TABLE 5-1 SOME IMPORTANT STANDARDS IN COMPUTING

| STANDARD	SIGNIFICANCE
American Standard Code for Information Interchange (ASCII) (1958)	Made it possible for computer machines from different manufacturers to exchange data; later used as the universal language linking input and output devices such as keyboards and mice to computers. Adopted by the American National Standards Institute in 1963.
Common Business Oriented Language (COBOL) (1959)	An easy-to-use software language that greatly expanded the ability of programmers to write business-related programs and reduced the cost of software. Sponsored by the Defense Department in 1959.
Unix (1969–1975)	A powerful multitasking, multiuser, portable operating system initially developed at Bell Labs (1969) and later released for use by others (1975). It operates on a wide variety of computers from different manufacturers. Adopted by Sun, IBM, HP, and others in the 1980s, it became the most widely used enterprise-level operating system.
Transmission Control Protocol/Internet Protocol (TCP/IP) (1974)	Suite of communications protocols and a common addressing scheme that enables millions of computers to connect together in one giant global network (the Internet). Later, it was used as the default networking protocol suite for local area networks and intranets. Developed in the early 1970s for the U.S. Department of Defense.
Ethernet (1973)	A network standard for connecting desktop computers into local area networks that enabled the widespread adoption of client/server computing and local area networks, and further stimulated the adoption of personal computers.
IBM/Microsoft/Intel Personal Computer (1981)	The standard Wintel design for personal desktop computing based on standard Intel processors and other standard devices, Microsoft DOS, and later Windows software. The emergence of this standard, low-cost product laid the foundation for a 25-year period of explosive growth in computing throughout all organizations around the globe. Today, more than 1 billion PCs power business and government activities every day.
World Wide Web (1989–1993)	Standards for storing, retrieving, formatting, and displaying information as a worldwide web of electronic pages incorporating text, graphics, audio, and video enables creation of a global repository of billions of Web pages.

5.2   INFRASTRUCTURE COMPONENTS

IT infrastructure today is composed of seven major components. Figure 5-9 illustrates these infrastructure components and the major vendors within each component category. These components constitute investments that must be coordinated with one another to provide the firm with a coherent infrastructure.

In the past, technology vendors supplying these components were often in competition with one another, offering purchasing firms a mixture of incompatible, proprietary, partial solutions. But increasingly the vendor firms have been forced by large customers to cooperate in strategic partnerships with one another. For instance, a hardware and services provider such as IBM cooperates with all the major enterprise software providers, has strategic relationships with system integrators, and promises to work with whichever database products its client firms wish to use (even though it sells its own database management software called DB2).

COMPUTER HARDWARE PLATFORMS

U.S. firms will spend about $109 billion in 2010 on computer hardware. This component includes client machines (desktop PCs, mobile computing devices such as netbooks and laptops but not including iPhones or BlackBerrys) and

