MODERN OPERATING SYSTEMS

Third Edition

ANDREW S. TANENBAUM

Chapter 1
Introduction

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What Is An Operating System (1)

A modern computer consists of:

- One or more processors
- Main memory
- Disks
- Printers
- Various input/output devices

Managing all these components requires a layer of software – the **operating system**

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What Is An Operating System (2)

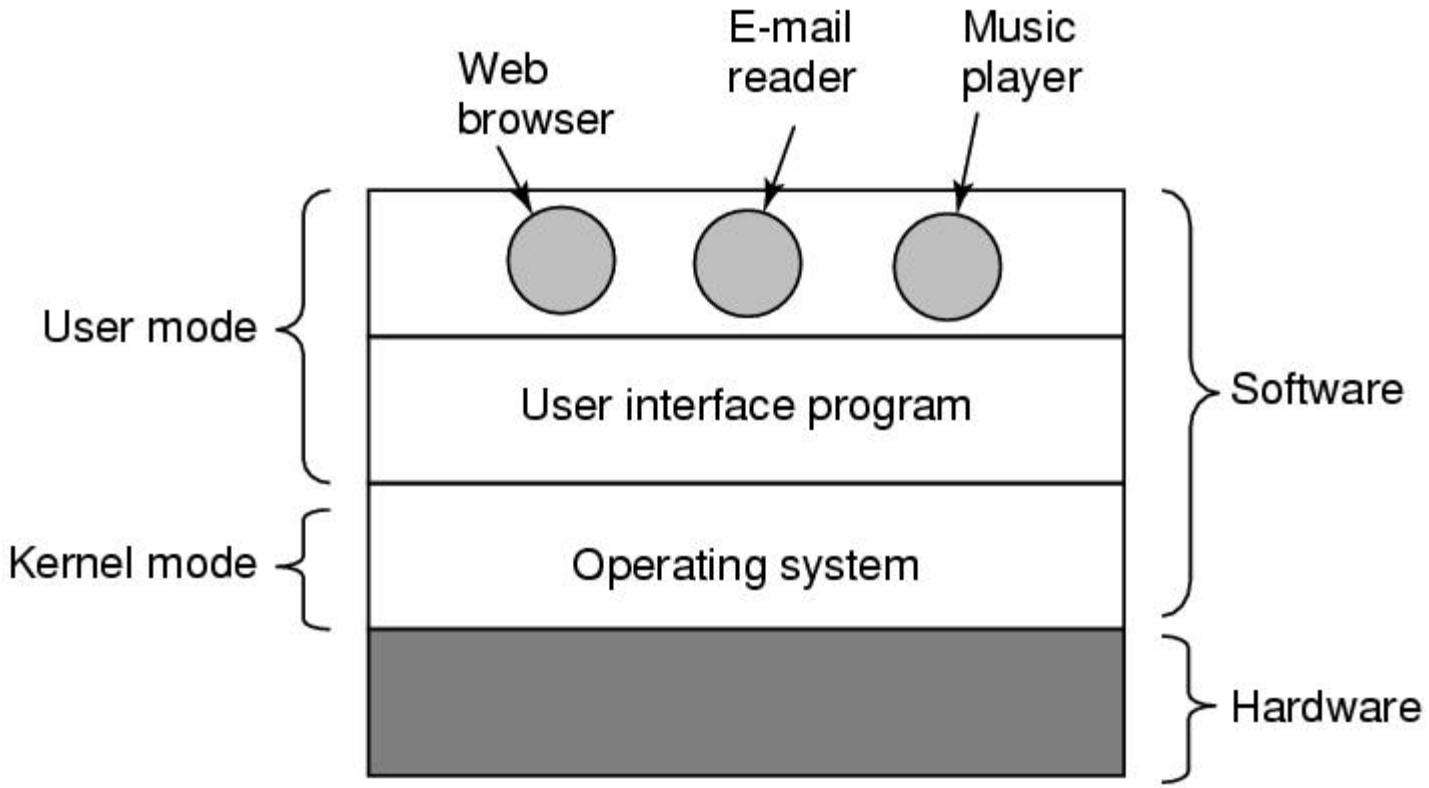

Figure 1-1. Where the operating system fits in.

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The Operating System as an Extended Machine

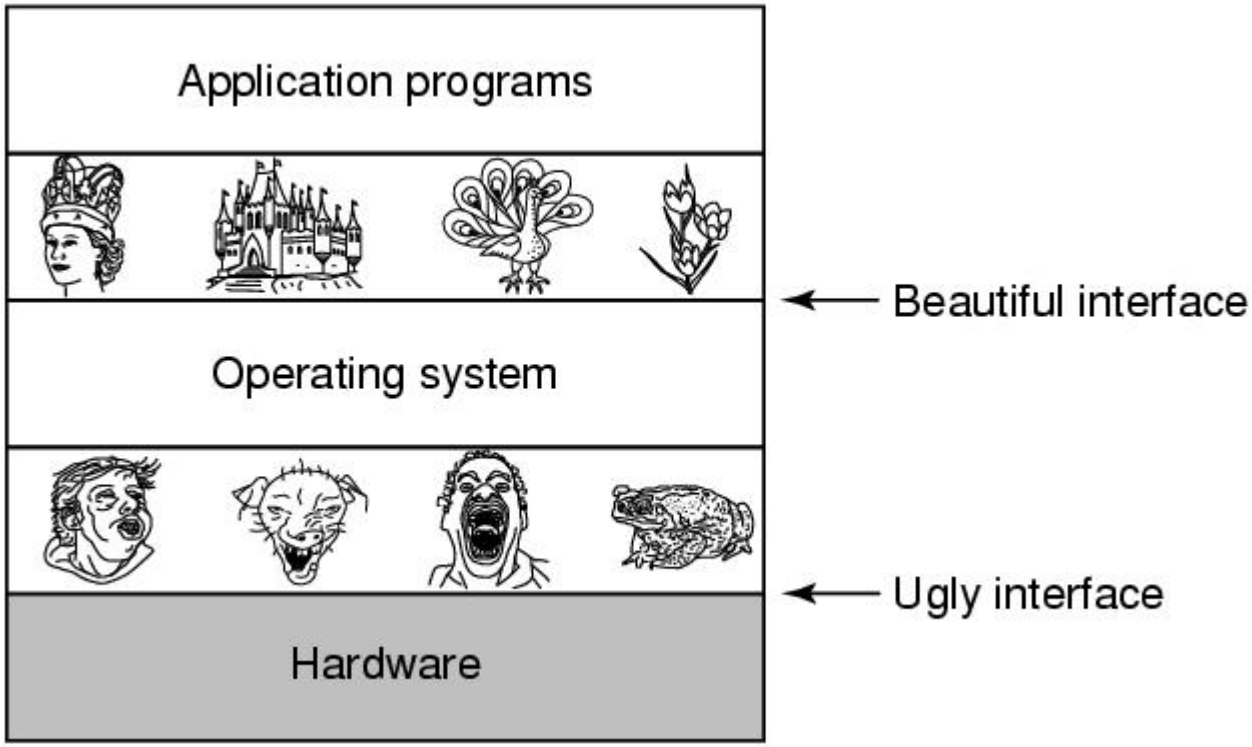

Figure 1-2. Operating systems turn ugly hardware into beautiful abstractions.

