Linux History

- Development convention
  - Odd numbered minor versions “development”
  - Even numbered minor versions “stable”
- 1995, v1.2
  - more hardware
  - 8086 mode (DOS emulation) included
  - Sparc, Alpha, Mips support started
- 1996, v2.0
  - multiple architectures, multiple processors
  - threads, memory management ….



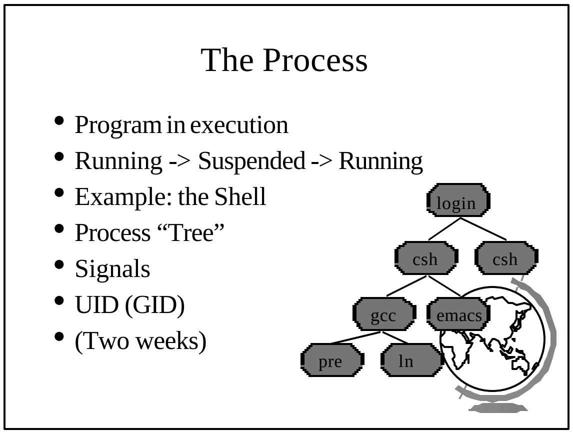
Linux Today

- v2.2
- 1,000,000 lines of code
- 7-10 million users
- Estimated growth 25%/year through 2003
  - all others, 10% combined



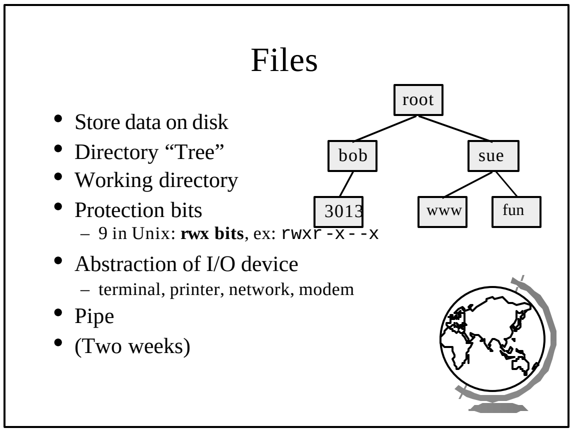
Outline

- Operating System Concepts ¬
  - Processes
  - Files
  - System Calls
  - Shells
- Operating System Structure
  - Simple Systems
  - Virtual Machines
  - Micro Kernels



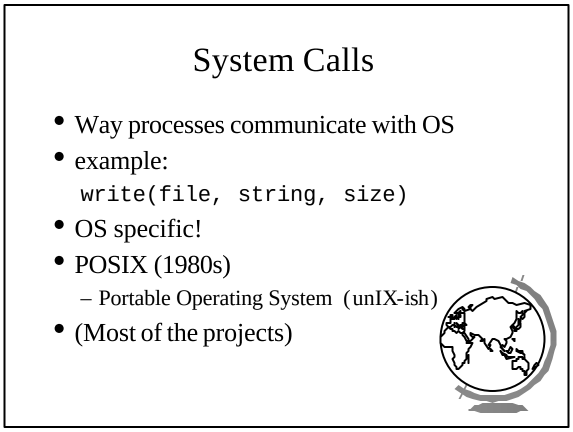
The Process

- Program in execution
- Running -> Suspended -> Running
- Example: the Shell
- Process “Tree”
- Signals
- UID (GID)
- (Two weeks)



Files

- Store data on disk
- Directory “Tree”
- Working directory
- Protection bits
  - 9 in Unix: **rwx bits**, ex: `rwxr-x--x`
- Abstraction of I/O device
  - terminal, printer, network, modem
- Pipe
- (Two weeks)



System Calls

- Way processes communicate with OS
- example:
  `write(file, string, size)`
- OS specific!
- POSIX (1980s)
  - Portable Operating System (unIX-ish)
- (Most of the projects)

Shells

- (Project 0 uses a shell to execute system programs, that then execute system calls)
- User's interface to OS
- Simple commands

  "`cd`", "`cat`", "`top`"
- Modifiers

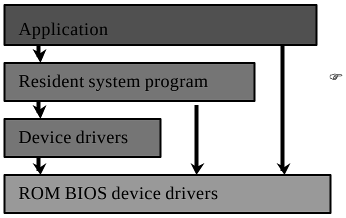
  '&', '|', '>'
- (Project 1 is to write a Shell)
- (Hey, do some process and shell examples!)