FIGURE 5-9 **THE IT INFRASTRUCTURE ECOSYSTEM**
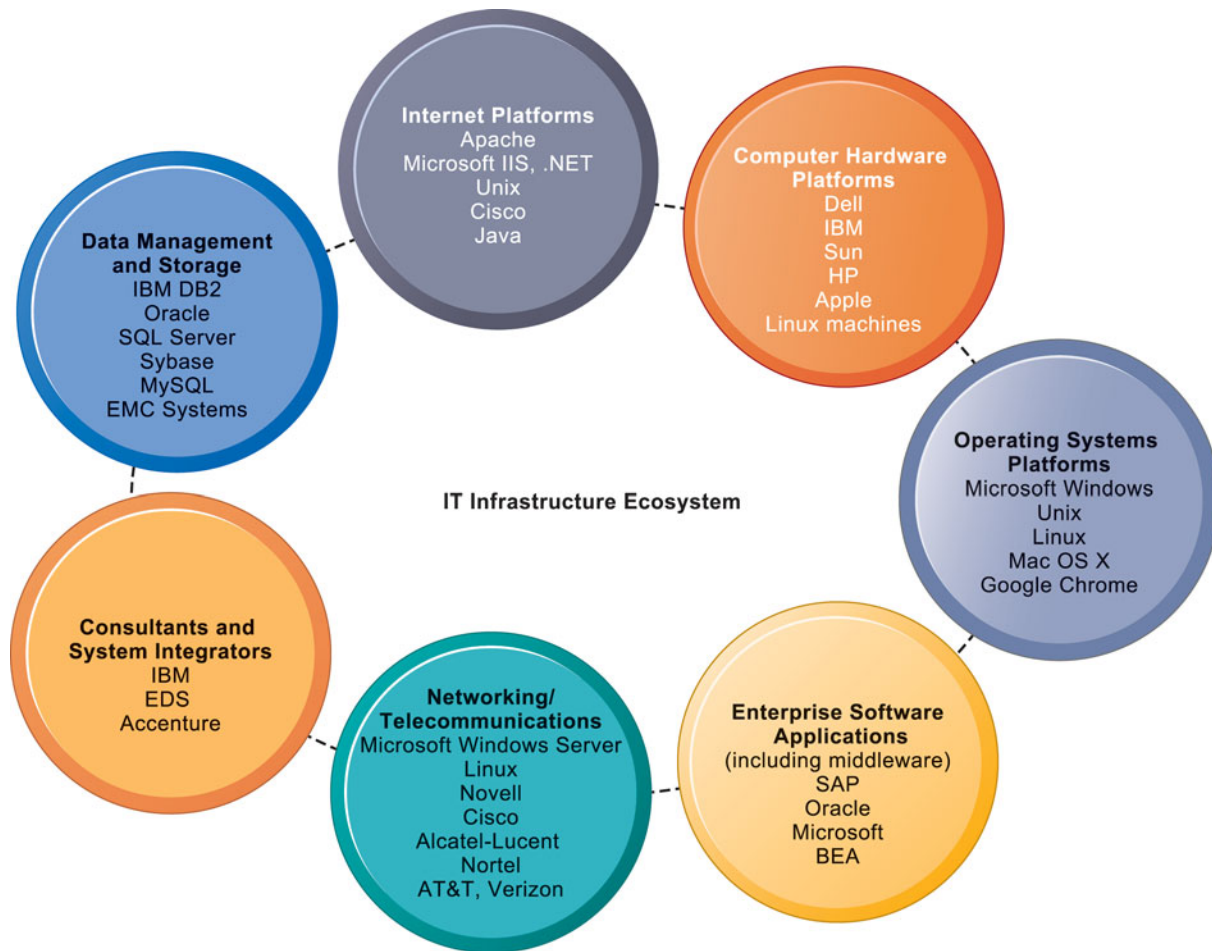
There are seven major components that must be coordinated to provide the firm with a coherent IT infrastructure. Listed here are major technologies and suppliers for each component.

server machines. The client machines use primarily Intel or AMD microprocessors. In 2010, there will be about 90 million PCs sold to U.S. customers (400 million worldwide) (Gartner, 2010).

The server market uses mostly Intel or AMD processors in the form of blade servers in racks, but also includes Sun SPARC microprocessors and IBM POWER chips specially designed for server use. **Blade servers**, which we discussed in the chapter-opening case, are ultrathin computers consisting of a circuit board with processors, memory, and network connections that are stored in racks. They take up less space than traditional box-based servers. Secondary storage may be provided by a hard drive in each blade server or by external mass-storage drives.

The marketplace for computer hardware has increasingly become concentrated in top firms such as IBM, HP, Dell, and Sun Microsystems (acquired by Oracle), and three chip producers: Intel, AMD, and IBM. The industry has collectively settled on Intel as the standard processor, with major exceptions in the server market for Unix and Linux machines, which might use Sun or IBM Unix processors.

Mainframes have not disappeared. The mainframe market has actually grown steadily over the last decade, although the number of providers has dwindled to one: IBM. IBM has also repurposed its mainframe systems so they can be used as giant servers for massive enterprise networks and corporate Web sites. A single IBM mainframe can run up to 17,000 instances of Linux or Windows server software and is capable of replacing thousands of smaller blade servers (see the discussion of virtualization in Section 5.3).

OPERATING SYSTEM PLATFORMS

In 2010, Microsoft Windows comprises about 75 percent of the server operating system market, with 25 percent of corporate servers using some form of the **Unix** operating system or **Linux**, an inexpensive and robust open source relative of Unix. Microsoft Windows Server is capable of providing enterprise-wide operating system and network services, and appeals to organizations seeking Windows-based IT infrastructures (IDC, 2010).

Unix and Linux are scalable, reliable, and much less expensive than mainframe operating systems. They can also run on many different types of processors. The major providers of Unix operating systems are IBM, HP, and Sun, each with slightly different and partially incompatible versions.