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The Operating System as a Resource Manager

- Allow multiple programs to run at the same time
- Manage and protect memory, I/O devices, and other resources
- Includes multiplexing (sharing) resources in two different ways:
  - In time
  - In space

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ICs and Multiprogramming

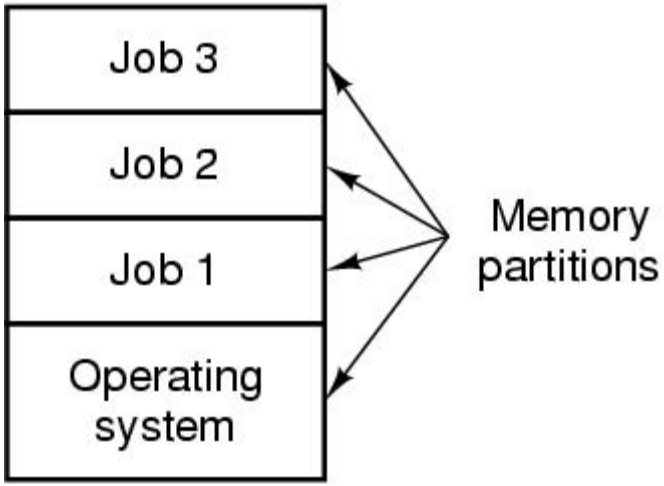

Figure 1-5. A multiprogramming system with three jobs in memory.

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Computer Hardware Review

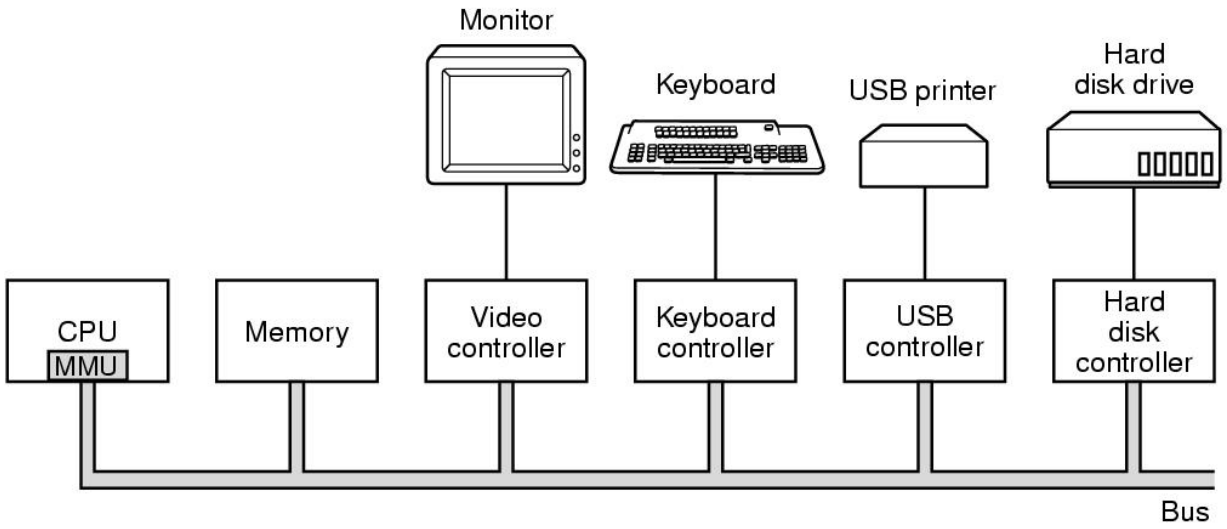

Figure 1-6. Some of the components of a simple personal computer.

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Multithreaded and Multicore Chips

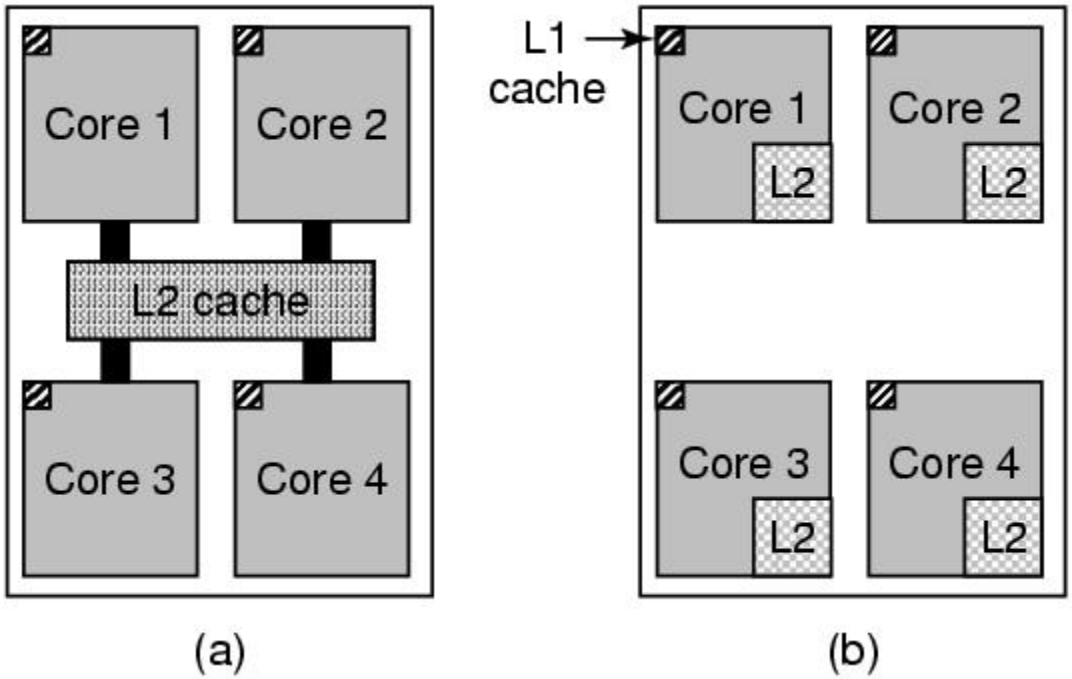

Figure 1-8. (a) A quad-core chip with a shared L2 cache. (b) A quad-core chip with separate L2 caches.

