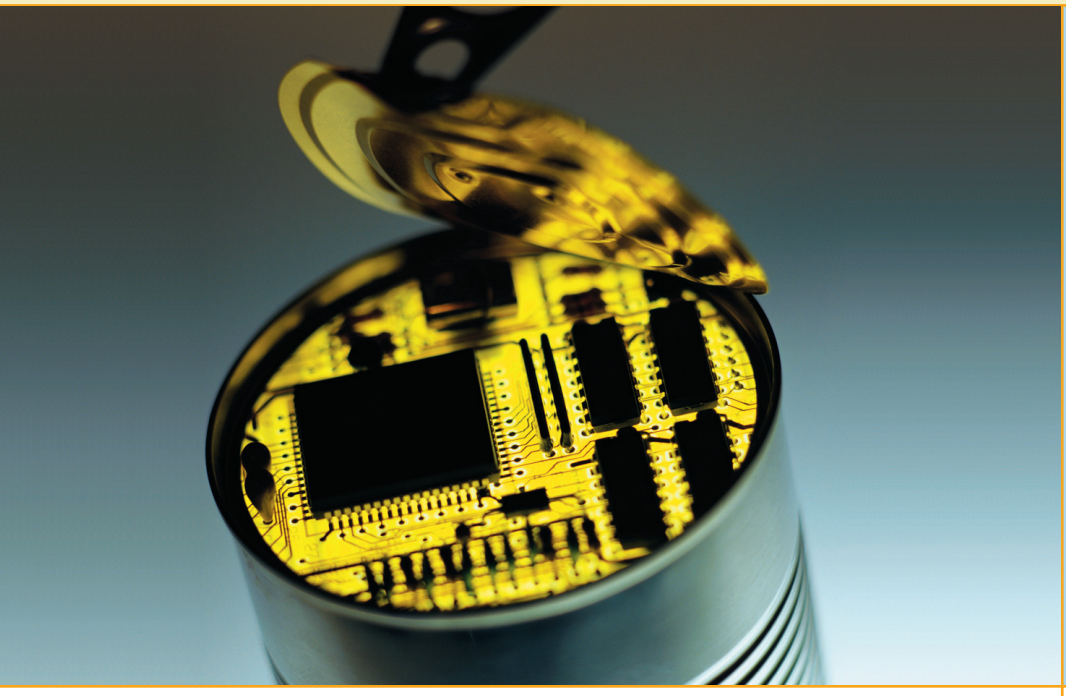
Introduction to Operating Systems

chapter 1



"The future isn't what it used to be."

—Yogi Berra

Understanding microcomputer operating systems (OSs) is critical to your future success in life. Well, it is. Just believe us. You don't? You say you drive a car just fine, but you don't understand the engine, transmission, and other systems? So why can't you just use your computer? Why do you have to even know it has an OS? If you successfully operate a car, you know more about its internals than you admit. You turn on the ignition, take the car out of park, press the accelerator, and drive down the street. You stop it (in time, usually). Maybe you use your car to drive to work, school, shopping, or the lake or beach, making the car your tool, just as your computer is a tool to write a letter, send e-mail, create a report, or create a graphic.

This chapter is an overview of microcomputer operating systems. It begins by defining what a microcomputer is and what types of microcomputers you may encounter. Expanding on this, it describes the physical components you can expect to find in a microcomputer. Then, after a brief definition of OSs and their purpose, this chapter presents an in-depth discussion of OSs and the functions they perform. Next, you'll take a brief journey back in time to learn the history of microcomputer operating systems. Finally, you will be introduced to the microcomputer OSs in common use today, and you'll consider when you would use each of them.

In this chapter, you will learn how to:

- **Describe the microcomputers in use today**
- **Identify common computer hardware components**
- **Describe the purpose and functions of microcomputer operating systems**
- **Describe major events in the evolution of microcomputer operating systems**
- **List and compare the common microcomputer operating systems**

Inside Information

Computers Have Shrunk!

Forty years ago, before the advent of microcomputers, most people would have laughed at the thought of dedicating an entire computer to the use of an individual, because computers were far from "micro." They were very large (filling rooms and weighing tons), expensive, high-maintenance machines dedicated to the operations of a government agency, university, or company.

Microcomputers Today

Before you learn about microcomputer operating systems, you may have a few more general questions: What is a microcomputer? What types of microcomputers are used today? You will find the answers to these questions in this section.

What Is a Microcomputer?

A **microcomputer** is a computer built around a special integrated circuit (IC), or chip (a small electronic component made up of transistors and other miniaturized parts), which performs the calculations, or processing, for the computer. Often referred to as the brain of a computer, this chip is the **central processing unit (CPU)**, but is also called a **microprocessor**, or simply a processor. A microcomputer is small enough, and even cheap enough, to be dedicated to the use of a single person. This was a revolutionary idea in the 1970s when microcomputers first became available.

Courtesy of Dell Computer Corp.

• A typical PC with components

What Types of Microcomputers Are Used Today?

The word *microcomputer* was first widely used in the late 1970s to describe the early forms of these computers. We're now more likely to use the term **personal computer (PC)**, which applies to computers that comply with hardware standards set and supported by Microsoft, Intel (the largest computer chip manufacturer), and to a lesser extent, other companies. We call these the Microsoft/Intel standards (also called Wintel). However, many important microcomputers don't comply with these standards—most notably, computers from Apple and the small handheld computers that are growing in popularity today.

Desktops and Laptops

Today the majority of computers found on desktops in private and public organizations comply with the Microsoft/Intel standard, with Macintosh computers a distant, but significant second. The Macintosh has ardent supporters in the education area and in any line of work requiring high-quality graphical and multimedia support. Most of the portable laptop or notebook computers available today are Microsoft/Intel compatible.

Furthermore, the types of microcomputers can be distinguished based on how they are used. This book is dedicated to the operating systems used by individuals on desktop and portable microcomputers, whether they are PCs or Macs.

Beware of PC naming confusion! The term *personal computer* (*PC*) actually excludes some microcomputers because it is often interpreted as referring specifically to any computer that complies with the standards that evolved from the IBM PC, which originated in 1981, and that are now manifest in the Wintel standards.

Servers

A PC or Mac can also be used as a **server**, which is a computer that plays one of several important roles in a network. In all of these roles, it provides services to other computers, and the computers on the receiving end of these services are referred to as **clients**.

What kind of services does a server provide? A server may be used to store all of the data files of the users in a department or company—this is a file server—and if a server has one or more printers connected to it that it shares with users on the network, it is called a print server; these are often combined into a file and print server. Other servers may offer messaging services (e-mail and fax), web services, and many, many other services. Note that one server can offer multiple services at the same time.

In this book, we'll use the term *microcomputer* to refer to all small computers as a group, and we'll use the term *PC* when discussing computers that comply with the Microsoft/Intel standards, both desktop and portable. We'll use the term *Mac* to refer to today's Apple computers (which include several models), both desktop and portable.

Handheld Devices

There are also many different handheld devices, and they are often proprietary devices that comply with no, or very few, standards in their design. Despite their size, they are still called microcomputers because they are built around microprocessors. They include a wide variety of products ranging from simple handheld computers to multifunction mobile devices. Some handheld computers are dedicated to a single purpose; examples include the handheld devices that employees use in grocery stores to track inventory. Others are wireless phones that not only allow voice communications, but also let you connect to the Internet and view your e-mail on their tiny color screens.

This book is not about the OSs for servers, although you will learn about servers and network operating systems in Chapter 10.

What's Contained in and Attached to a Microcomputer?

We have a friend named Brianna. She uses a PC at work and a Macintosh at home, and she will soon take night classes in which she will use a laptop PC that she carries to and from school. She wants to learn more about the computers that she uses each day, beginning with the hardware.

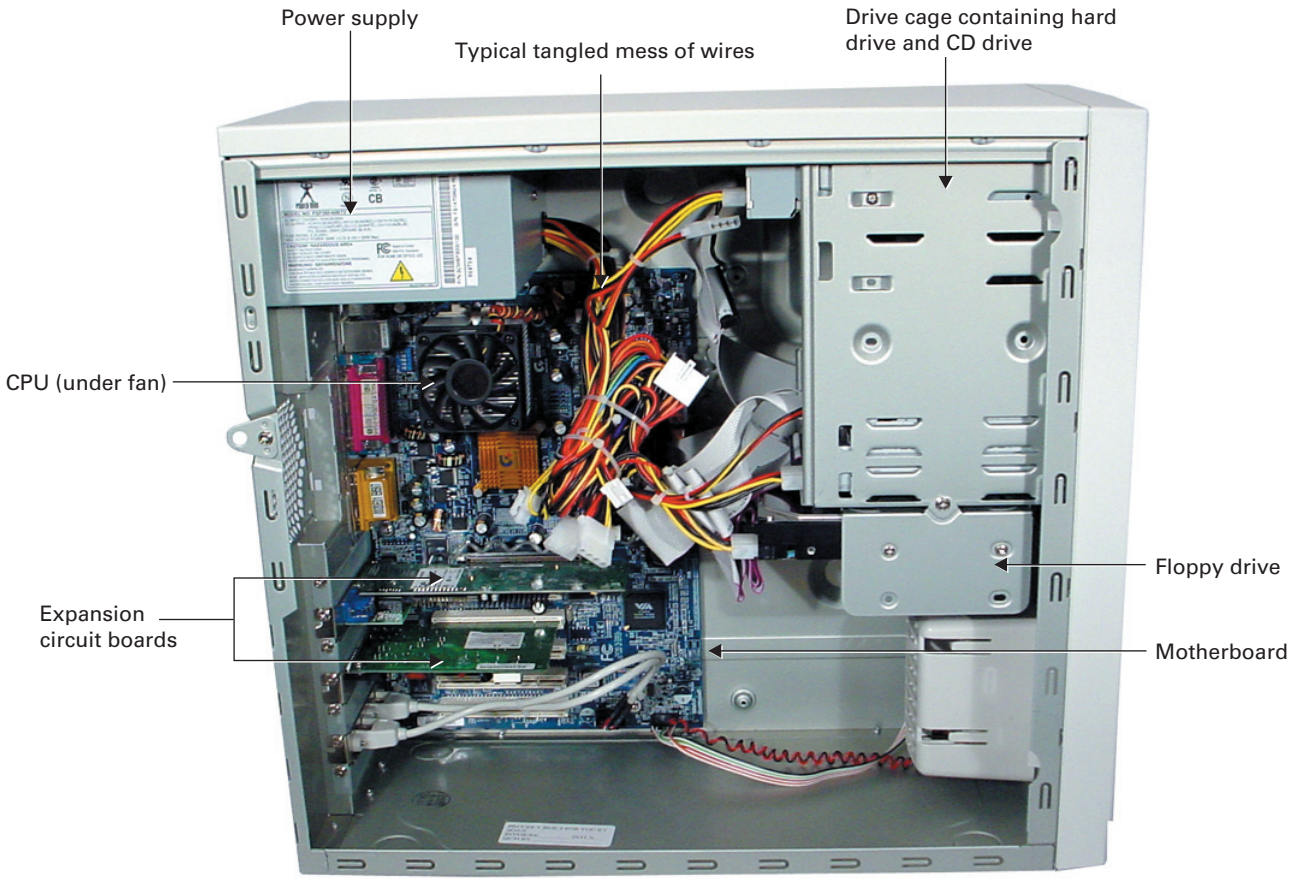
Each computer that Brianna and the rest of us use is a metal and plastic hardware device composed of many components, some of which allow us to interact with the computer. In techie talk, interaction with a computer is called **I/O**, which stands for **input/output**. When you send something into the computer, say when you enter information via the keyboard or have your word processing program read a file from disk, it is called **input**. When something comes out of the computer, like the text and graphics you see on the display screen or the printed results on paper, it is **output** from the computer.

Try This!

More About Handhelds

Although this book will mention handheld devices from time to time, you will not really study these devices in this book. Satisfy your curiosity about this growing area. Try this:

1. Use an Internet search engine, such as `www.google.com`, and search on the term *handheld*. Browse through the sites you find in the search engine. Results will vary, but some likely sites are `www.Microsoft.com/mobile/handheldpc`, `www.handheldmed.com`, and `www.hhp.com`.
2. What OSs do the handheld devices you discovered use?
3. What industries are using handheld devices?



- Open computer showing internal components

Regardless of the brand of microcomputer you use, the list of common hardware components is basically the same, although only a very few components can actually be interchanged between PCs and Macs. In general, common microcomputer hardware devices include processors, a motherboard, memory, ROM BIOS, a keyboard, pointing devices, disk drives, and peripheral devices. This section provides a brief description of each of these hardware components; first, though, you need to learn a little about the basic technology underlying today's microcomputers.

Cross Check

Required Hardware

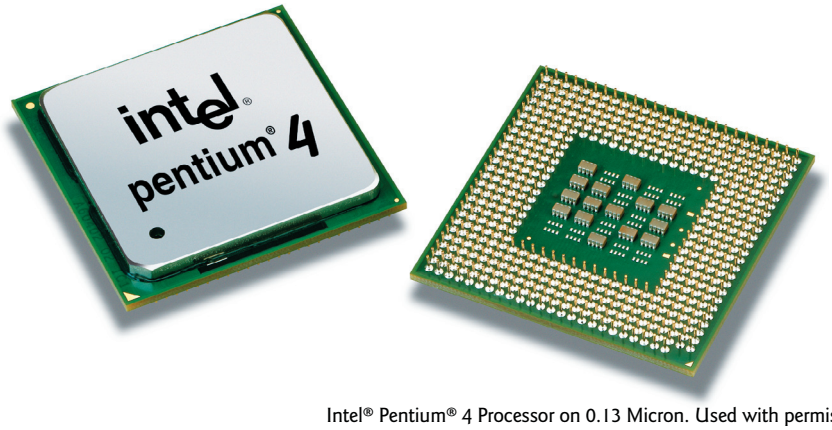
All operating systems require certain hardware. Flip ahead to Chapter 2, "Disk Operating System (DOS);" Chapter 7, "Windows XP;" and Chapter 8, "Macintosh OS 9 and OS X." Compare the hardware requirements of these OSs.