At the client level, 90 percent of PCs use some form of Microsoft Windows **operating system** (such as Windows 7, Windows Vista, or Windows XP) to manage the resources and activities of the computer. However, there is now a much greater variety of operating systems than in the past, with new operating systems for computing on handheld mobile digital devices or cloud-connected computers.

Google's **Chrome OS** provides a lightweight operating system for cloud computing using netbooks. Programs are not stored on the user's PC but are used over the Internet and accessed through the Chrome Web browser. User data resides on servers across the Internet. Microsoft has introduced the *Windows Azure* operating system for its cloud services and platform. **Android** is a mobile operating system developed by Android, Inc. (purchased by Google) and later the Open Handset Alliance as a flexible, upgradeable mobile device platform.

Conventional client operating system software is designed around the mouse and keyboard, but increasingly becoming more natural and intuitive by using touch technology. *IPhone OS*, the operating system for the phenomenally popular Apple iPad, iPhone, and iPod Touch, features a **multitouch** interface, where users use their fingers to manipulate objects on the screen. The Interactive Session on Technology explores the implications of using multitouch to interact with the computer.

ENTERPRISE SOFTWARE APPLICATIONS

In addition to software for applications used by specific groups or business units, U.S. firms will spend about $165 billion in 2010 on software for enterprise applications that are treated as components of IT infrastructure. We introduced the various types of enterprise applications in Chapter 2, and Chapter 9 provides a more detailed discussion of each.

The largest providers of enterprise application software are SAP and Oracle (which acquired PeopleSoft). Also included in this category is middleware software supplied by vendors such as BEA for achieving firmwide integration by linking the firm's existing application systems. Microsoft is attempting to move into the lower ends of this market by focusing on small and medium-sized businesses that have not yet implemented enterprise applications.

INTERACTIVE SESSION: TECHNOLOGY

NEW TO THE TOUCH

When Steve Jobs first demonstrated "the pinch"—the two-finger gesture for zooming in and out of photos and Web pages on the iPhone, he not only shook up the mobile phone industry—the entire digital world took notice. The Apple iPhone's multitouch features dramatized new ways of using touch to interact with software and devices.

Touch interfaces are not new. People use them every day to get money from ATMs or to check into flights at airport kiosks. Academic and commercial researchers have been working on multitouch technology for years. What Apple did was to make multitouch more exciting and relevant, popularizing it just as it did in the 1980s with the mouse and the graphical user interface. (These had also been invented elsewhere.)

Multitouch interfaces are potentially more versatile than single-touch interfaces. They allow you to use one or more fingers to perform special gestures that manipulate lists or objects on a screen without moving a mouse, pressing buttons, turning scroll wheels, or striking keys. They take different actions depending on how many fingers they detect and which gestures a user performs. Multitouch gestures are easier to remember than commands because they are based on ingrained human movements that do not have to be learned, scientists say.

The iPhone's Multi-Touch display and software lets you control everything using only your fingers. A panel underneath the display's glass cover senses your touch using electrical fields. It then transmits that information to a LCD screen below it. Special software recognizes multiple simultaneous touch points, (as opposed to the single-touch screen, which recognizes only one touch point.) You can quickly move back and forth through a series of Web pages or photos by "swiping," or placing three fingers on the screen and moving them rapidly sideways. By pinching the image, you can shrink or expand a photo.

Apple has made a concerted effort to provide multitouch features in all of its product categories, but many other consumer technology companies have adopted multitouch for some of their products. Synaptics, a leading supplier of touchpads for laptop makers who compete with Apple, has announced that it is incorporating several multitouch features into its touchpads.

Microsoft's Windows 7 operating system sports multitouch features: When you pair Windows 7 with a touch-screen PC, you can browse online newspapers, flick through photo albums, and shuffle files and folders using nothing but your fingers. To zoom in on something on the screen of a multitouch-compatible PC, you would place two fingers on the screen and spread them apart. To right-click a file, touch it with one finger and tap the screen with a second.

A number of Microsoft Windows PCs have touch screens, with a few Windows laptops emulating some of the multitouch features of Apple computers and handhelds. Microsoft's Surface computer runs on Windows 7 and lets its business customers use multitouch in a table-top display. Customers of hotels, casinos, and retail stores will be able to use multitouch finger gestures to move around digital objects such as photos, to play games, and to browse through product options. The Dell Latitude XT tablet PC uses multitouch, which is helpful to people who can't grasp a mouse and want the functionality of a traditional PC. They can use a finger or a stylus instead. The Android operating system for smartphones has native support for multi-touch, and handsets such as the HTC Desire, Nexus One, and the Motorola Droid have this capability.