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Memory (1)

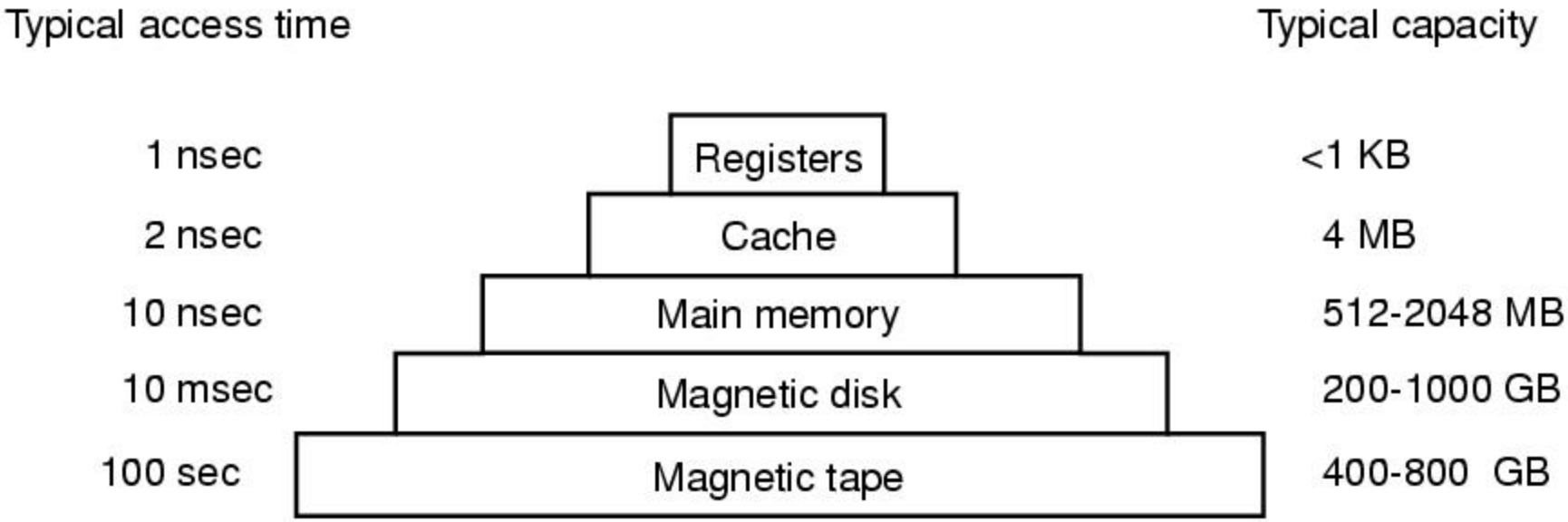

Figure 1-9. A typical memory hierarchy.
The numbers are very rough approximations.

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Disks

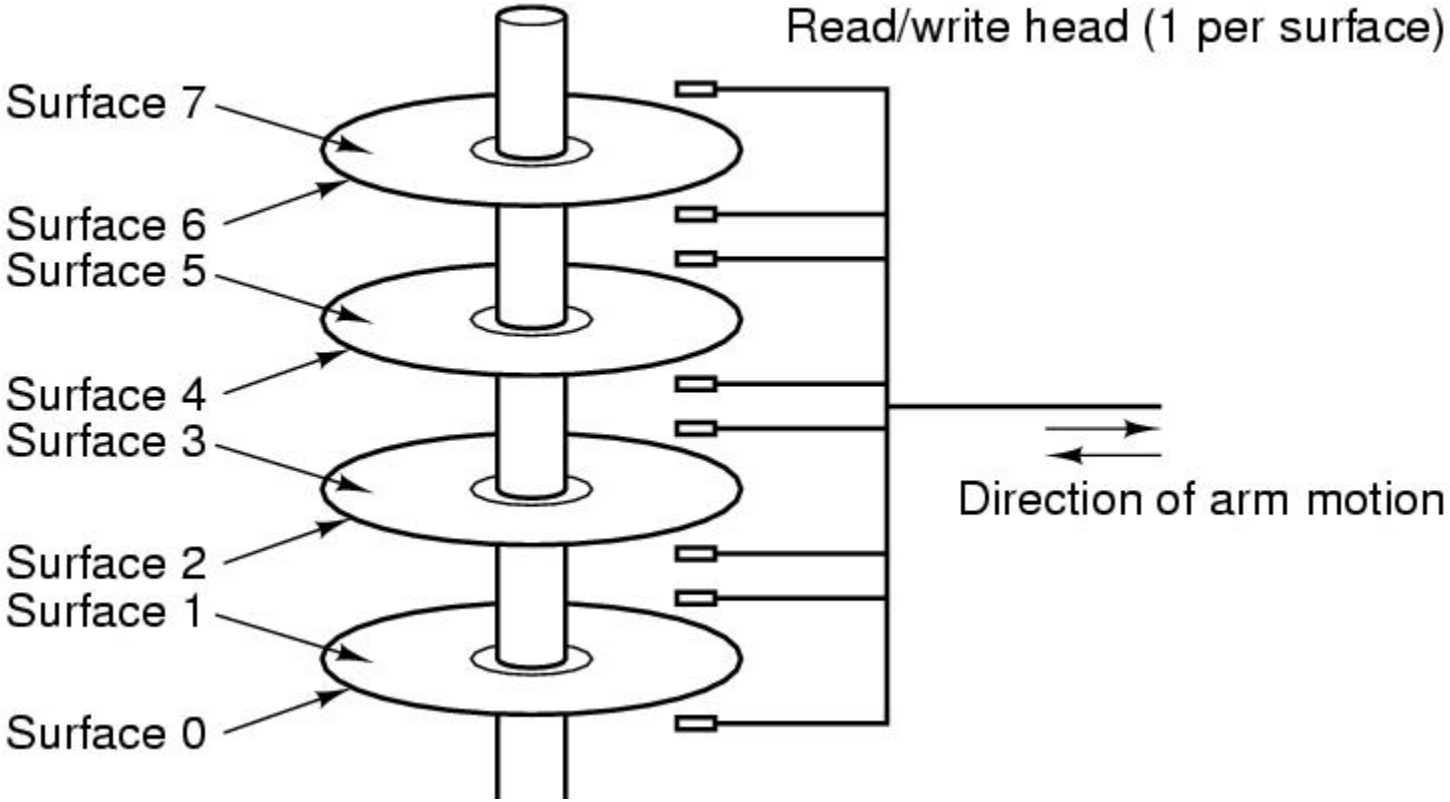

Figure 1-10. Structure of a disk drive.