1. What hardware requirements do they have in common?
2. What is the major difference in requirements between DOS and Windows XP?
3. What is the major difference in requirements between Windows XP and Mac OS/X?

All electronic devices include components such as resistors, capacitors, and transistors that enable the device to do the task the designer intended it to do. Not so long ago, 20 or 30 years or so, these components were all discrete entities—that is, they were individually made and individually placed on the circuit cards (the flat plastic boards that have networks of circuitry on their surfaces to which electronic components are attached). That's why the early computers were physically huge. The technological revolution that enabled the microprocessor to exist was the invention of integrated circuits (ICs). ICs still contain all the components necessary to make the device work, but they are created by special processes that vastly miniaturize all of the individual pieces and place them on a wafer (or chip) of material. Thus, today a computer chip can contain many millions of devices within it and still be only an inch or so in size.

Processor

A microcomputer always has at least one microprocessor, which is also called a central processing unit (CPU), or simply a processor. Like many of the electronic components in a computer, a processor is an integrated circuit (IC), or chip. The processor is the central component of the computer—its brain. Like your own brain, the processor sends and receives commands to and from the computer's hardware and software. For example, when Brianna wants to print a letter she typed on her computer, she chooses the Print command. This seems like a very simple command, but it actually causes many commands to be sent to the processor: commands to transfer the file from memory to the printer, commands to communicate with the printer, and many, many others. The processor doesn't just perform calculations; it is involved in nearly everything that happens in your computer.



Intel® Pentium® 4 Processor on 0.13 Micron. Used with permission.

- Top and bottom views of a processor with many gold pins visible on the bottom

The capabilities of the processor also define the limits and capabilities of the computer, including the speed of the system. In addition, because operating systems must work closely with the processor and other hardware, an operating system is written to work with a certain specific processor and chipset. This limits your choice of OSs that you can run on a computer.

Inside Information

Early Intel Processors

For the past decade, the Intel processors have been variations on the Pentium processor, but in the 1980s there were several major models, beginning with the CPU in the original IBM-PC, the 8088. This was a slightly less capable version of the 8086 (these two models are so similar that they are often considered as one). The next major advance was the 80286 (also called the 286), followed by the 386. Intel often brought out variations on a major model, using letters to distinguish the different CPUs. The 386DX was a specific sub-model of the 386, as was the 386SX, which was less capable. For instance, the 386SX could use less physical memory than the 386 DX. Intel followed this practice with the 486, which also came out in SX and DX versions: one (the SX) lacking and one (the DX) containing a special math co-processor on the CPU.

Try This!

Microprocessors

You can use the Internet to learn more about microprocessors. Try this:

1. Use your computer's Web browser to surf to `www.webopedia.com`.
2. Under Search, enter the word **processor** in the By Keyword box; then click the Go button.
3. Read the information on the microprocessor page. Any word or phrase that is underlined is usually a link to more information, meaning that you can click it to learn more.
4. Click each link, read the additional information on processors, and then use the Back button to return to the microprocessor page.
5. Look for information about processors from Intel, Apple, and AMD. At the time of this writing one of the links had a great comparison chart at that included microprocessors from Intel, Apple, and AMD.
6. Remember that websites come and go, so if that chart is no longer available, search elsewhere. Other good search sites (with or without comparison charts) are `www.whatis.techtarget.com`, `www.techweb.com`, and `www.intel.com`.

Among the distinguishing features of a processor are operation modes and the size of the chunks of data with which the processor can work.

Processor Modes

We'll use the Intel processors to briefly look at some basic processor features. The Intel 8086 and 8088 processors used in PCs in the early 1980s had a limited bag of tricks, because they had only one mode of operation: real mode. Newer Intel processors beginning with the 386DX have three modes: real mode plus two flavors of protected mode, called 286 protected mode and 386 protected mode.

Real mode is the mode in which an Intel processor (even today) wakes up when the computer is turned on, and it is very limited. It offers the operating system a small amount of memory to work with and doesn't allow for multi-tasking (running more than one program at a time), protection of the hardware from other software, or something called a virtual machine, which is a pretend computer in memory used to isolate and run certain programs.

The **286 protected mode** was introduced with the 80286 processor. We almost never talk about this mode or this processor any more. In brief, 286 protected mode allows an operating system (written for this mode) to access up to 16 megabytes (millions of bytes, usually abbreviated 16MB) of physical RAM, but it does not allow the operating system to create virtual machines.

The **386 protected mode** is the mode usually meant when people talk about Intel processors and protected mode. This mode allows an OS to use up to 4 gigabytes (billions of bytes, normally written as 4GB) of physical RAM. If an OS runs out of physical memory, it can use virtual memory, a system of memory management in which the OS moves programs and data in and out of memory as needed. This mode also allows the use of virtual machines in which older programs can be run. In this book, when we talk about protected mode, this more powerful mode is the one meant.

Inside Information

16-Bit OSs and 32-Bit OSs

An operating system that can take advantage of the features of a processor is called an x-bit OS. DOS is a 16-bit OS, as is Windows 3.0 and its sub-versions. Although Microsoft refers to Windows 95 and 98 as 32-bit OSs, these are really hybrids, with mostly 32-bit pieces, but some 16-bit pieces for downward compatibility. The newer Windows OSs and the Mac OSs we discuss in this book are all 32-bit OSs.

16-Bit Processors and 32-Bit Processors

Another important issue is the size of the chunks of data with which a processor can work. We talk of a processor being an 8-bit processor (now extinct), 16-bit processor (8086/8088), 32-bit processor (80386DX through Intel Pentium models), or 64-bit processor (coming soon). The number of bits (binary digits) refers to the amount of data that can be processed at one time;

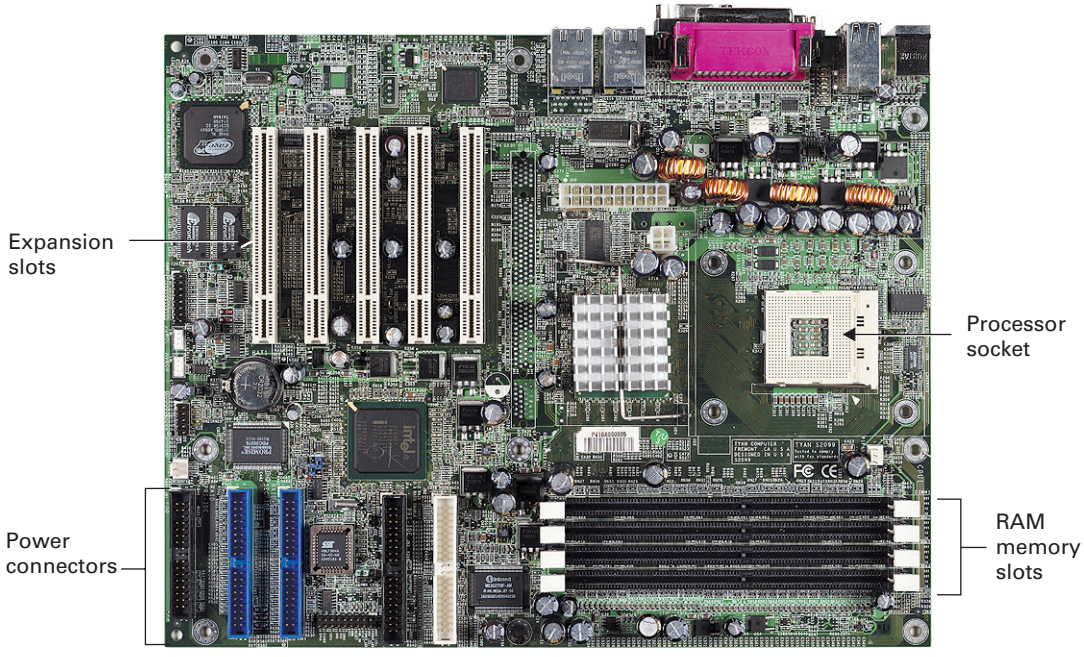
this number also refers to the number of bits in the address bus that the processor uses to work with physical memory in the computer.

A Vital Component

Without a processor, no computer will operate, because it can't "think." Some of the other components can be missing, and the computer will simply have reduced capability in a particular area. For instance, if you don't have a printer, you can't print; if you don't have a modem, you can't connect to the Internet over a phone line—but the rest of the computer will work fine. However, without a processor, your computer simply will not work.

Motherboard and Chipset

The **motherboard** is the central circuit board of a computer. All other devices are connected to it in one way or another. It contains one or more CPU slots or sockets into which the processor(s) is plugged, the controlling chipset, some memory slots, the voltage regulator module (VRM), the ROM BIOS, and the expansion bus slots. The chipset consists of several chips that control much of the flow of signals to and from the processor and other components. It is another key element in the overall limits and capabilities of the microcomputer.



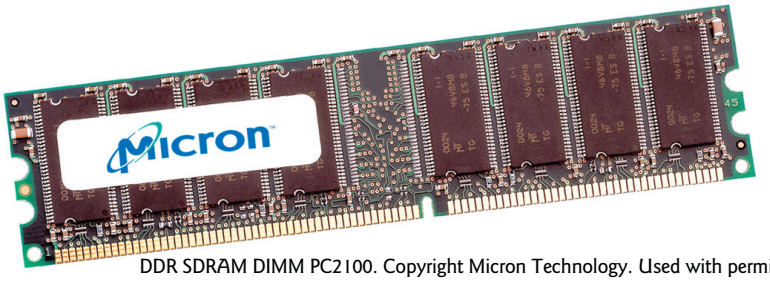
Tyan Trinity i845E. Used with permission from Tyan Computer Corporation.

- A typical motherboard with some components installed

Memory

Memory is a huge topic, but we can condense it to the one basic statement: memory *remembers*. Too simple? Let's try again. Computer **memory** involves chips that store programs and data. Got that? Here's the low-tech, but long,

explanation. Memory, in a computer, refers to one of several different types. One type of memory, **random-access memory**, or **RAM**, provides the temporary storage for programs and data. RAM consists of one or more special circuit cards that contain memory chips. It is called random-access memory because each of its locations is assigned a discrete address. An address is a pointer to a specific location in memory, used by your OS to organize its use of memory. Programs and data can be stored directly in each of these addresses—thus, each memory location can be directly accessed at random.



DDR SDRAM DIMM PC2100. Copyright Micron Technology. Used with permission.

- Memory module

A Bit About Bytes

If the words *megabyte* and *gigabyte* just sound like jargon, read this. If you learned about megabytes and gigabytes before you ate your first french fries, skip this.

When we talk about storing things in memory or on disk, we use terms like **megabyte** and **gigabyte** to describe amounts of memory or disk space. To understand these terms, first consider the smallest unit of storage (disk or memory), which is a **binary digit** (abbreviated as **bit**). You can think of a single bit as being like a light switch: it is either on or off. When it is on, it represents 1; when it is off, it represents 0. Computers (or the folks who make computers) like binary notation because it can be represented by anything that has two states, like on or off. This is exactly how RAM and ROM works: with the equivalent of on and off switches. Floppy and hard disks have a metallic oxide coating that contains particles that can be magnetized (polarized) by a charge, or left unmagnetized, and can thus represent on and off states.

To put this into context, a relative of ours just called to boast that he had bought a computer with 1 gigabyte of RAM (roughly a billion bytes of RAM) and a hard drive with 120 gigabytes of disk space. (We know that computer memory and hard drives are growing rapidly, so please don't send us e-mail if that sounds like a ridiculously wimpy computer by the time you read this!)

RAM

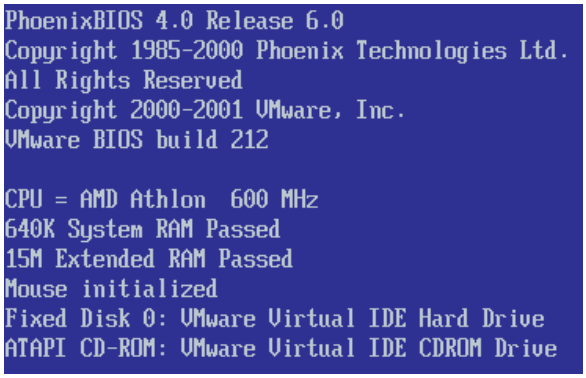
The most important memory in your computer is the system memory, also called main or physical memory, which active programs use when they're running. System memory is volatile, meaning that when you turn off or reboot your computer, whatever is contained in memory disappears. When an advertisement for a computer states "with 512MB (megabytes) of memory," this is system memory.

Inside Information

Kilobyte, Megabyte, Gigabyte, and Terabyte

In computers, bits are often used in groups of 8, which we call a ***byte****. A single byte can represent a character, like the letter A in a word processing document, or a very simple command, like the command to move down one line. When you have 1,024 bytes, you have 1 kilobyte (2 to the 10th power—*kilo *means thousand); 1,048,576 bytes equal 1 megabyte (2 to the 20th power—*mega *means million); 1,073,741,824 bytes equal 1 gigabyte (2 to the 30th power—*giga *means billion); 1,099,511,627,776 bytes equal 1* ***terabyte*** *(2 to the 40th power—*tera *means trillion). (Notice that the actual number of bytes is not a round number, so when you have a kilobyte of data, you actually have a little more than a thousand bytes—and it really adds up! A gigabyte is actually almost 74 million bytes larger than one would expect.)*

RAM has historically been very expensive, but in recent years technical advances have vastly increased the amount of RAM available on a single chip while at the same time drastically reducing the cost of each chip. Nowadays, even inexpensive computers have memory capacity only dreamed of a few years ago.



• **Figure 1-1.** BIOS bootup information

Beyond the system memory, many components in your computer, and the peripherals attached to your computer, also contain memory, but this memory is not included in system memory.

ROM BIOS

Another type of memory is **read-only memory (ROM)**, which is used to store programs more or less permanently. When you turn off your computer, the contents of ROM remain intact. So why did we say "more or less?" Because some ROM can actually be modified, using a special program and sometimes also requiring a temporary change to the hardware, but that is beyond what you need to know right now, so just think of what is contained in ROM as permanent.