Outline

- Operating System Structure ←
  - Simple Systems
  - Virtual Machines
  - Micro Kernels

Simple Systems

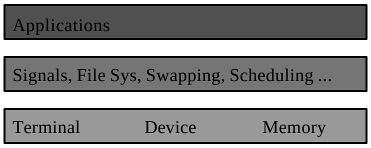
- Started small and grew, no hardware support
- MS-DOS



☞ Protection!

Simple Systems

- Unix (see `/vmunix`)

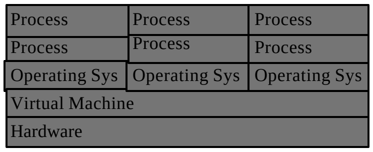


☞ "The Big Mess"

☞ Some move towards a more modular kernel

Virtual Machines

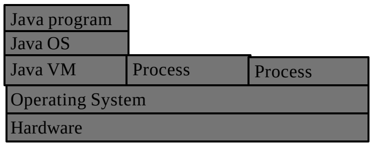
☞ IBM VM/370



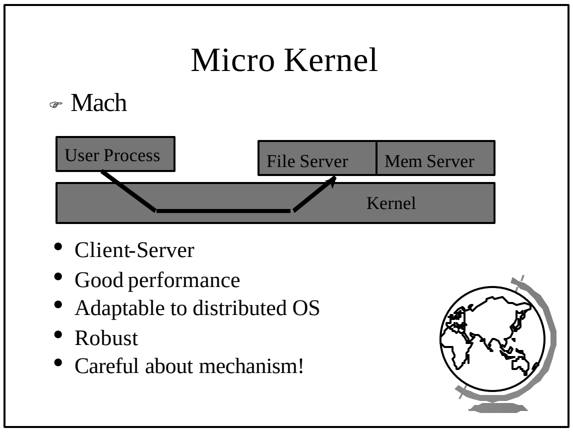
- Complete protection
- OS development, emulation
- Performance!

Virtual Machines

- Java Virtual Machine



☞ Platform independence!



Micro Kernel

☞ Mach

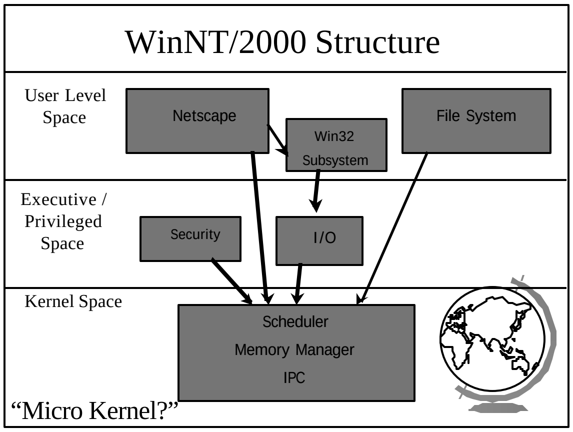
User Process

File Server

Mem Server

Kernel

- Client-Server
- Good performance
- Adaptable to distributed OS
- Robust
- Careful about mechanism!