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I/O Devices

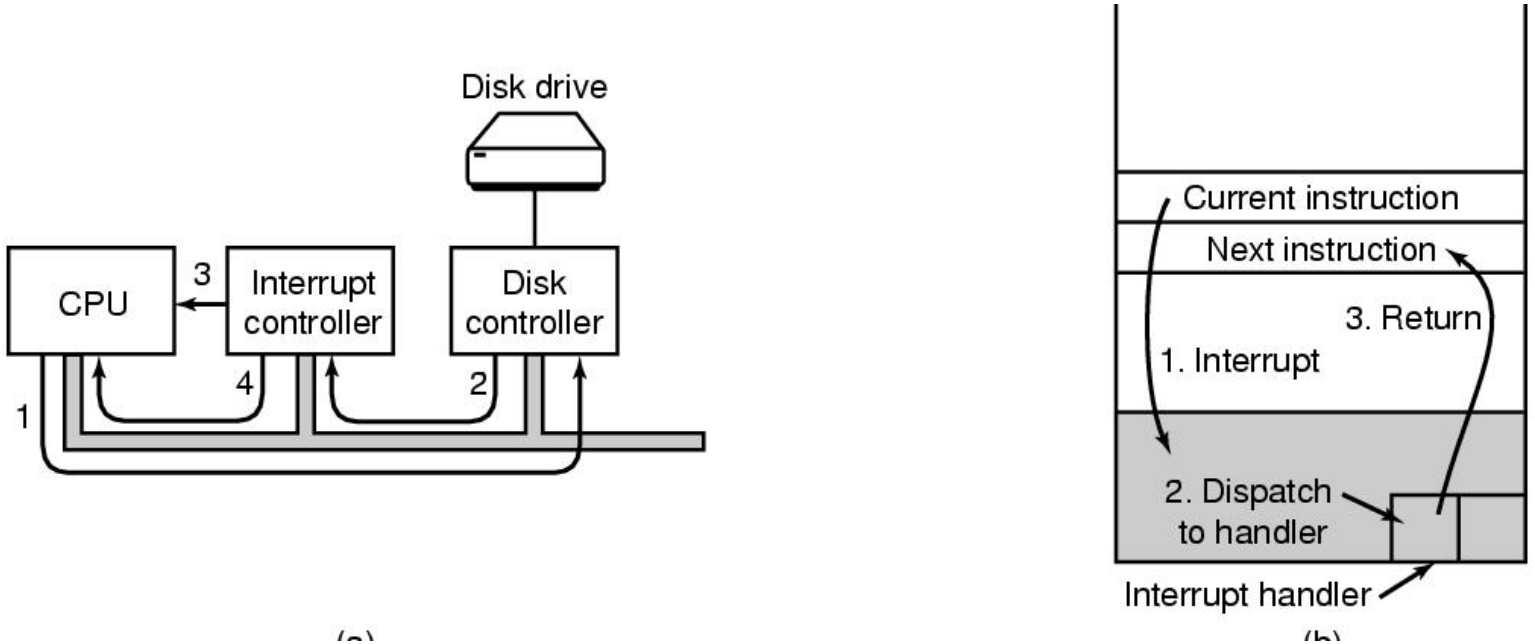

Figure 1-11. (a) The steps in starting an I/O device and getting an interrupt.