The **ROM BIOS** is the chip containing the **read-only memory basic input-output system**. The BIOS is a set of program instructions for starting the computer, as well as for controlling communication between the processor and other components (the input and output). That's why this information is stored in ROM: so that it doesn't vanish when the power is turned off. Also stored in ROM is the system setup program that lets us define the basic configuration information, which is, in turn, stored in another special kind of nonvolatile (doesn't disappear when power is turned off) RAM, called CMOS RAM.

This basic configuration information includes the following:

- The type and capacity of the installed disk drives (both floppy and hard)
- The disk boot order (the order in which the system searches disks for bootup programs)
- The configuration of system memory
- The configuration of the various connectors
- The configuration of power management
- Other system-level configuration options determined by the makers of the motherboard and the creators of the ROM BIOS

Inside Information

More About ROM

The term ROM BIOS *usually refers to the system BIOS that is central to each computer. However, most components and peripherals have their own ROM that contains program code for operating that component. Because the software that is stored in ROM is nonvolatile, it is often referred to as firmware. If you're quick, you can see information fleetingly displayed on your screen by the system ROM BIOS and the ROM of other devices during bootup, as shown in Figure 1-1.*

Video Adapter and Display

ATI RADEON 9700 PRO Video Card. Copyright ATI.

- Video adapter

The video adapter is a set of circuitry (either embedded in the motherboard or on a separate circuit board) that receives video control signals from the computer and sends the controlling output signals to the display screen.

A computer will usually have a **display screen**, either a **monitor** or a flat-panel display (FPD), for the visual output from the computer. Traditionally, a display screen was built around a cathode-ray tube (CRT), which is physically bulky and looks like a TV set. However, recent improvements in flat-panel displays, and rapidly falling prices, make these types of displays increasingly common since an FPD has a much smaller footprint on the desktop than a monitor with an equal-sized screen. There are several types of FPDs with varying characteristics.

Keyboard

- Keyboard

A keyboard is an input device, usually built around a typewriter-style layout of alphanumeric and punctuation keys (commonly known as the QWERTY key layout after the first six letters in the top letter row) plus additional function, control, arrow, caps lock, and editing keys. Most computer keyboards also have a separate numeric keypad, with the exception of portable computer keyboards, which often have the keypad embedded within the alphanumeric keys (doing double duty).

Pointing Device

- Mouse

A **pointing device** is required to move a graphical pointer called a **cursor** around a graphical user interface (GUI). A **mouse**, the most common pointing device, is roughly the size of a bar of soap and connects to the computer by a physical cable or through a wireless connection (using infrared or radio signals). When a mouse is moved around on a flat surface, its device driver (the piece of software that tells the computer what a device is doing) translates its movements into similar movements of the cursor on the display screen. Other pointing devices that provide essentially the same function include track balls, joysticks, and light pens.

Disk Drives

Computers today contain one or more **disk drives**, for storing data and programs. A disk drive stores data by putting it onto the surface of small spinning platters using either magnetic or optical technology. Floppy drives and hard disk drives use a magnetic technology in which each disk platter has a metal oxide coating that can be easily magnetized, and data is encoded on this surface magnetically.

A floppy disk has only a single flexible platter, usually made of Mylar, while a hard disk drive will have one or more rigid metal platters. Compact

disc (CD) and digital versatile disc (DVD) drives use an optical technology in which a focused light beam generated by a tiny laser is used to read and write information on the disk. CDs and DVDs are made of plastic with a material embedded in the plastic that can be altered by the light beam when information is written to the disk, and which reflects variations in the light beam when the disk is read. Floppy and hard disks are always rewriteable, whereas CDs and DVDs come in both read-only and readable and writeable forms.

IBM Ultrastar 73LZX disk drive. Courtesy of International Business Machines Corporation. Unauthorized use not permitted.

- A hard disk drive with the cover removed

Peripheral Devices

Peripheral device is a very broad term that pretty much covers all computer components beyond the motherboard components (processor, basic chipset, and memory). Although this term does include a great deal of "under the hood" stuff (that is, devices that are contained within the computer cabinet along with everything else), we most often use the word *peripheral* to refer to nonessential add-on devices such as digital cameras, printers, scanners, pointing devices, and external modems and disk drives.

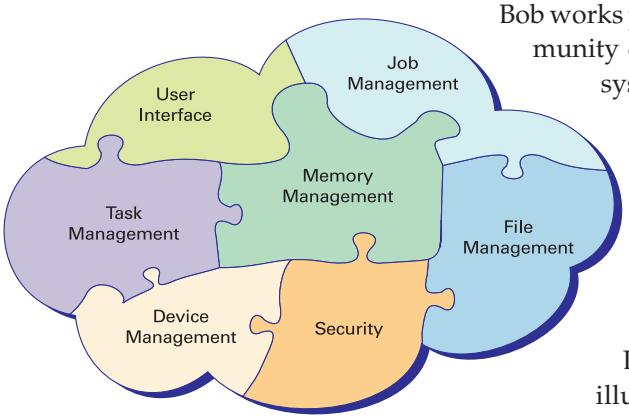
Courtesy of International Business Machines Corporation. Unauthorized use not permitted.

- IBM Infoprint 1130 laser printer

Storage space is not memory! Don't fall into the trap of confusing memory with storage space. Memory is RAM or ROM. Most of the memory you work with is RAM, used as the temporary workspace for your OS and applications. Storage space is disk space where you save your programs and data as files.

Learn more about current hardware technology and future trends at `www.hardwarecentral.com`, `www.aceshardware.com`, `www.apple.com/hardware`, and `www.hwextreme.com`.

Purpose and Functions of Microcomputer Operating Systems



- The functions of an operating system

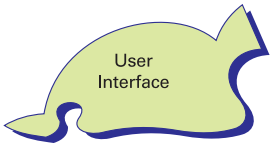
Bob works part-time in a legal office and is a full-time student at a community college, where he is enrolled in the computer information systems (CIS) track. Recently, he took a Saturday community education class in computer graphics. He finds himself confused by all of the different operating systems that he uses. At work, he has Windows XP Professional on his desktop computer; in the open lab at night school, he uses Windows 2000; and in his recent Saturday afternoon graphics class, he used a Macintosh. His next class at the community college will involve working with Linux. Although Bob's experience might seem extreme, it illustrates a fact: you are likely to encounter different desktop operating systems at work, school, and home. In addition, as computers proliferate, it becomes more important to learn the common characteristics that they share.

Bob spends most of his time on each computer he uses working in one or another specific application, such as a word processor, a graphical drawing program, or an Internet browser. However, he often needs to perform tasks outside of these applications, such as logging on to the computer, launching each application, managing files, and even troubleshooting the occasional problem that may arise with the computer. He has recently gone from not even realizing that such a thing as an operating system existed to wondering how he can learn to perform these common tasks in each of the different operating systems that he encounters. He wants to gain a better understanding of the OSs so that he can both perform better on the job and feel more comfortable while working on the various computers. He has decided to begin by learning what an OS is and what functions it performs, as described in the following sections.

Although a specific operating system can run effectively only on a computer with a specific type of processor and chipset, there are a variety of operating systems that will run on a PC, including MS-DOS, Microsoft Windows (any version), and UNIX (if it is a version created for PCs). Macintosh computers are proprietary and run only Apple operating systems, referred to as Mac OS followed by the version—most recently 9 and X (10).

What Is an Operating System?

An **operating system (OS)** is the program (or group of programs) that acts as the central control program for the computer. As such, it is loaded (or booted up, a derivation of the adage "lifting yourself by your own bootstraps") when the computer is turned on. Its main component (the **kernel**) always remains in memory while the computer is running. The operating system acts as an intermediary between the applications and the hardware. There are several functions performed by the operating system. We'll study them next.



User Interface

The **user interface** is the software layer, sometimes called the shell, through which the user communicates with the OS. The OS, in turn, communicates

with the computer. Thus, the user interface includes the command processor, which loads programs into memory, as well as the many visual components of the operating system (what you see when you look at the monitor). On a computer running DOS, this visual component consists of a character-based command line that provides only sparse amounts of information. Figure 1-2 shows the classic DOS prompt: white characters against a screen with a blinking cursor waiting for you to type a command at the keyboard. Only a limited set of characters can appear on the screen, each in its own little equal-sized grid of space.

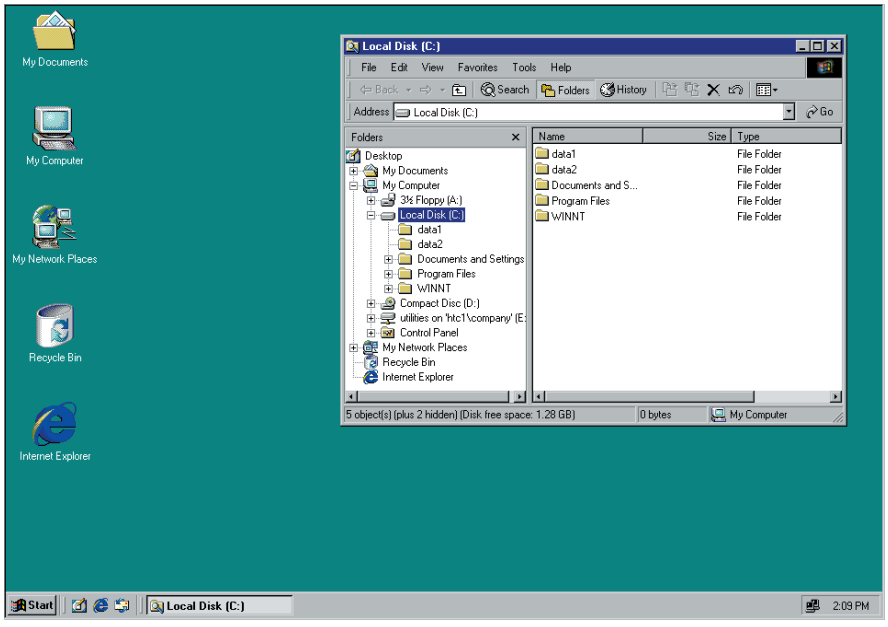
• **Figure 1-2.** MS-DOS prompt

To become proficient with DOS, you must memorize the somewhat cryptic commands and their modifiers and subcommands. On the other hand, Apple's Mac OSs, and Microsoft's Windows operating systems all provide an information-rich **graphical user interface (GUI)** through which you communicate with the OS and the computer.

The GUI is the grouping of many dots into colorful objects that become elements that you see on the screen. Such a presentation, or interface, offers menus and graphical icons (small graphics) that allow you to use the pointing device to select programs to run and to perform many other tasks, such as opening a word-processed file.

Although UNIX traditionally had a DOS-like interface, most current versions of UNIX also allow you to use GUIs.

Although you do not have to memorize arcane commands, working within a GUI does require you to learn the meaning of the various graphical pieces that make up the GUI and how to navigate among these pieces to find your programs and data. In addition, you must learn how to make a program become active (to start) so that you can get your work or play done. Figure 1-3 shows a GUI screen. Notice the icons and other graphical components, such as the bar at the bottom containing the button labeled Start.

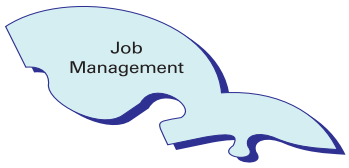


• **Figure 1-3.** A typical GUI screen

Inside Information

Programmers Make It Work!

When programmers (people who create software programs) write an application, they design the application to interact with the operating system and make all requests for hardware services through the operating system. To do this, they must write the program to use the correct commands to request services from the operating system. The operating system, in turn, interacts with the hardware on behalf of the application and fulfills the requests made by the application.



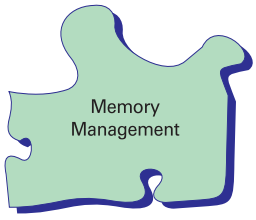
Job Management

Job management is an operating system function that controls the order and time in which programs are run. Two examples of programs that may perform this function are a scheduling program that schedules other programs or batch files to be run on a certain day and time, and a print program that manages and prioritizes multiple print jobs.

Task Management

Task management is an operating system function found in **multitasking** operating systems. Multitasking implies that a computer is simultaneously running two or more programs (tasks) at the same time. In reality, a computer cannot run more tasks simultaneously than the number of processors that exist within the computer. Because most microcomputers only have a single processor, multitasking is accomplished through a scheme that makes order out of chaos by determining which program responds to the keystrokes and mouse movements.

Task management controls the **focus** (where the system's attention is at any given moment). It also allows the user to switch between tasks by giving the focus to the application the user brings to the foreground. In Windows, this application runs in the **current window**. This is the window that is on top of other windows on the screen, and the window that receives input from the keyboard when the user types.



Memory Management

Memory management is an operating system function that manages the placement of programs and data in memory, while keeping track of where it put them. In the case of advanced operating systems, such as Windows NT, Windows 2000, and later similar Windows versions, this involves a scheme for making optimal use of memory. Virtual memory allows more code and data to be active than the actual physical system memory can hold. Using a memory management OS component called the **virtual memory manager**, these operating systems move code and data, as necessary, to a portion of the disk that has been defined as **virtual memory**. This means that this disk space is used as if it were memory, not just disk storage space. This transfer is performed for code and data that is part of any program that currently does not have the user's attention. Reason? This not-needed-right-now information does not need to be kept in RAM memory for immediate use.

The memory management function may not be included in every definition of an operating system, but it is a very important function, especially in Windows, Macintosh, and UNIX operating systems.

File Management

File management, also referred to as data management, is an operating system function that allows the operating system to be used to read, write, and modify data.

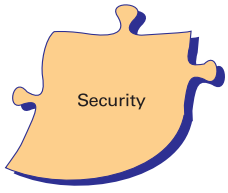
Data is organized into entities called files that are saved to storage devices (usually disks). File management also allows users to organize their files, using other special files that act as containers. These special files are called **folders** or **directories**, and they can contain other folders as well as files.