Hewlett-Packard (HP) now has laptops and desktops that use touch technology. Its TouchSmart computer lets you use two fingers at once to manipulate images on the screen or to make on-screen gestures designating specific commands without using cursors or scroll bars. To move an object, you touch it with a finger and drag it to its new location. Sliding your finger up and down or sideways smoothly scrolls the display.

The TouchSmart makes it possible for home users to engage in a new type of casual computing—putting on music while preparing dinner, quickly searching for directions before leaving the house, or leaving written, video, or audio memos for family members. Both consumers and businesses have found other uses as well. According to Alan Reed, HP's vice president and general manager for Business Desktops, "There is untapped potential for touch technology in the business marketplace to engage users in a way that has never been done before."

Chicago's O'Hare Airport integrated a group of TouchSmart PCs into "Explore Chicago" tourist kiosks, allowing visitors to check out a virtual Visitor's Center. TouchSmart computing helped an autistic student to speak to and communicate with others for the first time in the 14 years of his life. Without using the TouchSmart PC's wireless keyboard and mouse, users can hold video chats with remote workers through a built-in Webcam and microphone, access e-mail and the Internet, and manage contacts, calendar items, and photos.

Touch-enabled PCs could also appeal to elementary schools seeking an easy-to-use computer for students in early grades, or a wall-mountable information kiosk-type device for parents and visitors. Customers might use touch to place orders with a retailer, conduct virtual video service calls, or to teach or utilize social networking for business.

It's too early to know if the new multitouch interface will ever be as popular as the mouse-driven graphical user interface. Although putting ones fingers on the screen is the ultimate measure of "cool" in the cell phone market, a "killer application" for touch on the PC has not yet emerged. But it's already evident that touch has real advantages on devices where a mouse isn't possible or convenient to use, or the decades-old interface of menus and folders is too cumbersome.

Sources: Claire Cain Miller, "To Win Over Today's Users, Gadgets Have to be Touchable," *The New York Times*, September 1, 2010; Katherine Boehret, "Apple Adds Touches to Its Mac Desktops," *The Wall Street Journal*, August 4, 2010; Ashlee Vance, " Tech Industry Catches Its Breath," *The New York Times*, February 17, 2010; Kathy Sandler, "The Future of Touch," *The Wall Street Journal*, June 2, 2009; Suzanne Robitaille, "Multitouch to the Rescue?" Suite101.com, January 22, 2009; and Eric Lai, "HP Aims TouchSmart Desktop PC at Businesses," *Computerworld*, August 1, 2009.

CASE STUDY QUESTIONS

1. What problems does multitouch technology solve?
2. What are the advantages and disadvantages of a multitouch interface? How useful is it? Explain.
3. Describe three business applications that would benefit from a multitouch interface.
4. What management, organization, and technology issues must be addressed if you or your business was considering systems and computers with multitouch interfaces?

MIS IN ACTION

1. Describe what you would do differently on your PC if it had multitouch capabilities. How much difference would multitouch make in the way you use your computer?

DATA MANAGEMENT AND STORAGE

Enterprise database management software is responsible for organizing and managing the firm's data so that they can be efficiently accessed and used. Chapter 6 describes this software in detail. The leading database software providers are IBM (DB2), Oracle, Microsoft (SQL Server), and Sybase (Adaptive Server Enterprise), which supply more than 90 percent of the U.S. database software marketplace. MySQL is a Linux open source relational database product now owned by Oracle Corporation.

The physical data storage market is dominated by EMC Corporation for large-scale systems, and a small number of PC hard disk manufacturers led by Seagate, Maxtor, and Western Digital.

Digital information is estimated to be growing at 1.2 zettabytes a year. All the tweets, blogs, videos, e-mails, and Facebook postings as well as traditional corporate data add up in 2010 to several thousand Libraries of Congress (EMC Corporation, 2010).

With the amount of new digital information in the world growing so rapidly, the market for digital data storage devices has been growing at more than 15 percent annually over the last five years. In addition to traditional

disk arrays and tape libraries, large firms are turning to network-based storage technologies. **Storage area networks (SANs)** connect multiple storage devices on a separate high-speed network dedicated to storage. The SAN creates a large central pool of storage that can be rapidly accessed and shared by multiple servers.