WinNT/2000 Structure

User Level Space

Netscape

Win32 Subsystem

File System

Executive / Privileged Space

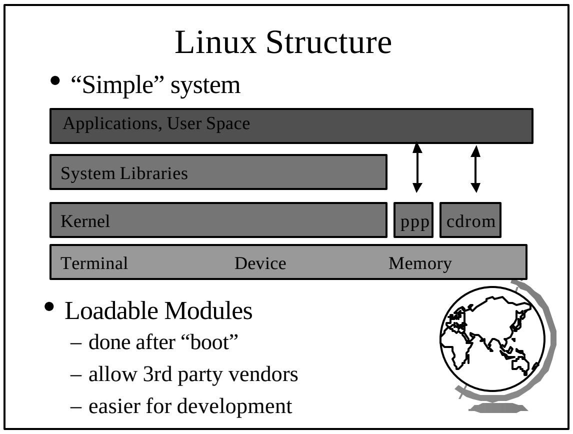
Security

I/O

Kernel Space

Scheduler
Memory Manager
IPC

"Micro Kernel?"



Linux Structure

- "Simple" system

Applications, User Space

System Libraries

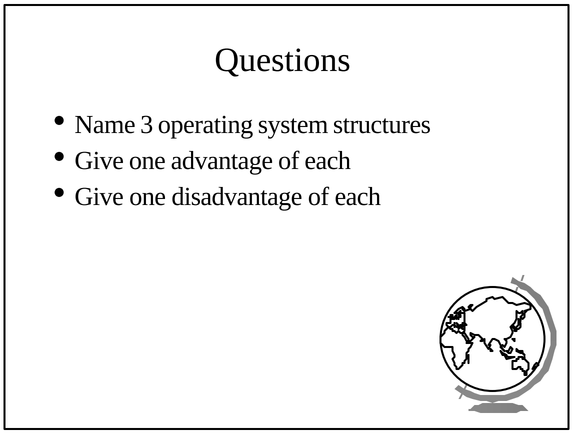
Kernel

ppp

cdrom

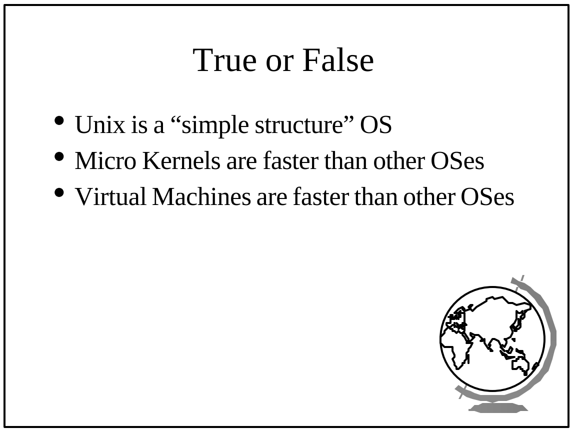
Terminal Device Memory

- Loadable Modules
  - done after "boot"
  - allow 3rd party vendors
  - easier for development



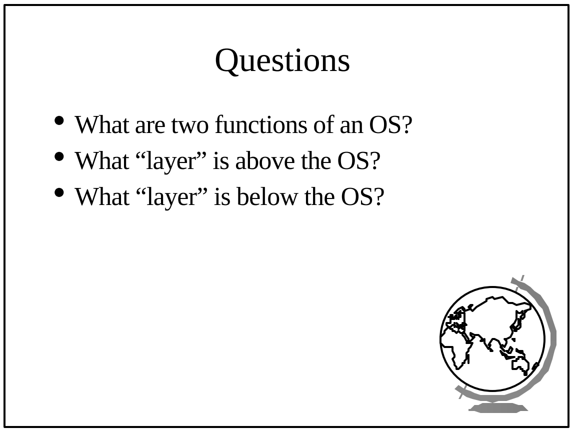
Questions

- Name 3 operating system structures
- Give one advantage of each
- Give one disadvantage of each



True or False

- Unix is a "simple structure" OS
- Micro Kernels are faster than other OSes
- Virtual Machines are faster than other OSes



Questions

- What are two functions of an OS?
- What "layer" is above the OS?
- What "layer" is below the OS?

Questions

- When is it appropriate for OS to “waste” resources?
- How might the growth in networks influence OS design?

Review

- OS History X
  - user change and hardware change
- OS Concepts X
  - processes, files, system call, shell
- OS Structure ¬

Questions

- What causes OS to change?
  - Or, why aren’t we still running MS-DOS?
- What is a *process?*
- What is a *file?*