The user works with a specific logical file organization with which he or she is comfortable, while the operating system file management function relates that logical organization to the actual physical location of the file or folder so that it can store and retrieve the data.

Device Management

The **device management** function controls hardware devices through the use of special software called **device drivers**, which must be installed in the operating system. Device drivers are unique to the device and are created by the manufacturer of the device to work with a specific operating system. For instance, a printer or video adapter will come with drivers for several different operating systems. The device driver contains the commands understood by the device and uses these commands to control the device in response to requests it receives from the operating system. You need a component-specific device driver for each unique hardware component with which the operating system interacts.

Security



The **security** function of an operating system provides password-protected authentication of the user before allowing access to the local computer and may restrict what someone can do on a computer. For example, Rachel is the accounting clerk in a small company. She has confidential information on her computer, and she doesn't want just anyone to be able to walk up to her computer and look at the information stored there. What can be done with the OS to help Rachel secure her computer? You could set up her computer so that anyone getting into it must have a user account. A user account includes a name and an associated password stored inside the PC.

After you set up Rachel's account, when she logs on to her computer, she must enter her user name and password. Before giving her access to the computer, her operating system will verify that she used a valid user name and password. The validation of the user account and password is called **authentication**.

A part-time clerk, Kirsten, has just been hired to work at night entering accounts payable information into Rachel's computer. To allow Kirsten to also log on to Rachel's computer, you can create a new user account for Kirsten. Only Rachel and Kirsten can log on to this computer, but Rachel does not want Kirsten to be able to access the payroll information, also stored on Rachel's computer. Now, this is private information, right? What might be done to help Rachel with this problem? One thing you could do (if

Inside Information

Computer Security and Your Career

Although your operating system may provide a security function, it takes special skills to manage security. If you're pursuing a career that involves managing computers, you will need to learn the skills needed to make computers secure. Here are some types of professionals who need a good understanding of security:

- ***Server administrator*** *A server administrator must understand the authentication and authorization processes of the operating systems on the network servers being administered. A server administrator must know how to use accounts, permissions, and privileges to give users only that required level of access that they need to do their jobs. A server administrator must understand how to implement policies that will protect data and must have the means to recognize when unauthorized access has succeeded, or even been attempted.*
- ***Network administrator*** *A network administrator is concerned with the larger picture of network-wide security. This type of administrator is involved in implementing a network security plan that complements the security plan implemented on the servers. The network administrator's focus is on the integrity of the network infrastructure of media and connection devices.*
- ***Desktop support analyst*** *A desktop support analyst works on the front line of information technology support. This person works directly with the end user and may be the person who educates the end user on the security policy of the organization. The desktop support analyst must have a good understanding of the security policies of the organization and how users must behave to comply with the policies. Good communication skills are also a real plus!*

her operating system supports it) is to set up Rachel's computer so that she can assign special permissions to the files and folders on her hard disk, giving each user account the level of permission needed. For instance, Kirsten needs to be able to add accounting information to the accounts payable files, so you could give Kirsten's account the permission that will allow her to write to the files in the accounts payable folder. You will not give Kirsten's account access to any of the other folders, and you will give Rachel's account full control of all of the folders that Rachel needs to use.

Yesterday's Operating Systems

Ever read the book *The Rise and Fall of the Roman Empire*? Even if you haven't, you may know an oft-quoted line from it: "Those who fail to learn about the past are doomed to repeat it." Nothing could be truer in the PC world also—with a small change. Here's the Mike Meyers' amendment to that famous phrase: "Those who fail to understand older PC technology will never understand the current stuff." You would be amazed at how much of the oldest OSs are still alive and well in the newest ones!

1968

Stanford Research Institute's Douglas Engelbart demonstrates the use of a mouse to move a "bug" around a screen.

1969

A small group at Bell Labs begins to work on what eventually becomes UNIX.

ARPANET is created, the first step in the building of the Internet.

1970

Xerox opens Palo Alto Research Center (PARC).

IBM introduces the floppy disk.

Intel creates the 4004 processor, leading the way to the birth of the PC.

1973

PARC creates the Altos, the first PC with a GUI, laser printer, and a connection to the first Ethernet network.

First the Machines

Computers didn't arrive just yesterday. If you want to, you can argue that they started with the computers that were designed (but never built) by Charles Babbage in the 1820s. Or perhaps you would start with the U.S. military's World War II computers. In general, consumers encountered their first microcomputers in 1977 with the introduction of Apple's Apple II, Radio Shack's TRS-80, or Commodore's PET.

Although computers and microcomputers existed before the Apple II, this computer was the first one to combine a number of critical elements to make what today is considered a microcomputer, including a keyboard, monitor, operating system, desirable and useful applications, and a reasonable price tag.

- Apple II

Then the Operating Systems

The idea for an operating system as complex as what you see on your desktop today didn't just pop into someone's head one day. In fact, an operating system as a separate entity didn't exist in the early years of digital computing (defined roughly as from World War II into the 1950s). Each computer was dedicated to a single purpose, such as performing trajectory calculations for weapons or mathematical analysis for a science lab, in addition to the system I/O functions. Operating systems evolved through many small steps, some in the form of technical advances and others in evolutionary changes in how computers were used.

Operating systems evolved because people saw the need to use computers as multipurpose devices. The "user," who at first was a government agency, research institute, or large business, would define the computer's purpose at any given time by the program chosen to run. Some early "operating systems" were developed in the 1950s to manage data storage on tape for mainframe computers, but it was much more common for application programmers to write system I/O routines (the stuff of today's OSs) right into their programs. By the mid 1960s, as disk systems became more common on large computers, operating systems were needed to manage these disks and to perform other common system-level routines.

1974

John Torode and Gary Kildall introduce a microcomputer disk operating system CP/M.

Intel releases the 8088 processor.

1975

MITS Altair 8800 is introduced in Popular Electronics.

Bell Labs releases UNIX version 6.

Bill Gates and Paul Allen write a programming language called BASIC.

1976

Apple Computer founded by Steve Jobs and Steve Wozniak.

The Apple I computer is released.

1977

Apple II introduced at the West Coast Computer Faire.

Commodore PET is introduced.

Microsoft is founded by Bill Gates (bottom left) and Paul Allen (bottom right).

Inside Information

The Need for OS Functions

Until we made the transition from single-purpose machines to multipurpose machines, there was no need for a user interface because users weren't going to interact with an OS. Anything resembling job management, such as running an analysis of batches of data, was folded into the single-use software. There was no need for task management on a system with only one job to perform. The computers were proprietary (each manufacturer did its own thing, without much regard for program or computer interchangeability), and the software was written to interact with all of the hardware of the system. Therefore, device management was not the big deal that it is today, with the enormous choice of peripheral devices. Memory technologies were also very different from today, because those mammoth computers of the 50s, 60s, and 70s actually had very little memory. Think 16KB, if you can imagine such a small amount of memory. Furthermore, memory management was very simple with only a single program running in memory.

The computer enthusiasts who bought the earliest microcomputers of the 1970s, such as the MITS Altair, were infatuated with the technology. Slow CPU speeds, very limited memory, clumsy I/O devices, and lack of software did not deter them. They would network with like-minded people, have informal meetings and discussions, and then gather in self-help groups and form clubs like the Home Brew Computer Club in Silicon Valley. They shared their techniques for creating hardware and programming language software for these computers. Almost every one of these early microcomputers exceeded the expectations of their makers and users, but for a variety of reasons, most of the early entrepreneurial companies and their products disappeared before long.

DOS, CP/M, Apple, and the Killer App

For a microcomputer to truly be a successful, widely accepted product—used in businesses as well as by hobbyists—it had to be a tool that performed an important task; it had to have an application that people needed. That application would be called a Killer App.

One of these tasks was spreadsheet calculations. Before microcomputers, spreadsheets were created manually, on large sheets of paper. People would enter a column of numbers—say, sales for one product in a drugstore on a day-by-day basis for a month. Then the daily columns would be added up to get the total sales for that product for that month. The next column was for the next product, and so on. The process was tedious and error prone, but very valuable to the manager of the drugstore.

Thus, when VisiCalc, an electronic spreadsheet program that ran on early microcomputers, appeared, it became a very successful application. It automated this thankless job, remembering the formulas for the calculations and allowing people to recalculate a column of numbers after a change was made. VisiCalc did more than this, though: it gave people a reason to want a personal computer. Many people were introduced to VisiCalc on the Apple II computer, and this contributed to the success of the Apple II in the late 1970s. However, as the 1980s arrived, Apple failed to come out with a successor to the Apple II in a timely fashion. This strategic error gave IBM the opportunity to bring out the IBM PC.

1978

Apple Computer introduces a 5 ¼ disk drive for the Apple II.

Berkeley Software Distribution (BSD) UNIX is developed at UC Berkeley.

Bell Labs releases UNIX version 7.

1979

Steve Jobs visits Xerox PARC and is given demos of a GUI, icons, and a mouse.

VisiCalc, the first spreadsheet program to run on a personal computer, is released.

MicroPro International introduces WordStar, the first commercially successful word processing program for PCs.

1980

Microsoft announces Microsoft XENIX OS, a UNIX OS for 16-bit microprocessors.

Lotus Development Corporation unveils the Lotus 1-2-3 spreadsheet program.

Sony and Phillips develop first technology standards for compact disc.

1981

Adam Osborne introduces the Osborne 1.

IBM introduces the IBM PC with Microsoft's BASIC in ROM and PC DOS 1.0.

First time *Internet* is used to describe the ARPANET.

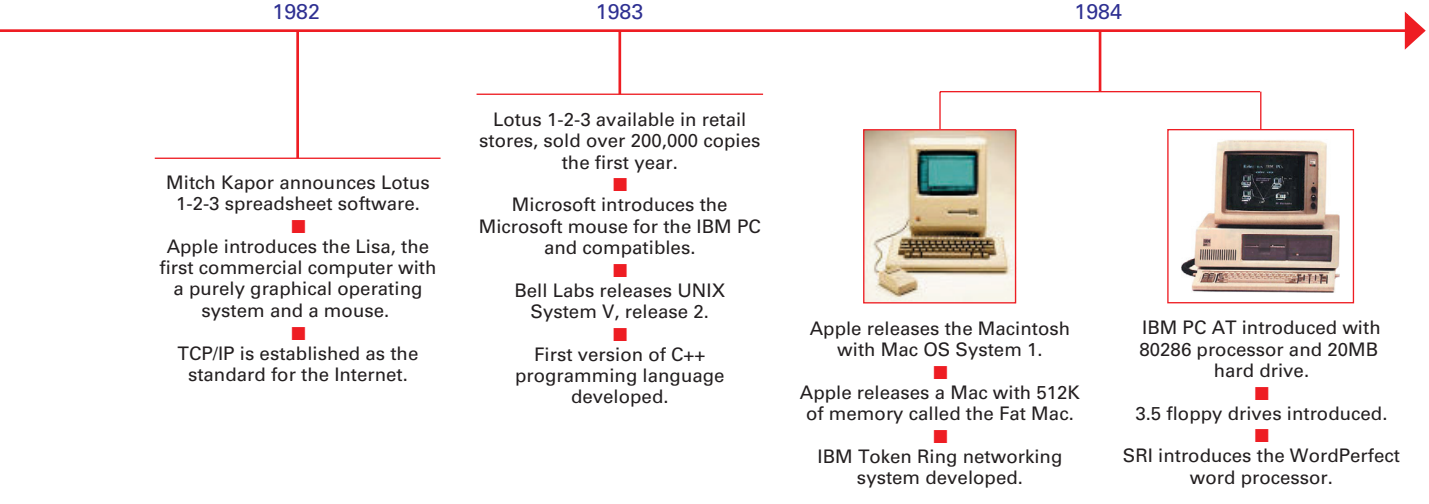
Another fateful series of events revolved around the choice of an OS for the IBM PC. IBM came to Microsoft, then a fledgling software company, for the BASIC interpreter, which was being used in other machines at that time. IBM also talked to Bill Gates about providing an OS; but he sent IBM to another company, Digital Research, the creators of the popular CP/M OS. Digital Research, however, refused to sign a contract with IBM, so IBM came back to Bill Gates for the OS.

The IBM PC came with Microsoft's BASIC interpreter installed in ROM, which allowed programs written in the BASIC programming language to be run on the PC. It also came with either PC DOS or a version of CP/M as the operating system for those computers that had the optional floppy drive rather than just the tape drive. IBM, however, priced CP/M far higher than it did PC DOS, which contributed to the demise of CP/M. This computer far exceeded IBM's sales forecast, which was for about a quarter of a million units during the predicted five-year lifetime of the product. According to one account, IBM took orders for half a million computers in the first few days after the IBM PC was introduced. Many who bought it were enthusiasts, who bought it in spite of its roughly $5,000 price tag for a typical configuration, just to see what it could do. However, the "IBM" name behind the product inspired many business users to buy it as well because they could see the potential of the PC.

Want to learn more about the history of PCs? Our favorite book on the subject is *Fire in the Valley: The Making of the Personal Computer* (ISBN 0-07-135892-7). You can read excerpts from the book at `www.fireinthevalley.com`.

The Second Wave

VisiCalc was the killer app that brought attention, and early success, to microcomputers before the IBM PC was released. And although many say that just having the letters IBM on the box sold that computer, the groundwork that was laid by VisiCalc was enhanced by a second wave of applications. In the fall of 1982, Mitch Kapor of Lotus Corporation introduced Lotus 1-2-3, a DOS spreadsheet application designed to use all of the 640KB of system memory that DOS would allow. Both the 1-2-3 program and the spreadsheet were kept in memory while the user worked. Compared to VisiCalc (written to run on the CP/M OS and designed to use much less memory), it was very fast, and it had additional functionality, such as database functions and a program that would create and print graphs from the spreadsheet data. Lotus 1-2-3 was the "killer app," the software that made the IBM PC and



Through the 1980s, PCs with DOS and a variety of DOS applications made great inroads into organizations of all sizes. In the decade after its introduction, thousands of applications were written for DOS, but Lotus 1-2-3, dBase (database management), and WordPerfect (word processing) were the de facto business standards at the end of that decade.