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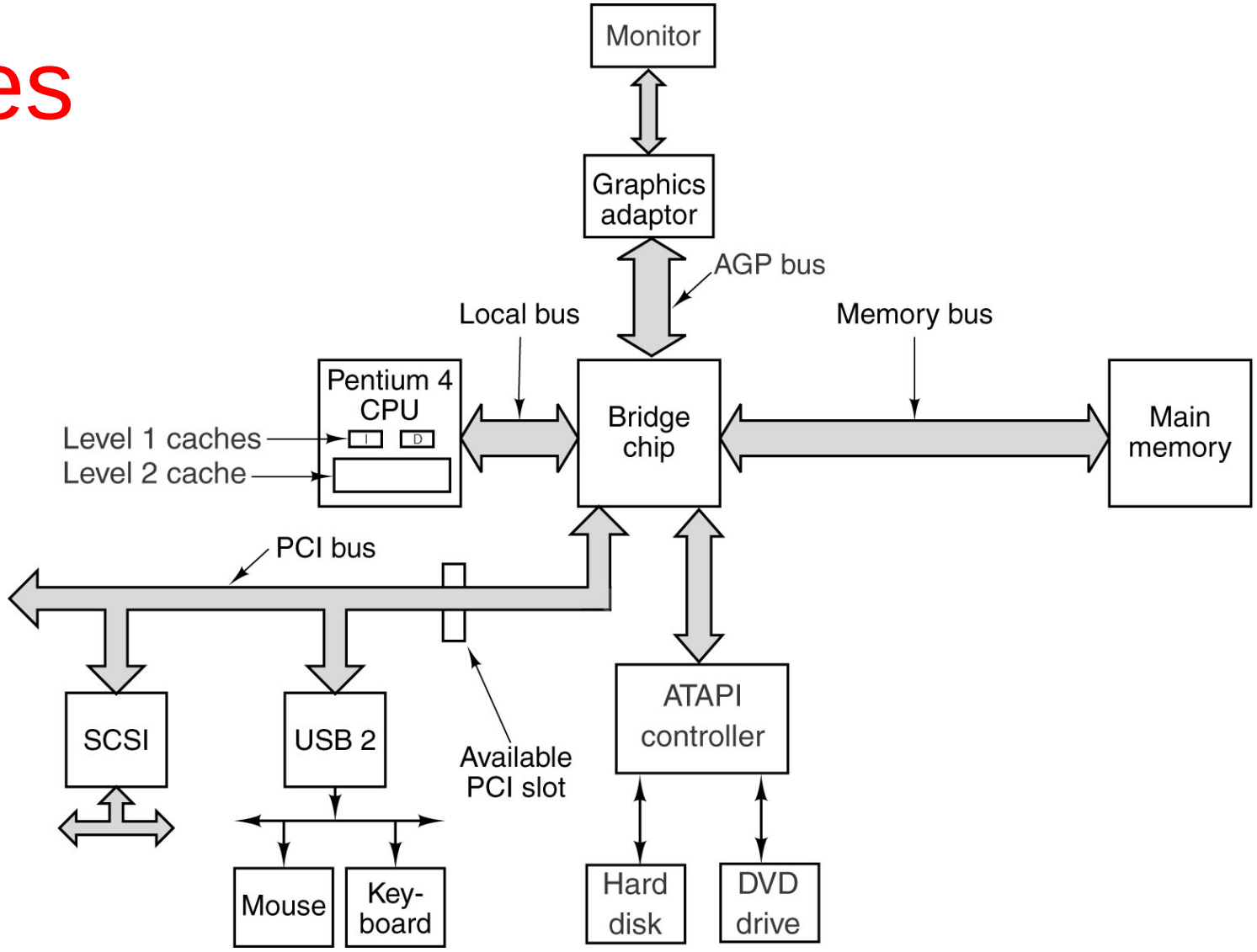
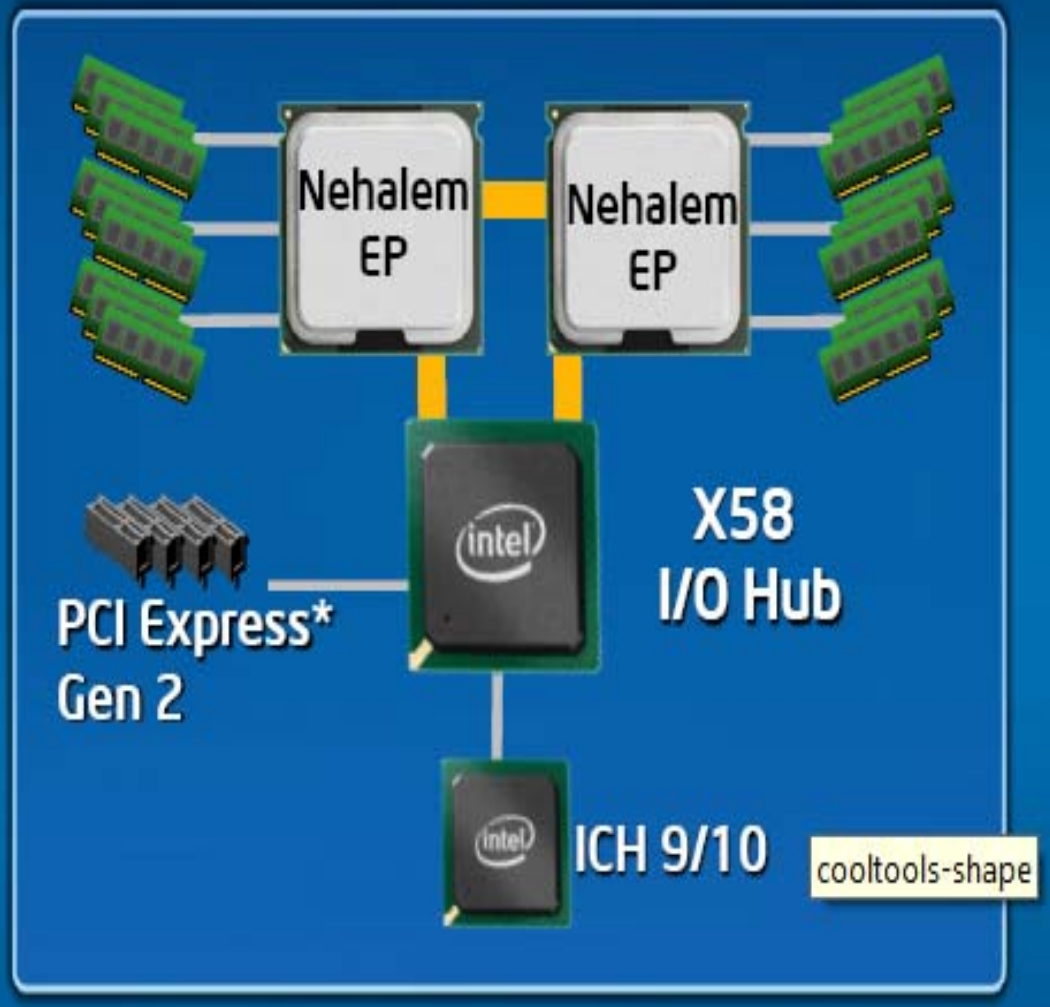
Buses



The bus structure of a modern Pentium 4.

