Operating System

Introduction
(Ch 1)

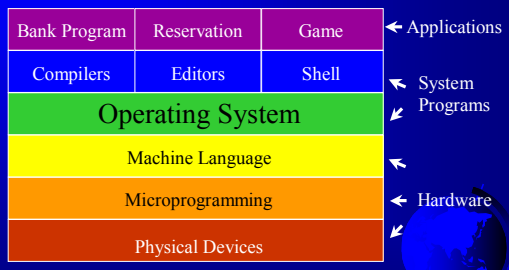
Topics

- 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?



What is an Operating System?

- An Extended Machine (Top-down)
  - Transforming - new resource
    - ex: Windows 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"

Topics

- What is an OS? (done)
- OS History (next)
- OS Concepts
- OS Structures

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
  - size
    - small == 1 million
    - large == 10 million
  - 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
- Aiming at robust, server market
  - network, web and database
- Platforms
  - Intel 386+ only
- WinNT is 12 million lines of code
- Win2000 is 18 million 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

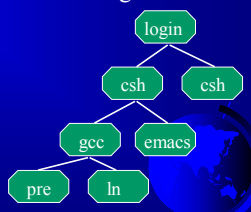
- v2.4
- 3 million lines of code
- 7-10 million users
- Growth by 25%/year through 2003 (and continues)
  - all others, 10% combined

Outline

- Operating System Concepts ←
  - Processes
  - Memory management
  - Input/Output
  - Files
  - System Calls
  - Shells
- Operating System Structures

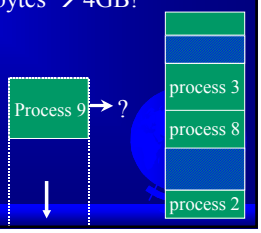
The Process

- Program in execution
- Running -> Suspended -> Running
- Example: the Shell
- Process "Tree"
- Signals
- UID (GID)
- (4 hours)



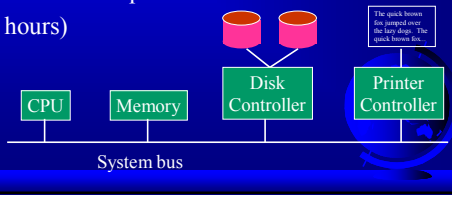
Memory Management

- One chunk of physical memory
- Needs to be shared with all processes
  - multiprocessing
- 32 bit architecture, 2^{32} bytes → 4GB!
  - virtual memory
- (8 hours)



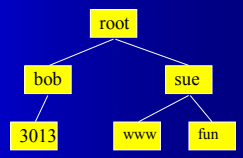
Input/Output

- OS manage resources, including other devices
- Significant fraction of code
  - Up to 90% (complete distribution source)
- Want to be simple to use
- (2 hours)



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
- (4 hours)



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 use them)
- (One of the projects will add system calls)

Shells

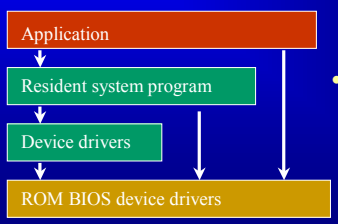
- User's interface to OS
- Simple commands
  "`cd`", "`cat`", "`top`"
- Modifiers
  '&', '|', '>'
- (Hey, do some process and shell examples!)

Outline

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

Simple Systems

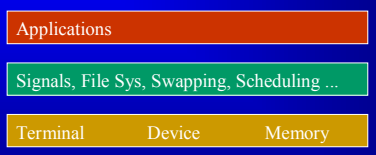
- Started small and grew, no hardware support
- MS-DOS



- Protection!

Simple Systems

- Unix (see `/vmunix`)



- "The Big Mess"
- Some move towards a more modular kernel

Virtual Machines

- IBM VM/370 → VMWare

Process	Process	Process
Process	Process	Process
Operating Sys	Operating Sys	Operating Sys
Virtual Machine		
Hardware		

- Complete protection
- OS development, emulation
- Performance!
- (Exokernel says can have subset of kernel)

Virtual Machines

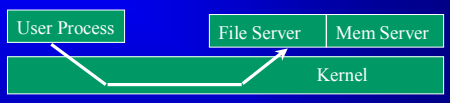
- Java Virtual Machine

Java program		
Java OS		
Java VM	Process	Process
Operating System		
Hardware		

- Platform independence!

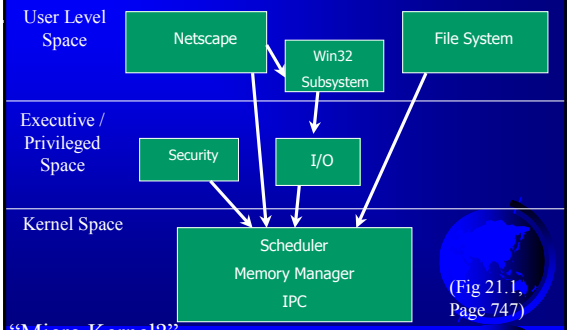
Micro Kernel

- Mach



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

WinNT/2000 Structure

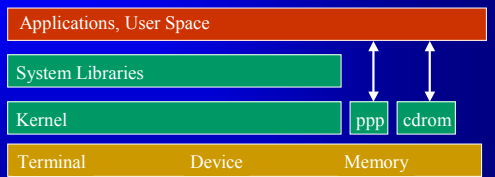


(Fig 21.1, Page 747)

"Micro Kernel?"

Linux Structure

- "Simple" system



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