PC DOS a must-have combination for people who worked all day crunching numbers and doing what-if calculations. Figure 1-4 shows the Lotus 1-2-3 program with a sample spreadsheet.

OS/2

In 1987, Microsoft and IBM introduced their jointly developed OS/2 (Operating System/2), intended to replace DOS. However, version 1.0 was underpowered in that it was written for the Intel 80286 processor, which had serious memory and mode limits. In spite of the memory limits, it still required much more memory and disk space than DOS (2MB of memory and 8MB of disk space) at a time when 2MB of memory and a 40MB hard drive (considered large in the late 1980s) cost several thousand dollars. Although OS/2 multitasked applications in memory, only one application at a time could be visible on the screen. Also, applications had to be written specifically for OS/2, because it had very limited support for DOS applications.

A1: MENU

Worksheet Range Copy Move File Print Graph Data System Quit
Global, Insert, Delete, Column, Erase, Titles, Window, Status, Page

	A	B	C	D	E	F	G	H
1								
2	Acme Drugs		Monthly Product Sales Report			May		
3	Store #84							
4		SKU 13	SKU 25	SKU 53	SKU 57	SKU 61	SKU 73	
5	1	6	6	54	32	21	31	
6	2	3	31	21	12	54	34	
7	3	2	0	78	5	14	15	
8	4	8	5	31	87	15	24	
9	5	9	53	11	14	21	32	
10	6	13	12	14	21	24	14	
11	7	3	52	87	65	19	18	
12	8	7	13	54	54	23	19	
13	9	2	25	21	21	26	17	
14	10	8	46	11	14	28	24	
15								
16	Total	61	243	374	325	245	228	
17								
18								
19								
20								

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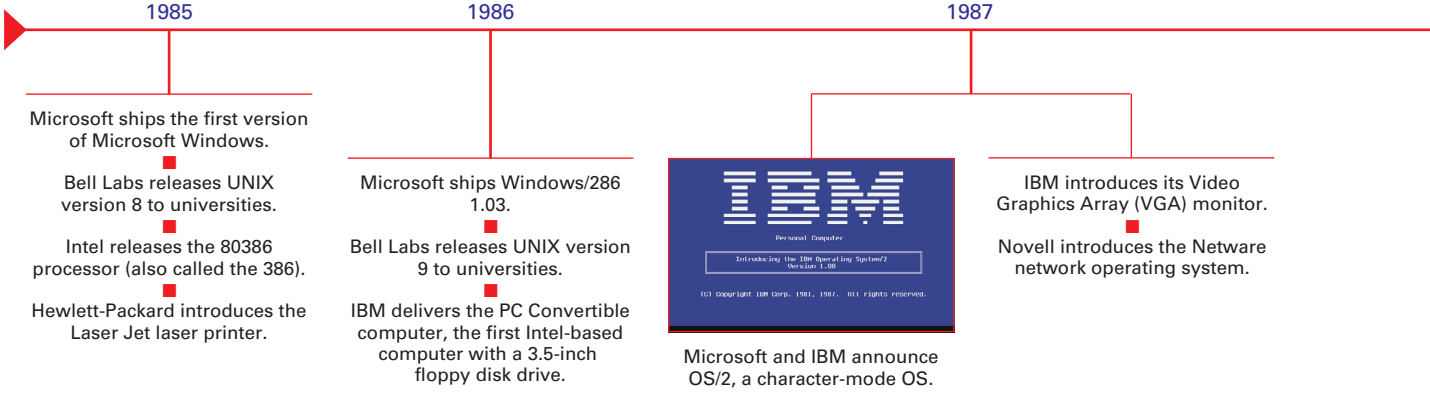
• **Figure 1-4.** Lotus 1-2-3 spreadsheet



In the 1990s, IBM introduced OS/2 Warp, a greatly improved version of OS/2 with a very nice GUI, and pretty much removed itself from the battle for the desktop. IBM now targets the high-end server market. You will find a great deal of information about OS/2 on the Web, where you will discover that it has a very strong following among individual programmer/consultants.

Microsoft Windows

In 1985, when the first version of Windows appeared, it was more smoke than OS. It was a not-very-good GUI balanced precariously on top of DOS. It was very slow and had a very flat look—you couldn't lay one graphic on top of another; the ability to overlap graphical elements, such as windows and icons, did not show up until a later version. However, the GUI gradually improved with each version.

From 1985 to 1990, Microsoft continued to work on both Windows and DOS, but Windows was not much more than a pretty face until 1990 and Windows 3.0, which supported the three Intel processor modes of operation, that Microsoft called Real mode, Standard mode, and 386 Enhanced mode. In Real mode, Windows 3.0 was just a GUI that ran on top of DOS; in the other two modes, it added functionality to DOS to take advantage of the 286 and 386 processor modes.

The most important feature of Windows 3.0 was better support for legacy DOS applications within Windows, which was related to the 386 processor mode. This meant that DOS apps and Windows apps could both be run simultaneously. This version still had its quirks, but for the first time, IT managers saw a potential GUI replacement for DOS as the desktop OS of choice.

In the spring of 1992, Microsoft brought out a minor upgrade, Windows 3.1, which was adopted as the standard desktop OS by many organizations. The fact that Microsoft's entire suite of applications was also available in versions for Windows 3.*x* helped encourage adoption.

Figure 1-5 shows the Windows 3.1 desktop. Notice that there is no graphical task bar at the bottom of the screen, just the Program Manager window (the main window) with other windows nested in it.

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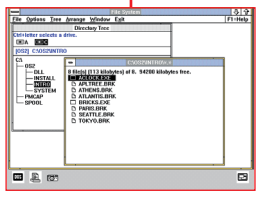
Versions

When a software publisher, say Microsoft or Apple, creates a new OS, it gives it a version number, usually 1.0. Software publishers receive constant feedback from customers about problems and the need for particular additional features in each OS. In response to this feedback, a publisher often introduces a modified version of the original product, in which case the number to the right of the decimal point will probably change (say, from version 1.0 to version 1.1—version is often abbreviated as simply "V"). On the other hand, an important change to an OS, in which significant new features are added or major problems repaired, generally will be reflected in an entirely new version number, with the value to the left of the decimal point being changed. For example, when Microsoft added the ability to work with hard drives to its DOS product, MS-DOS V1.0, the company introduced MS-DOS V2.0. In the last several years, Microsoft has gotten away from the old convention and modified the name of three OSs to coincide with the calendar year, as in Windows 95, Windows 98, and Windows 2000. The company departed from this practice with Windows XP.

1988



IBM and Microsoft ship OS/2 1.0, the first multitasking desktop operating system.

NeXT, Inc., unveils the NeXT computer.

"Internet Worm" virus invades Internet, disables ten percent of all Internet host computers.

1989

Bell Labs releases UNIX version 10 to universities.

Intel releases the 80486 chip (also called the 486).

Tim Berners-Lee develops HTML, the foundation for the World Wide Web.

1990

Microsoft releases Windows 3.0.

Motorola announces its 32-bit microprocessor, the 68040.

1991

Microsoft releases MS-DOS 5.0.

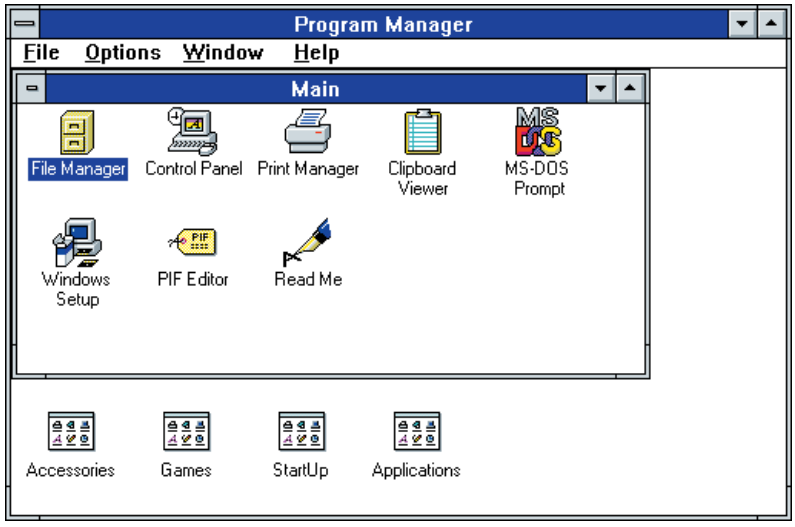
Linus Benedict Torvalds creates a free version of UNIX for the Intel platform.

Apple Computer launches the PowerBook series of portable computers.

Macintosh System 7.0 released.

Internet opened to commercial application.

In this book, when discussing versions that share a major number, such as all of the Windows 3 versions, we'll substitute an *x* for the subversion number (Windows 3.*x*). When discussing features common to both Windows 95 and Windows 98, we'll refer to Windows 9*x*.



• **Figure 1-5.** MS Windows 3.1 desktop

Inside Information

Protocols

A protocol is a standard, or a set of standards, that everybody agrees to abide by when they build a piece of software or hardware. Products that adhere to a specific protocol will be able to work together, regardless of who made them.

Windows for Workgroups

DOS and other OSs through Windows 3.*x* included only the operating system functions. If you wanted to connect to a network, you added a **network operating system (NOS)** on top of your installed OS. This separate network operating system might be from 3COM (yes, 3COM had its own NOS software in the 80s) or Novell, or it might be Microsoft's LAN Manager NOS, developed in the late 1980s.

Novell and LAN Manager were both server network operating systems, providing file and print sharing services to other computers. Network operating systems combined both the operating system functions and the networking functions. A computer needs special client software to connect to each of these servers. The client is the software component that allows users to connect to servers and to request services from them.

1992

- Microsoft releases Windows 3.1, the first widely accepted version of Windows.
- Microsoft Windows for Workgroups 3.1 released.
- IBM releases OS/2 2.0, the first 32-bit OS for PCs.
- IBM introduces its ThinkPad laptop computer.

1993

- Microsoft releases the first version of Windows NT (3.1).
- Microsoft releases MS-DOS 6.0.
- Mosaic, first web browser, developed by National Center for Supercomputing Applications (NCSA).
- Intel releases the Pentium processor.
- IBM ships its first RISC-based RS/6000 workstation.

1994

- Microsoft releases MS-DOS 6.22.
- IBM releases OS/2 Warp (OS/2 version 3).
- Netscape Communications releases Netscape Navigator.
- CompuServe, America Online, and Prodigy add Internet access.
- Yahoo! born in trailer on Stanford University campus.

1995

- Microsoft ships Windows 95.
- Intel releases the Pentium Pro microprocessor.
- Motorola releases the PowerPC 604 chip.
- Sun Microsystems creates the Java development language.
- Toy Story, the first fully computer animated film, released.

Early client network software, like Novell's client software today, included underlying networking components called drivers and protocols, as well as the component we think of as the client. The network software Microsoft provided for DOS and for Windows 3.1 on top of DOS included only the client component. However, beginning in October 1992 with Windows for Workgroups 3.1, Microsoft included both the client and server software in all of its OS products. This enabled **peer-to-peer networking**, meaning desktop computers could act as servers to their peers. This worked well in a very small workgroup environment of 10 or fewer computers.

Windows for Workgroups 3.1 was followed a year later by Windows for Workgroups 3.11, with the obligatory fixes and improvements. These included faster network and disk I/O operations. However, users were still working with a Windows OS that was running on top of DOS; that is, first DOS was started and then Windows. Windows depended on DOS, which had to be installed on the computer.

Inside Information

Users Have Evolved Too!

Over the past half-century, a significant change in who interacts with computers has changed the meaning of the term user. *An early computer user was the U.S. Army, which calculated ballistic tables for firing artillery. Soon scientists discovered the value of using computers to solve complex scientific problems, like those involved in atomic energy research. In each case, the person who touched the computer had to be a trained computer professional, knowledgeable enough to work with a computer that literally filled a room and cost immense amounts of money. The first business application of computers came in the 1950s when banks started using computers for check processing. This introduced a new class of user, the bank's bookkeepers, which eventually led to other business users directly touching the system, or at least an input device. What was new was that these users were mere mortals, not computer professionals or scientists. At last, ordinary people could access the power of a computer, which paved the way to the development of the personal computer, putting computing power right on the desktop.*

What OSs Are Available Today?

The most common microcomputer operating systems in use today include MS-DOS, Windows 98, Windows NT, Windows 2000, Windows XP, the Macintosh OSs, and UNIX (represented in this book by Linux). DOS is very, very rarely still on the desktop, but it survives today in some special devices and is still used by technicians and computer support people. Windows 98 and Windows NT are waning on the desktop as old computers are replaced. This is especially true in corporate settings, where computers are often leased for two or three years and then replaced with new systems with the latest OS under a new lease. At work, you probably won't have a choice, since OS decisions are usually made through the IT department. These OSs are included here because they still have a significant presence.

Table 1.1 summarizes the available OSs, listing the publisher, platform, and types of applications that can be run on each OS.

What follows is a brief description of each of these OSs, including a little history here and there to put things in perspective. You will also discover where you'll be most likely to encounter each operating system.