Enterprise: 2008 Nehalem Based

Two Socket System Architecture

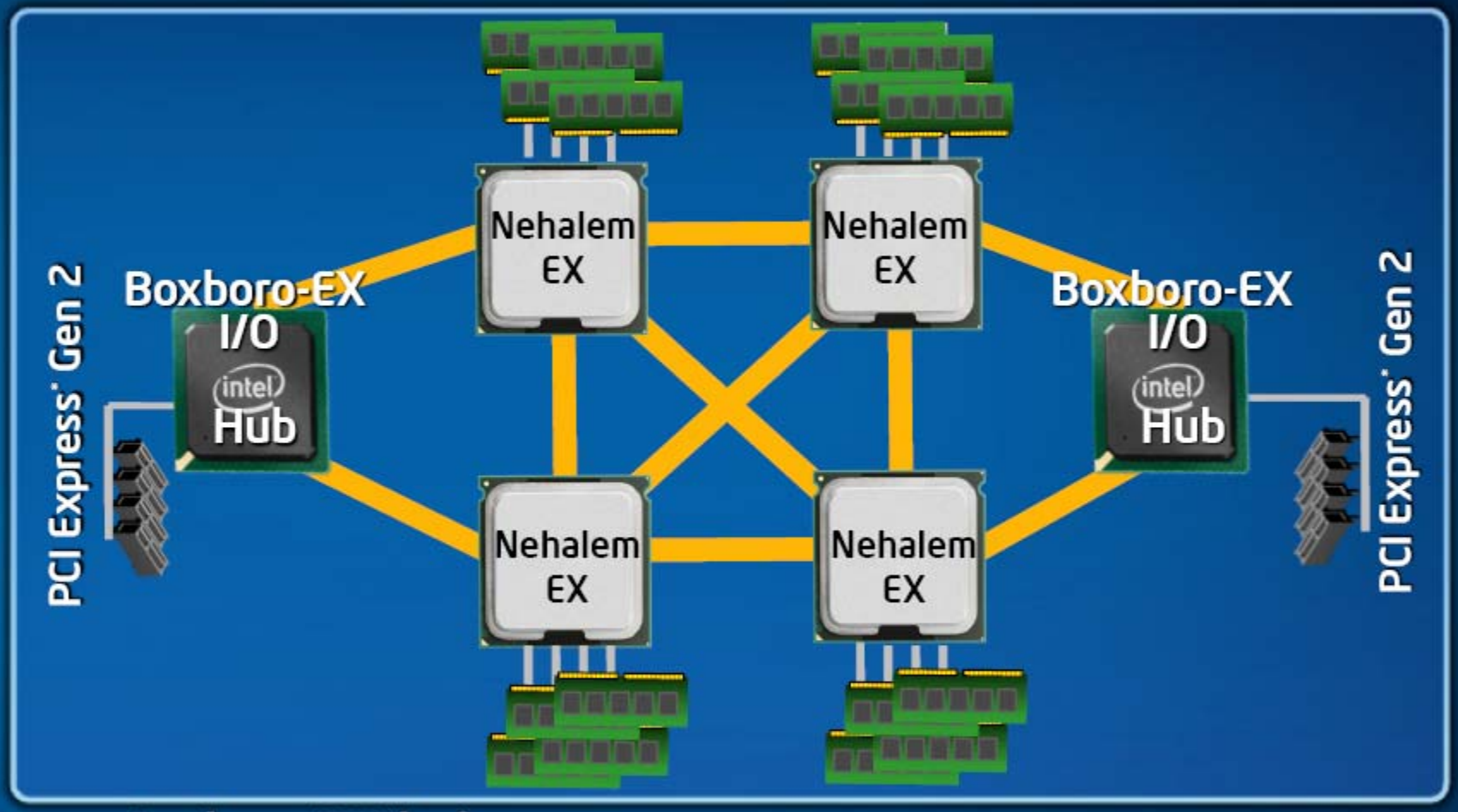


Nehalem-EP Platform:

- Two sockets each with Integrated Memory Controller
- Turbo mode operation
- Intel® QuickPath Architecture
- DDR3 Memory: 3 Channel, 3 DIMMs per channel
- Intel® Virtualization Technology
- PCI Express* Gen 2

Enterprise: 2009 Nehalem Based

Four Socket System Architecture



Boxboro-EX Platform:

Intel® QuickPath Interconnect

Four processors with Intel® QuickPath Interconnects

PCI Express* Gen 2, Integrated Memory Controller

* Other names and brands may be claimed as the property of others

The Operating System Zoo

- Mainframe operating systems
- Server operating systems
- Multiprocessor operating systems
- Personal computer operating systems
- Handheld operating systems
- Embedded operating systems
- Sensor node operating systems
- Real-time operating systems
- Smart card operating systems

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Operating System Concepts

- Processes
- Address spaces
- Files
- Input/Output
- Protection
- Ontogeny recapitulates phylogeny
  - Large memories
  - Protection hardware
  - Disks
  - Virtual memory

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Processes

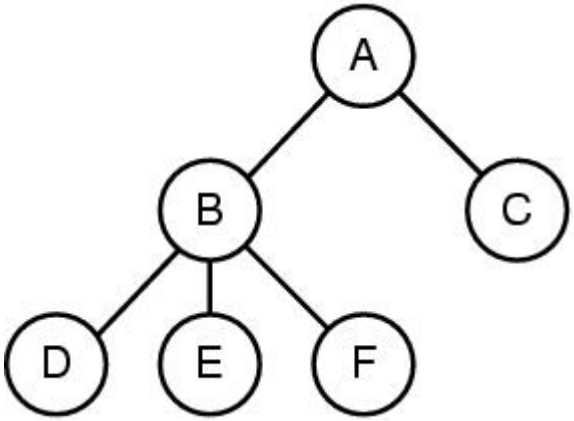

Figure 1-13. A process tree. Process A created two child processes, B and C. Process B created three child processes, D, E, and F.

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Files (1)