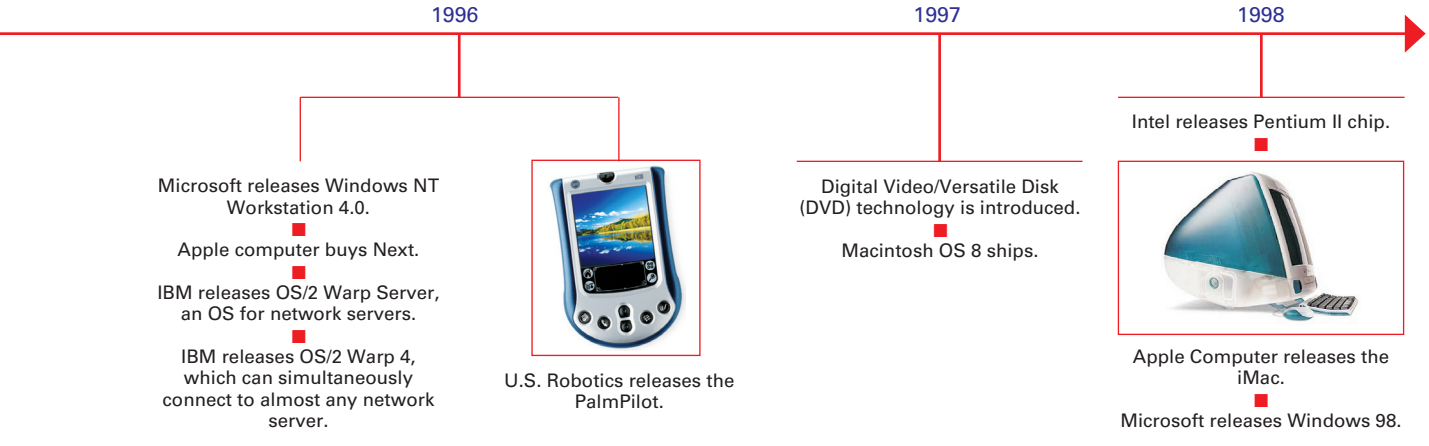


Table 1.1 Summary of Current OSs

OS Version	Company	Platform	Applications Supported
MS-DOS 6.22	Microsoft	Intel/Microsoft	DOS
Windows NT 4.0	Microsoft	Intel/Microsoft	DOS, 16-bit Windows, 32-bit Windows
Windows 98	Microsoft	Intel/Microsoft	DOS, 16-bit Windows, 32-bit Windows
Windows 2000	Microsoft	Intel/Microsoft	DOS, 16-bit Windows, 32-bit Windows
Windows Me	Microsoft	Intel/Microsoft	DOS, 16-bit Windows, 32-bit Windows
Windows XP	Microsoft	Intel/Microsoft	DOS, 16-bit Windows, 32-bit Windows
Mac OS 9	Apple	Apple Mac	Macintosh
Mac OS X	Apple	Apple Mac	Macintosh
UNIX/Linux	Various	Intel/Microsoft	UNIX

Inside Information

MS-DOS vs. PC DOS

In the context of today's microcomputers, DOS usually means Microsoft's DOS (MS-DOS). Microsoft's first version of DOS, called PC DOS, was introduced with the first IBM PC, in 1981. This and subsequent versions of PC DOS were customized specifically for IBM's PC products. Microsoft licensed versions, called MS-DOS, to other manufacturers, such as Compaq, Toshiba, and Dell. PC DOS and MS-DOS, as the names imply, are written to support disks, with minimal I/O support for other hardware.

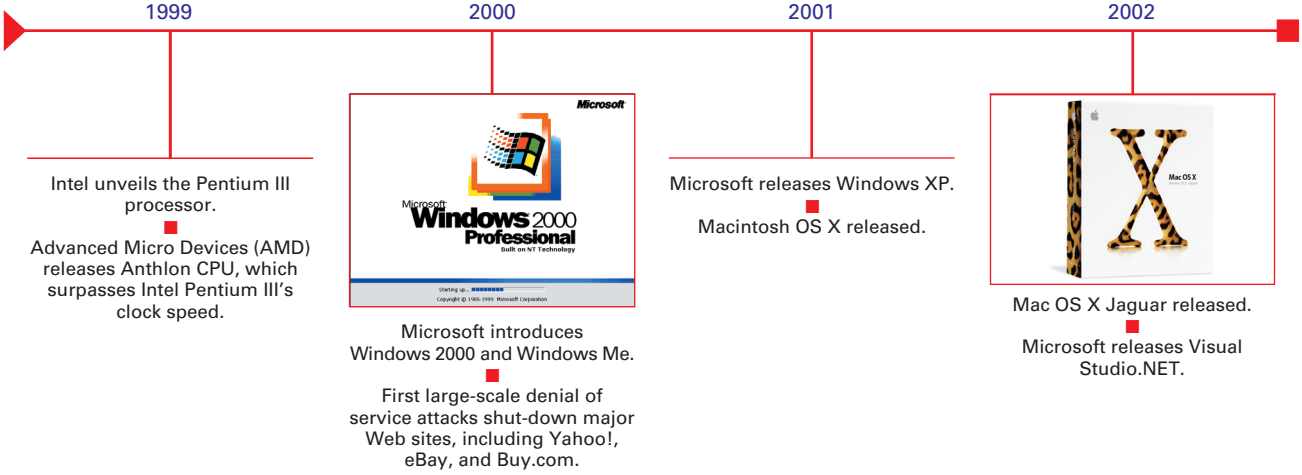
DOS from Microsoft

DOS, which stands for disk operating system, is an operating system that provides support for interaction, or input and output (I/O), between the memory and disk drives. There have been, and still are, DOS operating systems for computers other than microcomputers. In addition, all of the popular microcomputer operating systems in use include support for disks.

Each major version of DOS was released to support new disk capacities. PC DOS 1.0 supported single-sided 5¼-inch floppies; PC DOS 1.1 added support for double-sided 5¼-inch floppies; and PC DOS 2.0 was released with the IBM PC-XT and included support for the XT's 10MB hard drives. PC DOS 3.0 was released with the IBM PC-AT and included support for the larger AT hard drives. Support for 3.5-inch floppies and the larger hard drives of the IBM PS-2 computers was added in DOS 4.0. MS-DOS 6.22 was the last widely used version of MS-DOS.

The DOS Prompt

DOS has a text-mode, command-line interface that requires users to remember cryptic commands and their subcommands in order to perform file management functions and to launch DOS applications. Figure 1-6



file management functions and to launch DOS applications. Figure 1-6 shows a good example of how cryptic DOS can be. The first line is the format command with three parameters: the letter of the drive to be formatted, the /S switch telling the command to transfer the system files to the formatted disk, and the /U switch, which formats unconditionally, meaning that it does not try to save any existing data on the disk so that it can be unformatted later. This is followed by a warning that all data will be lost, and a query asking whether to proceed with the formatting, to which the user must respond by typing Y or N. Then some information is displayed about the progress of formatting, and the user is asked what to use as the volume label (an optional name for the volume); to not use a volume label, the user presses the ENTER key. Finally, some statistics on the formatted disk are displayed, along with the serial number that DOS gave to the disk. As you can see, this assumes knowledge of many, many concepts.

When Would You Use DOS?

Although you would not likely choose it as your main OS on your desktop computer, there are a few exceptions to this rule, as you will see in Chapter 2. Also, you might find DOS as the OS on some handheld devices that do not require a GUI interface, and computer professionals often find DOS handy as a very small OS that fits on a diskette. These will be explored in Chapter 2 as well.

Windows NT

Windows NT was called Windows NT 3.1 when it came out in 1993 because it had the same user interface as Windows 3.1. That was where the similarity ended. To begin with, it was a server operating system, including server protocols in its integrated network support. Furthermore, unlike Windows 3.*x*, it did not sit on top of DOS.

```
A:\>format c: /s /u

WARNING: ALL DATA ON NON-REMOVABLE DISK
DRIVE C: WILL BE LOST!
Proceed with Format (Y/N)?y


Formatting   502M
Format complete.
System transferred

Volume label (11 characters, ENTER for none)?

  526,106,624 bytes total disk space
      212,992 bytes used by system
  525,893,632 bytes available on disk

        8,192 bytes in each allocation unit.
       64,196 allocation units available on disk.

Volume Serial Number is 3A4E-17DA


A:\>_
```

• **Figure 1-6.** MS-DOS prompt with the format command

What's New in Windows NT?

Windows NT was the first Microsoft OS to take full advantage of the capabilities of the special protected mode that Intel introduced in its processors manufactured after 1986. A major benefit of this was more stability and security in the OS. In fact, NT was so powerful that Microsoft decided to make two versions of NT: one designed mainly for servers, and another geared more toward individual user systems—what some folks call workstations. Thus, the next version of NT (NT 3.5) was also the first Windows OS to have separate products: Windows NT Workstation and Windows NT Server. Both of these used the same kernel (you'll recall that a kernel is the main OS component) and interface, but the Server version had enhancements and components that were needed only on a network server. The Workstation version was configured as a desktop operating system.

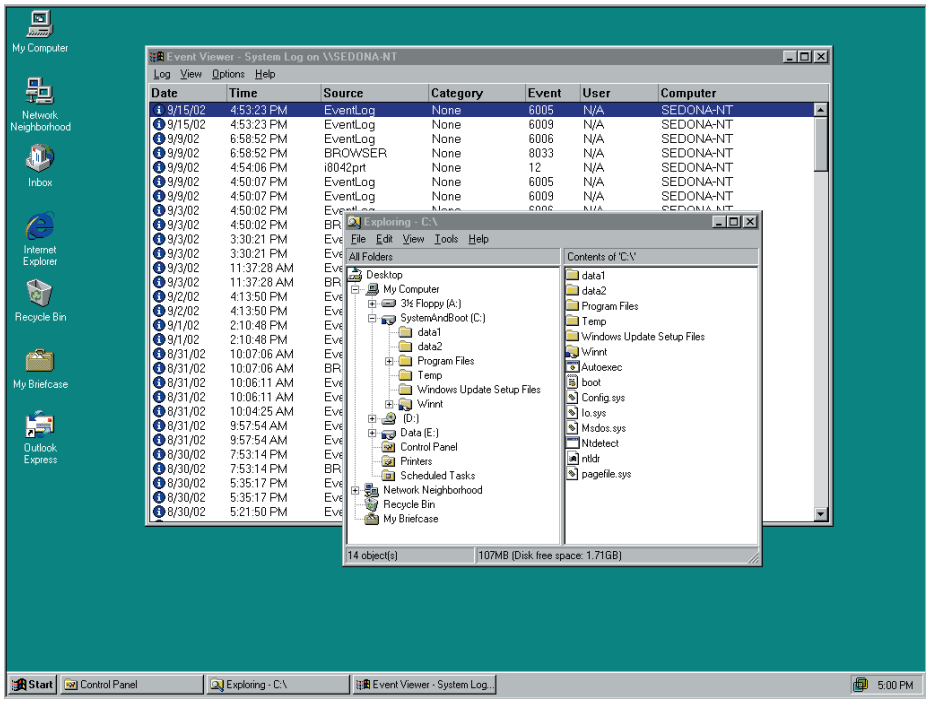
In 1996, Microsoft introduced Windows NT 4.0, which had a GUI similar to that of Windows 95 as well as other improvements and enhancements to the OS. Figure 1-7 shows the Windows NT desktop.

Windows 95 predated Windows NT 4 and has passed its seventh year in service. It has been replaced by Windows 98 and all other subsequent versions of Windows. We will not discuss Windows 95 in detail in this book, but we'll talk about it from time to time.

When Would You Use Windows NT Workstation?

Even when it was the latest Microsoft OS, you would not likely have used it at home, if only because of the cost, which was more than twice that of the Windows 3.*x* OSs that preceded it and of Windows 95, which was considered the upgrade OS for a Windows 3.*x* OS.

At this writing, you can still buy Windows NT 4.0 Workstation, but it will probably not be available by the time you read this. However, you may run into Windows NT 4.0 Workstation on existing PCs in an organization, and that is the main reason we include it in this book.



• **Figure 1-7.** MS Windows NT 4.0 desktop with open Windows

Windows 98

Windows 98 was an evolutionary development in the Windows operating system, including improvements in both visible and under-the-hood components. It offered more stability than its immediate predecessor, Windows 95, meaning that it was less likely to stop in its tracks just when you were about to complete that book order on Amazon. Although improved, Windows 98 is not as stable as the newer Windows OSs. We include it in this book only because very large numbers of people still use it. Figure 1-8 shows the Windows 98 desktop.

Cross Check

Compare GUIs

GUIs are not all that different from each other. Flip ahead to Chapter 7, "Windows XP," and Chapter 8, "Macintosh OS 9 and OS X," and compare the GUIs of these two OSs; then answer the following questions:

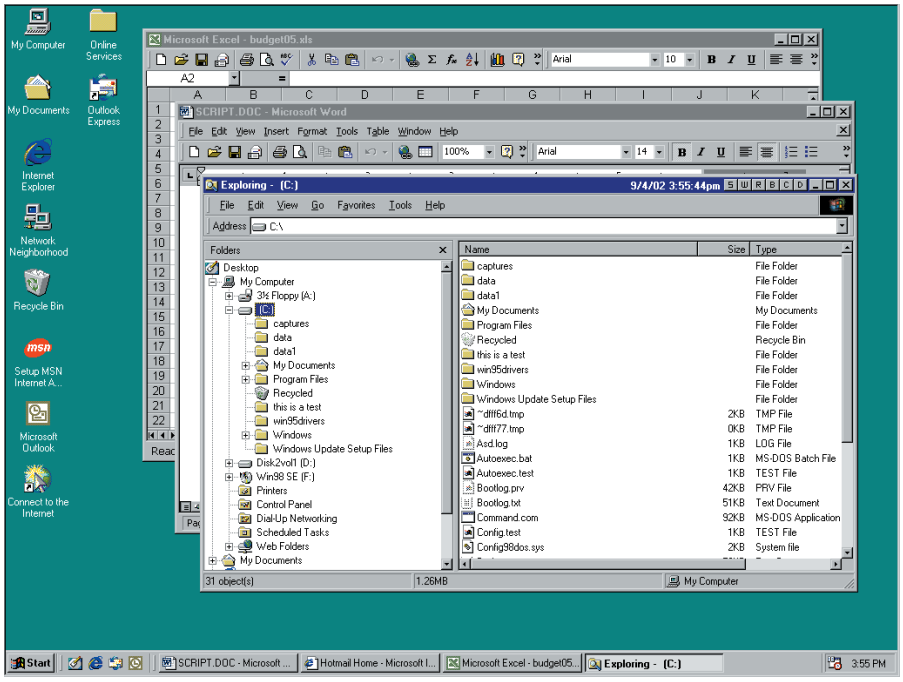
1. What are the major differences in these two GUIs?
2. How are these two interfaces similar?
3. In your opinion, which interface would be more intuitive to use?