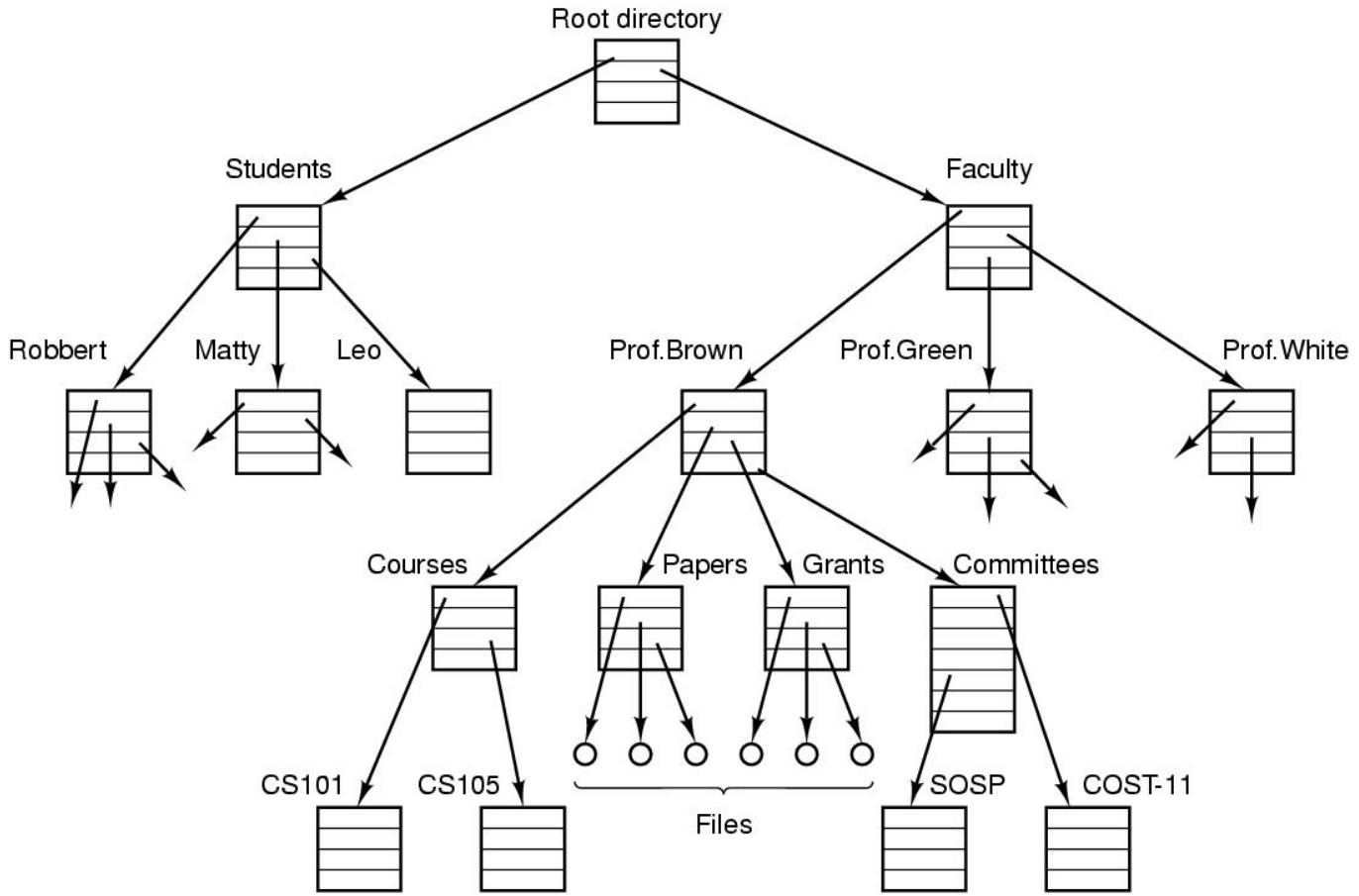

Figure 1-14. A file system for a university department.

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Files (2)

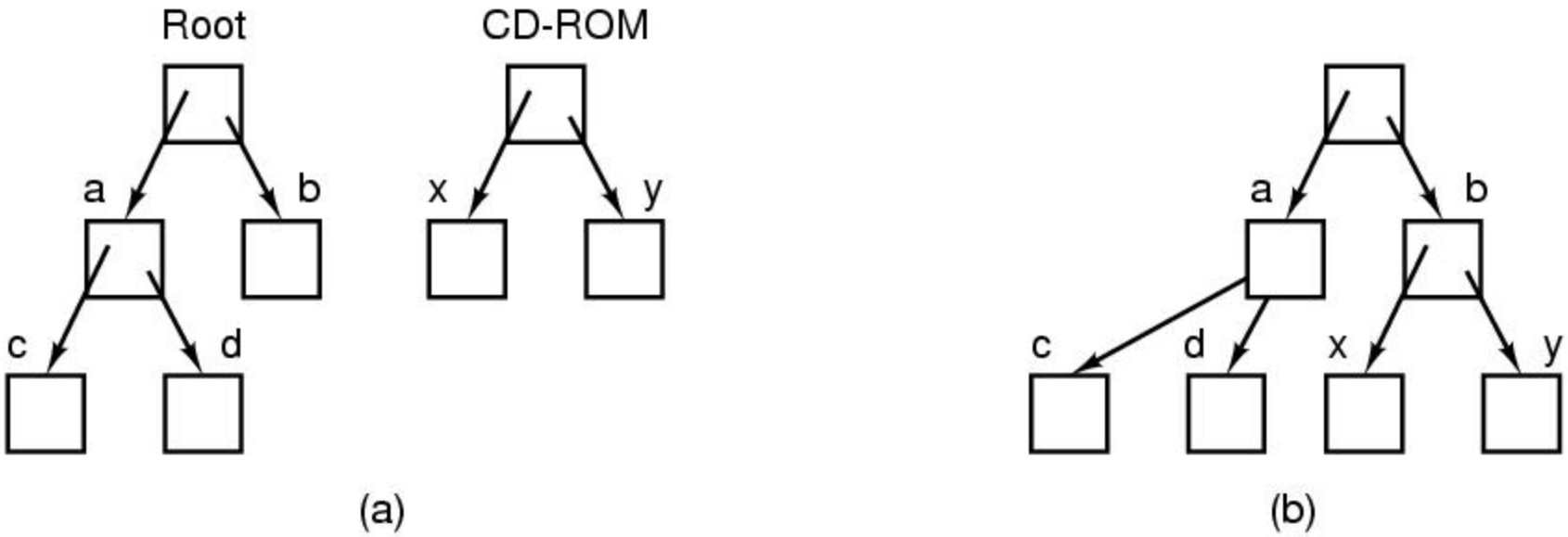

Figure 1-15. (a) Before mounting, the files on the CD-ROM are not accessible. (b) After mounting, they are part of the file hierarchy.

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Files (3)

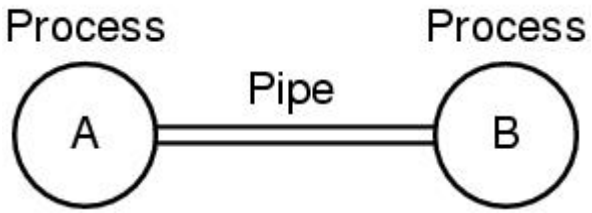

Figure 1-16. Two processes connected by a pipe.