What's New in Windows 98?

Windows 98 offered new options for customizing the GUI, including tighter integration with Microsoft's web browser, Internet Explorer (IE). This feature allows users to configure Windows so that they can, if they wish, always appear to be in an Internet browser, even when they are not browsing the Internet. Windows 98 came with drivers and support for devices, such as DVD drives, that were not included in Windows 95. As usual with an upgrade to an OS, Microsoft cleaned up existing problems and made the OS run faster.

When Would You Use Windows 98?

Well, it is now somewhat "long in the tooth," and there are newer choices from Microsoft. At the time it was introduced, however, the two choices of



• **Figure 1-8.** MS Windows 98 desktop with open Windows

desktop OSs from Microsoft were Windows 95 and Windows NT Workstation. Windows 98 was an upgrade of Windows 95, and Windows NT had only a limited list of supported hardware. NT also did not support an important technology called plug and play (PnP). Therefore, Windows 98 was the choice for PCs with PnP hardware and/or hardware not supported by Windows NT. It's in use today simply because people haven't yet upgraded to Windows 2000 or Windows XP.

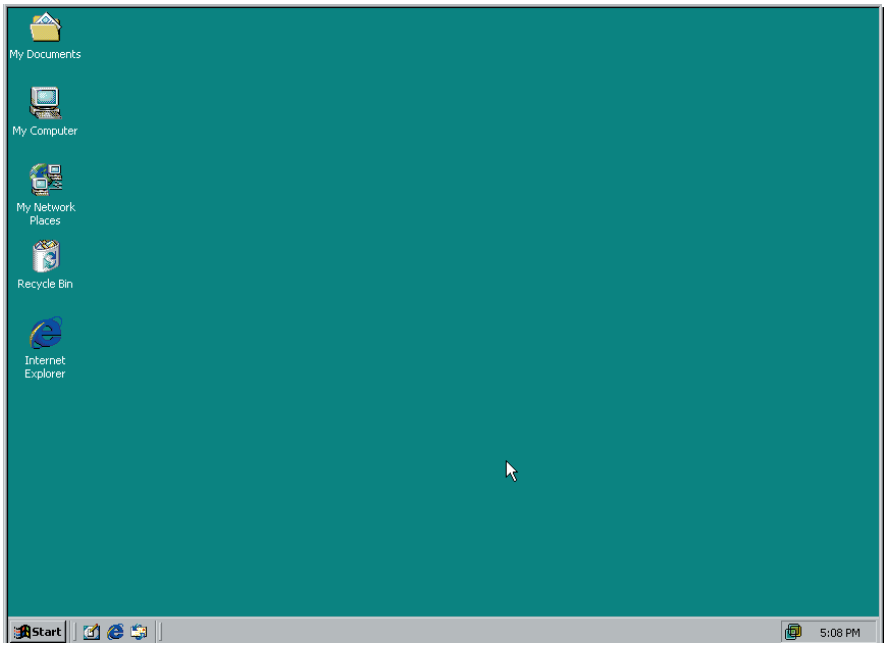
Windows Me (Millennium Edition)

Windows Me (Millennium Edition) was targeted at the home market when introduced in 2000. It is essentially Windows 98 with improved music, video, and home networking support. It included the System Restore utility, which allowed a user to roll back the PC software configuration to a date or time before a bad change was made to the computer. The Windows Movie Maker allowed users to digitally edit, save, and share their home videos, and the Windows Media Player gave users a tool for organizing digital music and video. This was the last Microsoft OS based on the Windows 95 internals (mainly the kernel).

Windows Me is included here only because it was installed on many computers that were sold to individuals, but it is not an OS that was adopted by organizations. You are not likely to encounter it in a work environment.

Windows 2000

In 2000, Microsoft introduced the Windows 2000 family of OS products, which brought together the best of Windows 98 and Windows NT. Microsoft had now united its operating systems in a group of products that all shared the same kernel and covered OS needs from the desktop to the enterprise server. The several versions of Windows 2000 include Windows 2000 Professional (the desktop OS), Windows 2000 Server (for a network server on a small network), Windows 2000 Advanced Server (for a network server in larger networks), and Windows 2000 Enterprise Edition (with lots of features for *really* big servers in *really* big networks).



• **Figure 1-9.** MS Windows 2000 desktop

When Would You Use Windows 2000 Professional?

This is no longer offered as a standard OS when you buy a new desktop computer, but you will find it on existing desktop computers in the workplace for a few more years. Figure 1-9 shows the Windows 2000 desktop. Windows 2000 Professional is included in this book because it is still on many computers.

Windows XP

With its Windows 2000 products, Microsoft brought all of its OSs together, building them on top of the same core internal piece (the *kernel*). Some of us, especially those whose jobs included supporting both desktop and server computers, thought it would simplify our lives. We really liked that idea because we could learn one OS for both the desktop and server. Well, with Windows XP, Microsoft departed from that model. Windows XP is intended only for the desktop, not for the server environment. The new server products come under the umbrella of the Microsoft .NET initiative, which we discuss in Chapter 10.

Cross Check

The Many Windows 2000 Products

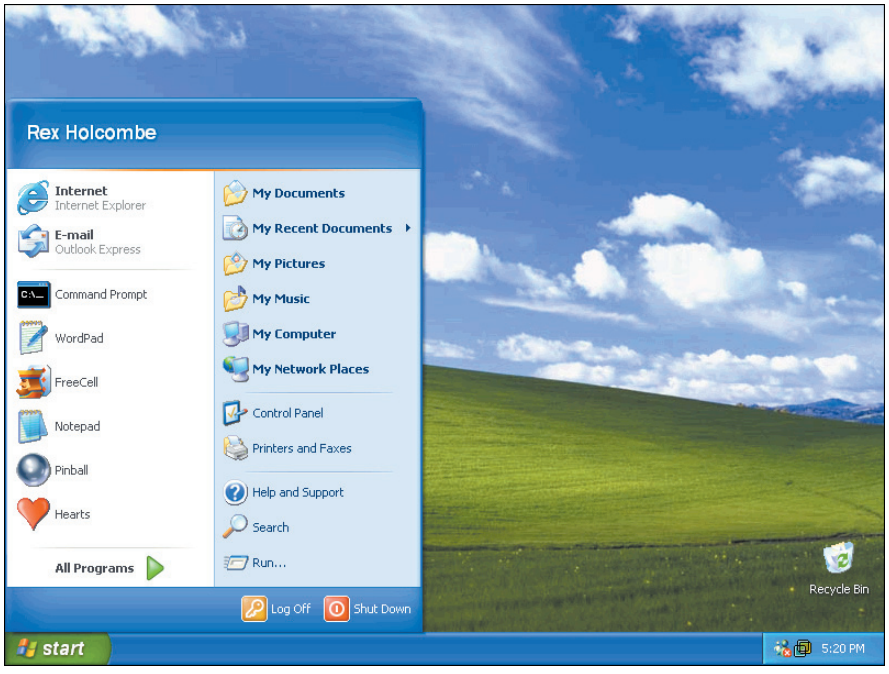
What's with these different Windows 2000 products? Skip ahead to the beginning of Chapter 6 and read more about these variations and then answer the following questions:

1. How many processors at one time does each product support?
2. Which product cannot be purchased by itself but is sold only in an OEM version?
3. Which product is appropriate for a small business that needs only a file and print server?

What's New in Windows XP?

There are two XP products: Windows XP Home Edition and Windows XP Professional. Both have the same improved GUI and share many of the same features, but only Windows XP Professional has several network- and security-related features.

The Windows XP default desktop is very different from that of previous versions of Windows in that the Recycle Bin (where deleted files are sent) is the only icon on the desktop. In addition, the Start menu has been redesigned and reorganized, as shown in Figure 1-10.



• **Figure 1-10.** MS Windows XP desktop and Start menu

Inside Information

Windows XP Professional vs. Windows XP Home

Here is a short list of features available in Windows XP Professional, but not in Windows XP Home: the ability to join a Windows NT or Active Directory domain (a grouping of users and computers for central administration of security), support for two processors, support for multiple (human) languages, and file encryption on an NTFS volume.

The Macintosh has a loyal following among people who first encountered it in school. Early in Apple's history, the company strategically targeted schools and universities as places to sell its products, which, over the years, has resulted in large numbers of people who learned computing on a Mac. However, today the largest market share for the desktop, especially in business and government, belongs to Windows-based computers.

When Would You Use Windows XP?

Introduced in 2001, Windows XP is the successor to Windows 2000, although both are available as of this writing. Windows XP Home Edition is the choice for home users who want a computer based on the Microsoft/Intel standards, who want to run a variety of personal use software and even many business applications, and who want to connect to the Internet. Windows XP Professional is the choice for corporate or home users who want a Microsoft/Intel standard computer and need to connect as a client computer to Microsoft Windows NT or Windows 2000 servers. The Professional version is also the choice for users who want to be able to run the enormous variety of software written for Windows and to take advantage of the features that are supported only in this version of Windows XP.

Macintosh OSs

The Macintosh operating systems run only on Apple Macintosh computers. The OSs in common use today are Mac OS 9 and Mac OS X (X is the roman numeral for 10). OS 9 reflects evolutionary changes from the first strictly GUI-based Mac operating systems, while OS X is a revolutionary change, based on NextStep, an OS with a UNIX kernel.

Macintosh hardware and software are proprietary products of the Apple Computer Company, which results in better integration of the OS and the hardware, but at a higher price. Apple computers are based on an entirely different architecture than the Microsoft/Intel personal computers. For the past several years, Macintosh computers have used the PowerPC chip with an architecture that is enhanced for graphics and multimedia.

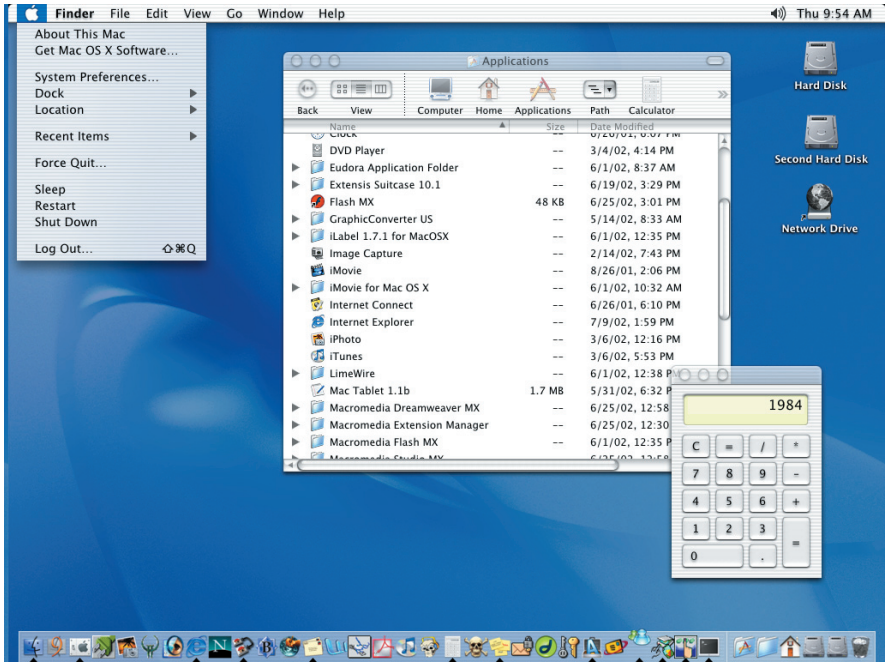
Until Mac OS X, the Macintosh OSs were strictly GUI environments, with no command-line option (see Figure 1-11). Mac OS X, with its UNIX origins, does give you the option of a character-based interface.

When Would You Use a Macintosh OS?

Well, it is your only choice if you buy a Macintosh computer. Basically, you can do everything with a Mac that you can do with a PC. Many business applications, including Microsoft Office, come in a version for the Macintosh. One area in which the Macintosh traditionally shines is ease of use, although Windows now provides competition in this area. In addition, the Macintosh is often the OS/computer of choice among graphics and video-editing professionals.

UNIX/Linux

UNIX has a longer history than any other popular operating system. It grew out of an operating system developed for an early Digital Equipment Corporation (DEC) computer and went through several generations of changes before it emerged from the Bell Labs Computing Science Research Center (Bell Labs) as UNIX version 6 in 1975. This was a portable operating system for minicomputers and mainframe computers, and it was distributed via government and commercial licenses and inexpensive academic licenses.



• **Figure 1-11.** Macintosh OS X GUI

The University of California at Berkeley (UCB) licensed UNIX, modified it, and distributed it to other schools as Berkeley Software Distribution (BSD) version 4.2. Later versions have followed. The schools paid licensing fees to Bell Labs. A lot of the development of **TCP/IP**, the Internet standard family of network protocols, occurred at UCB. Students and others improved on and added to UNIX, freely sharing their code with others. This tradition still prevails today.

In addition to portability (the ability to run on different types of computers), UNIX supports timesharing and multiuser systems, and there are versions that run on personal computers.

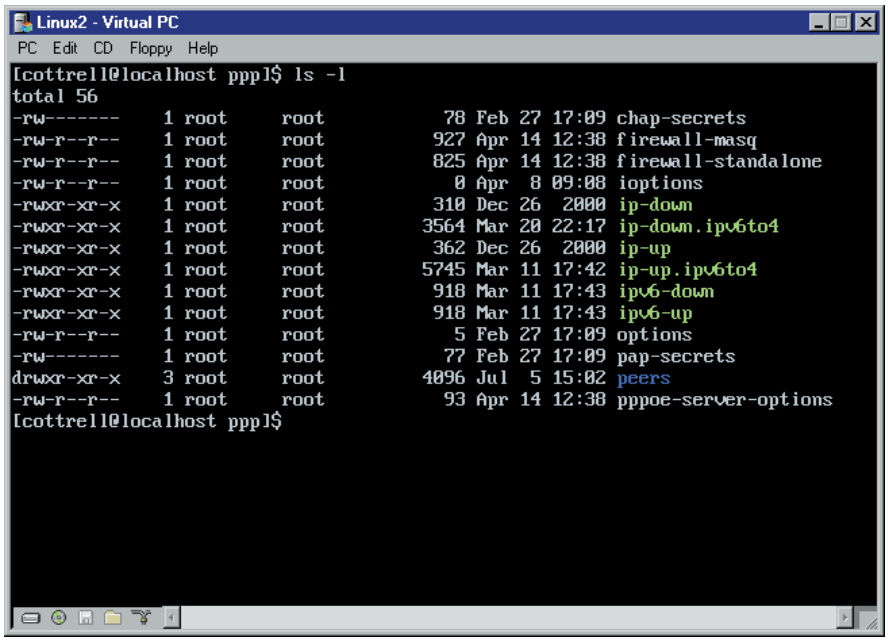
The Many Faces of UNIX

The current commercial versions of UNIX include Sun Microsystems' Solaris, Hewlett-Packard's HP-UX, IBM's AIX, and Compaq's Tru64 UNIX. These versions are high-end server applications and quite expensive, as are the computers they are intended to run on. There are also many **open source** versions of UNIX, including Linux, FreeBSD, and NetBSD. Even with these free versions available, however, it is worthwhile to buy one of the modestly priced packages from companies that charge small fees just for the value they have added to the OS in the form of additional software, installation and configuration instructions, and documentation. We use the Red Hat 7.3 version of Linux for the UNIX chapter in this book. Figure 1-12 shows an example of a Linux directory.

Inside Information

The User Interface

Most versions of UNIX also offer several different user interfaces. Some use character mode, like the traditional shells, such as the Bourne shell and the C shell. Others use a graphical interface, such as X Window.



• **Figure 1-12.** Red Hat Linux directory listing (ls command)

Open source is a certification standard of the Open Source Initiative (OSI) through which a program's source code (the original language in which a program is written) is made available free of charge to the general public. Learn more about open source at `www.opensource.org`.

Why Would You Use UNIX?

The Windows family of operating systems presently dominates the desktop, especially in corporate America. Even fierce UNIX advocates do not see UNIX taking over the desktop any time soon. However, it is an excellent server operating system, because it tends to use resources carefully, allowing you to load only the services needed. It is also considered very secure, and versions of UNIX are present on many of the world's web servers.

With several free or inexpensive versions now available for the Microsoft/Intel platform, this is the OS of choice for present-day hobbyist and computer enthusiasts, who use it to develop new UNIX utilities and other software and to run games. If you fit this description, you may be in the market for (or already own) UNIX.

Chapter 1 Review

Chapter Summary

After reading this chapter and completing the Try This! exercises, you should understand the following facts about operating systems:

Microcomputers Today

- A computer consists of hardware and two types of software: applications software and operating system software.
- The operating system allows the user to interact with the computer hardware.

Common Computer Hardware

- Certain computer hardware is common to most computers you will encounter. The basic components include the processor, motherboard, RAM, ROM BIOS, video adapter, display screen, keyboard, pointing device, and other peripheral devices.
- You can identify hardware components by a visual inspection, by observing information displayed during the bootup process, and by accessing a ROM BIOS setup program.

Purpose and Functions of Microcomputer Operating Systems

- There are certain functions provided by most, if not all current operating systems. These functions include user interface, job management, task management, memory management, file management, device management, and security.
- The operating system makes everything work together.
- You can identify most of the functions provided by your operating system by careful observation. For instance, evidence of support of the security function includes a required logon procedure when you start your computer and the need for authorization to access resources on your local computer.

Major Events in the Evolution of Microcomputer Operating Systems

- The history of current microcomputers and their OSs involved many technical advances and the imagination of a multitude of innovative people.
- You can find many accounts of the history of computers and operating systems by searching the Internet.

What OSs are Available Today

- The microcomputer operating systems common today include MS-DOS, several versions of Windows (Windows 98, Windows 2000, and Windows XP), Mac OS 9, Mac OS X, and several versions of UNIX.
- Each of today's common operating systems is best suited for certain uses.
- Microsoft desktop OSs are common in the business environment.
- The Mac OSs are commonly used in education and in graphic workstations.

Key Terms

286 protected mode *(6)*
386 protected mode *(6)*
authentication *(15)*
binary digit *(8)*
bit *(8)*
byte *(8)*
central processing unit (CPU) *(2)*
client *(3)*
current window *(14)*
cursor *(10)*
device driver *(15)*
device management *(15)*
directory *(15)*
disk drive *(10)*
display screen *(10)*
file management *(14)*
focus *(14)*
folder *(15)*
gigabyte *(8)*
graphical user interface (GUI) *(13)*
input *(3)*
input/output (I/O) *(3)*
job management *(14)*
kernel *(12)*
megabyte *(8)*
memory *(7)*
memory management *(14)*

microcomputer *(2)*
microprocessor *(2)*
monitor *(10)*
motherboard *(7)*
mouse *(10)*
multitasking *(14)*
network operating system (NOS) *(22)*
open source *(31)*
operating system (OS) *(12)*
output *(3)*
peer-to-peer networking *(23)*
peripheral device *(11)*
personal computer (PC) *(2)*
pointing device *(10)*
random-access memory (RAM) *(8)*
read-only memory (ROM) *(9)*
read-only memory basic input-output system (ROM BIOS) *(9)*
real mode *(6)*
security *(15)*
server *(3)*
task management *(14)*
TCP/IP *(31)*
terabyte *(8)*
user interface *(12)*
virtual memory *(14)*
virtual memory manager *(14)*

Key Term Quiz

Use the Key Terms list to complete the sentences that follow. Not all terms will be used.

1. The _____ is the hardware component most central to a computer.
2. If you save confidential data on your local hard drive, you should be using an operating system that includes a/an _____ function, which protects local files and folders from unauthorized access.
3. A/an _____ takes care of the interaction between a program and a computer's hardware, freeing application programmers from the task of including such functions in their programs.
4. An operating system that uses _____ will allow you to simultaneously run more programs than the physical memory of the computer will hold.
5. When you run several applications at once and switch between them, you are experiencing the _____ feature of an operating system.
6. Interaction with a computer involving getting data and commands into it and results out of it is called _____.
7. A/an _____ is an example of a pointing device.
8. Software that allows the operating system to use a hardware component is called a/an _____.
9. The type of memory used as the workspace for the operating system and applications is _____.
10. Your data and programs are stored on a _____.

Multiple-Choice Quiz

1. Which of the following operating systems will *not* work on a PC? Select all that apply.
   - **a.** Mac OS 9
   - **b.** Windows 98
   - **c.** Windows NT
   - **d.** Red Hat Linux
   - **e.** Windows XP
2. Select the two general types of software you are likely to use on a computer.
   - **a.** Peripheral
   - **b.** Operating system
   - **c.** I/O
   - **d.** Video
   - **e.** Application
3. In 1983, what "killer app" made the IBM PC a must-have business tool?
   - **a.** Microsoft Word
   - **b.** VisiCalc
   - **c.** BASIC
   - **d.** PC DOS
   - **e.** Lotus 1-2-3

4. Bill has a part-time business as a wedding photographer, taking both still and video pictures of these happy events. Which operating system is best suited for video editing?
   a. Windows 98
   b. Macintosh OS X
   c. Windows NT
   d. Red Hat Linux
   e. Windows for Workgroups 3.11
5. Select all of the input devices in the following list.
   a. Display
   b. Printer
   c. Trackball
   d. Keyboard
   e. Mouse
6. Select the kinds of computers that apply to a single user.
   a. Monitor
   b. Desktop
   c. Laptop
   d. USB
   e. Peer-to-peer
7. What types of components would you expect to be able to exchange between a PC and a Mac? Select all that apply.
   a. Printers
   b. Processors
   c. Mice
   d. Cameras
   e. Internal disk drives
8. Which component, if missing, will keep a PC from functioning?
   a. Scanner
   b. Printer
   c. Camera
   d. Processor
   e. Mouse
9. In the 1950s, the typical computer user would have been (select all that apply):
   a. A small business
   b. Your grandfather
   c. A politician
   d. A government agency
   e. A secretary
10. Which term would best be used in an analogy of an operating system?
   a. Salesman
   b. Intermediary
   c. Steering wheel
   d. Ignition
   e. Spreadsheet
11. What is the generic term for a very tiny computer that fits in your hand?
   a. Mouse
   b. Trackball
   c. Handheld
   d. Macintosh
   e. Laptop
12. Which of the following is not a peripheral device?
   a. Processor
   b. Printer
   c. Scanner
   d. Mouse
   e. Camera
13. What term describes the DOS user interface?
   a. GUI
   b. Dialog box
   c. Message
   d. Character-based command prompt
   e. Menu
14. What term describes both the Windows and Mac user interfaces?
   a. GUI
   b. Dialog box
   c. Message
   d. Character-based command prompt
   e. Menu

15. One important security component in an OS restricts who can work on a computer. What must each user do before working on a secure computer?

a. Back up all data
b. Connect to the Internet
c. Log on
d. Double-click the Start menu

Essay Quiz

1. Write a few sentences describing every interaction you have had with computers in the past 24 hours.
2. If you use more than one operating system on a regular basis, describe some of the similarities and differences you have noticed between two of those operating systems. You are not limited to the operating systems described in this chapter. (If you use a handheld computer and use a desktop Windows computer, these are two different operating systems.) If you do not work with more than one operating system, find someone who has (classmate or other) and interview that person to answer this question.
3. Explain why Windows 98 is not a good choice of operating system for a laptop computer holding confidential information being used by a person who works from different locations.
4. Describe virtual memory and list an OS that does not use it.
5. In studying the common operating systems, you have considered the availability of software that runs on each OS and the general reasons one may be chosen over the others. Put yourself in the position of an information technology professional in a new company that will open its doors on day one with 50 employees who will need computers on their desks connected to a corporate network and will need to work with standard business applications. What are some other practical considerations that you can think of that must come into play when making this decision? Your answer does not need to specify a particular OS.

Lab Projects

• Lab Project 1.1

Locate as many of the common components (listed next) in your lab computer as possible. If you're doing this in a class lab, you may use any means permitted by the instructor to find this information. You may need to refer to the documentation, use software, or open up the computer. Then write a brief description of the component. For instance, if you discover that your computer has a Pentium III processor, record that information, and if you can discover the quantity of memory installed, record that information also. If you're quick, you can discover information about your computer as it is booting up.

1. Processor _____
2. Motherboard _____
3. Memory _____
4. ROM BIOS _____

5. Video adapter

6. Keyboard

7. Pointing device

8. Disk drives

9. Peripheral device

• Lab Project 1.2

1. To understand the relative cost of each of the operating systems you are studying and the availability of each system, use a paper catalog from a software retailer or a website such as `www.us.buy.com` or `www.amazon.com` to research the price of each of the operating systems covered in this section. You are not bargain hunting, so you don't need to look for the lowest price; just find the relative cost of the operating systems. You will also find that some are not available as new retail products, although you may find them at other sources. We have listed the full retail versions separately from the upgrade versions. The full versions can be installed on a computer that does not have a previous version of Windows installed. The upgrade versions are cheaper than the full versions, but will not install without a previous version of Windows. In Table 1.2, enter the cost of each product. For those that are unavailable, enter N/A in the cost column.

2. Once again, using paper catalogs, retail stores, and/or the Internet, research the number of software titles that run in each of these operating systems. This information may be difficult to find. You may have to search other sources. You may find this information at the Microsoft, Apple, and Red Hat websites or at an Electronics Boutique or Wal-Mart. This will give you a rough idea of the amount of software available for each OS, because it takes into account only software sold at retail through the sites you selected and does not include other free or nearly free software distributed elsewhere. Be careful not to count other versions of the operating system, especially when looking for Linux software titles. Only count software that runs on the operating system. At the Buy.com site, we searched on each OS in turn, noticed the total number of titles in the results, and then browsed through them to estimate the total. You're looking only for estimated numbers, because your goal is to gain an understanding of the relative number of software titles available

Table 1.2 Price and Availability Comparison

Operating System	Cost	Operating System	Cost
MS-DOS (any version)	_____	Red Hat Linux	_____
Windows 98 full	_____	Red Hat Linux Professional	_____
Windows 98 upgrade	_____	Windows XP Professional full	_____
Windows NT 4.0 Workstation full	_____	Windows XP Professional upgrade	_____
Windows NT 4.0 Workstation upgrade	_____	Mac OS 9	_____
Windows XP Home Edition full	_____	Mac OS X	_____
Windows XP Home Edition upgrade	_____		

Table 1.3 Comparison of the Number of Available Software Titles

Operating System	Estimated Number of Titles	Operating System	Estimated Number of Titles
MS-DOS	N/A	Windows XP	
Windows 98		Mac OS 8/9	
Windows NT Workstation		Linux	

for each OS. While you are at it, notice the type of software available for each OS, which is an indication of the market for that OS. Windows OSs can usually run software written for any of the older versions of Windows, so a low number of titles that name Windows XP in their system requirements does not indicate that there are few applications that will run on XP. Enter your findings on the number of titles in Table 1.3.

• Lab Project 1.3

Examine the operating system on your class lab computer and answer questions related to the operating system functions described in this section. If you're not familiar with the operating system on your lab computer, you may need to do some research to answer some of these questions. If so, there are several places you can search. First, look for a Help program in the OS or read any documentation that is available to you for this OS. If you cannot find the answers in one of these sources, use a search engine on the Internet to find another source of information for your OS.

For this Lab Project, you will need the following:

- A computer with a desktop operating system
- Internet access

1. Start your computer and record the name and version number of your operating system here.

_____

2. In your own words, describe the user interface.

_____

_____

3. Can you see an indication that this operating system provides a job management function? If so, provide a description.

_____

_____

4. If your operating system supports task management, explain how you can demonstrate the task management functions to someone else.

_____

_____

5. Look for tools used to manage files. Then describe how you can copy a file from a location on your hard drive to a diskette.

_____

_____

6. Did you see any evidence that this OS provides security? If so, describe why you believe this.

_____

_____