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System Calls

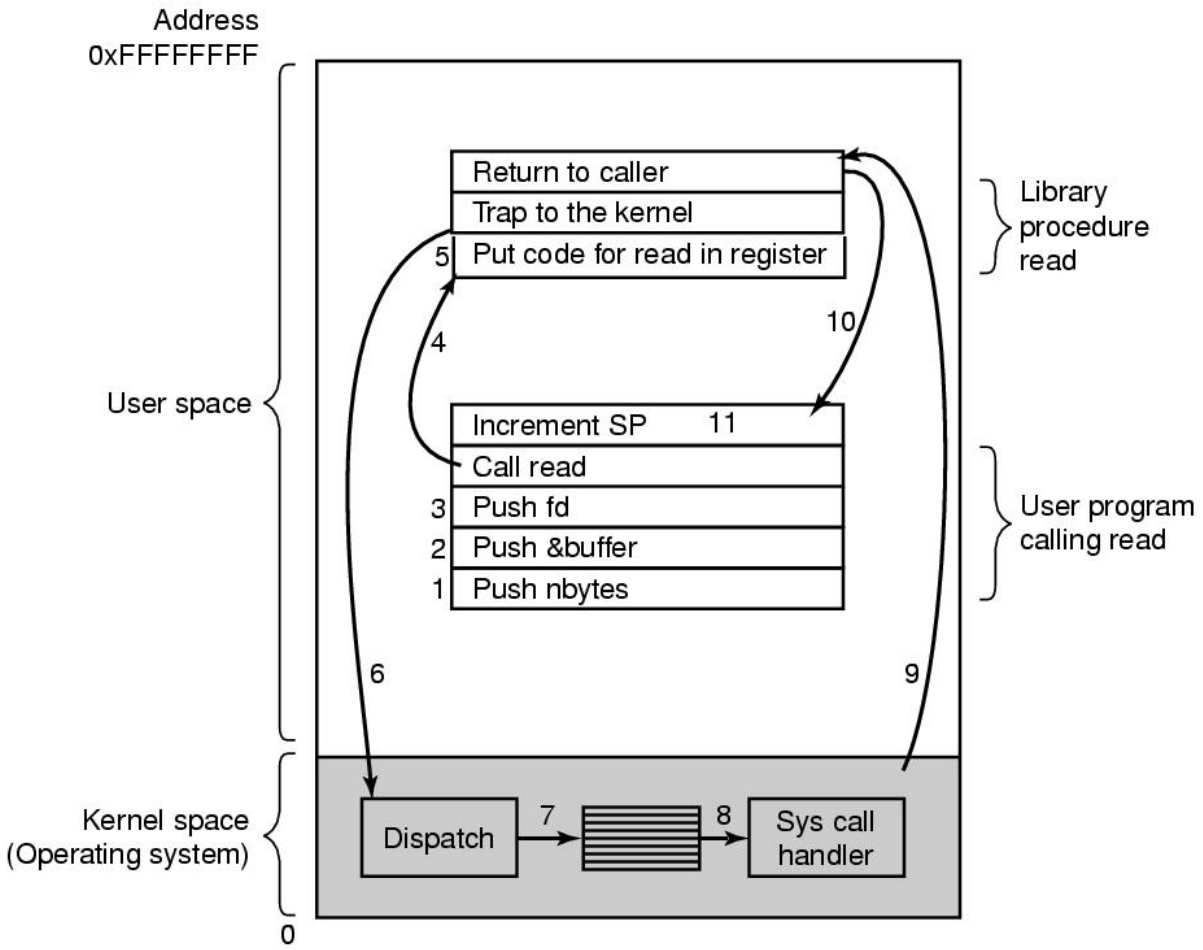

Figure 1-17. The 11 steps in making the system call read(fd, buffer, nbytes).

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System Calls for Process Management

Process management

Call	Description
pid = fork( )	Create a child process identical to the parent
pid = waitpid(pid, &statloc, options)	Wait for a child to terminate
s = execve(name, argv, environp)	Replace a process' core image
exit(status)	Terminate process execution and return status

Figure 1-18. Some of the major POSIX system calls.

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System Calls for File Management (1)

File management

Call	Description
fd = open(file, how, ...)	Open a file for reading, writing, or both
s = close(fd)	Close an open file
n = read(fd, buffer, nbytes)	Read data from a file into a buffer
n = write(fd, buffer, nbytes)	Write data from a buffer into a file
position = lseek(fd, offset, whence)	Move the file pointer
s = stat(name, &buf)	Get a file's status information

Figure 1-18. Some of the major POSIX system calls.

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System Calls for File Management (2)

Call	Description
s = mkdir(name, mode)	Create a new directory
s = rmdir(name)	Remove an empty directory
s = link(name1, name2)	Create a new entry, name2, pointing to name1
s = unlink(name)	Remove a directory entry
s = mount(special, name, flag)	Mount a file system
s = umount(special)	Unmount a file system

Figure 1-18. Some of the major POSIX system calls.

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Miscellaneous System Calls

Call	Description
s = chdir(dirname)	Change the working directory
s = chmod(name, mode)	Change a file's protection bits
s = kill(pid, signal)	Send a signal to a process
seconds = time(&seconds)	Get the elapsed time since Jan. 1, 1970

Figure 1-18. Some of the major POSIX system calls.

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Memory Layout

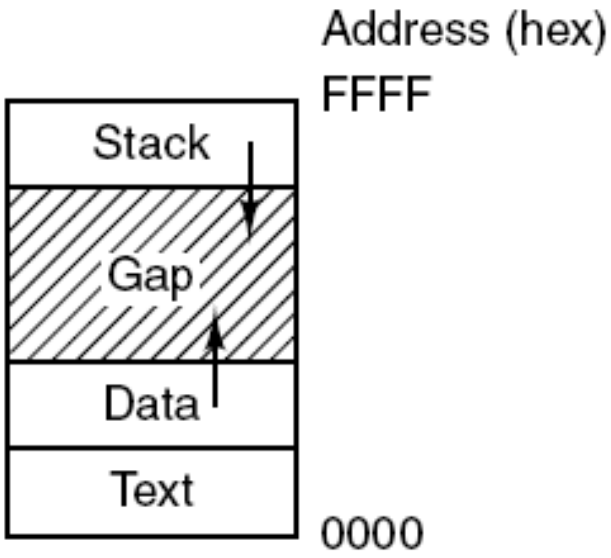

Figure 1-20. Processes have three segments: text, data, and stack.

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Windows Win32 API

UNIX	Win32	Description
fork	CreateProcess	Create a new process
waitpid	WaitForSingleObject	Can wait for a process to exit
execve	(none)	CreateProcess = fork + execve
exit	ExitProcess	Terminate execution
open	CreateFile	Create a file or open an existing file
close	CloseHandle	Close a file
read	ReadFile	Read data from a file
write	WriteFile	Write data to a file
lseek	SetFilePointer	Move the file pointer
stat	GetFileAttributesEx	Get various file attributes
mkdir	CreateDirectory	Create a new directory
rmdir	RemoveDirectory	Remove an empty directory
link	(none)	Win32 does not support links
unlink	DeleteFile	Destroy an existing file
mount	(none)	Win32 does not support mount
umount	(none)	Win32 does not support mount
chdir	SetCurrentDirectory	Change the current working directory
chmod	(none)	Win32 does not support security (although NT does)
kill	(none)	Win32 does not support signals
time	GetLocalTime	Get the current time

Figure 1-23. The Win32 API calls that roughly correspond to the UNIX calls of Fig. 1-18.

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