NETWORKING/TELECOMMUNICATIONS PLATFORMS

U.S. firms spend $100 billon a year on networking and telecommunications hardware and a huge $700 billion on networking services (consisting mainly of telecommunications and telephone company charges for voice lines and Internet access; these are not included in this discussion). Chapter 7 is devoted to an in-depth description of the enterprise networking environment, including the Internet. Windows Server is predominantly used as a local area network operating system, followed by Linux and Unix. Large enterprise wide area networks primarily use some variant of Unix. Most local area networks, as well as wide area enterprise networks, use the TCP/IP protocol suite as a standard (see Chapter 7).

The leading networking hardware providers are Cisco, Alcatel-Lucent, Nortel, and Juniper Networks. Telecommunications platforms are typically provided by telecommunications/telephone services companies that offer voice and data connectivity, wide area networking, wireless services, and Internet access. Leading telecommunications service vendors include AT&T and Verizon (see the Chapter 3 opening case). This market is exploding with new providers of cellular wireless, high-speed Internet, and Internet telephone services.

INTERNET PLATFORMS

Internet platforms overlap with, and must relate to, the firm's general networking infrastructure and hardware and software platforms. U.S. firms spent an estimated $40 billion annually on Internet-related infrastructure. These expenditures were for hardware, software, and management services to support a firm's Web site, including Web hosting services, routers, and cabling or wireless equipment. A **Web hosting service** maintains a large Web server, or series of servers, and provides fee-paying subscribers with space to maintain their Web sites.

The Internet revolution created a veritable explosion in server computers, with many firms collecting thousands of small servers to run their Internet operations. Since then there has been a steady push toward server consolidation, reducing the number of server computers by increasing the size and power of each. The Internet hardware server market has become increasingly concentrated in the hands of IBM, Dell, and HP/Compaq, as prices have fallen dramatically.

The major Web software application development tools and suites are supplied by Microsoft (Microsoft Expression Web, SharePoint Designer, and the Microsoft .NET family of development tools); Oracle-Sun (Sun's Java is the most widely used tool for developing interactive Web applications on both the server and client sides); and a host of independent software developers, including Adobe (Flash and text tools like Acrobat), and Real Media (media software). Chapter 7 describes the components of the firm's Internet platform in greater detail.

CONSULTING AND SYSTEM INTEGRATION SERVICES

Today, even a large firm does not have the staff, the skills, the budget, or the necessary experience to deploy and maintain its entire IT infrastructure. Implementing a new infrastructure requires (as noted in Chapters 3 and 14) significant changes in business processes and procedures, training and education, and software integration. Leading consulting firms providing this expertise include Accenture, IBM Global Services, HP Enterprise Services, Infosys, and Wipro Technologies.

Software integration means ensuring the new infrastructure works with the firm's older, so-called legacy systems and ensuring the new elements of the infrastructure work with one another. **Legacy systems** are generally older transaction processing systems created for mainframe computers that continue to be used to avoid the high cost of replacing or redesigning them. Replacing these systems is cost prohibitive and generally not necessary if these older systems can be integrated into a contemporary infrastructure.

5.3 CONTEMPORARY HARDWARE PLATFORM TRENDS

The exploding power of computer hardware and networking technology has dramatically changed how businesses organize their computing power, putting more of this power on networks and mobile handheld devices. We look at seven hardware trends: the emerging mobile digital platform, grid computing, virtualization, cloud computing, green computing, high-performance/power-saving processors, and autonomic computing.

THE EMERGING MOBILE DIGITAL PLATFORM

Chapter 1 pointed out that new mobile digital computing platforms have emerged as alternatives to PCs and larger computers. Cell phones and smartphones such as the BlackBerry and iPhone have taken on many functions of handheld computers, including transmission of data, surfing the Web, transmitting e-mail and instant messages, displaying digital content, and exchanging data with internal corporate systems. The new mobile platform also includes small low-cost lightweight subnotebooks called **netbooks** optimized for wireless communication and Internet access, with core computing functions such as word processing; tablet computers such as the iPad; and digital e-book readers such as Amazon's Kindle with some Web access capabilities.

In a few years, smartphones, netbooks, and tablet computers will be the primary means of accessing the Internet, with business computing moving increasingly from PCs and desktop machines to these mobile devices. For example, senior executives at General Motors are using smartphone applications that drill down into vehicle sales information, financial performance, manufacturing metrics, and project management status. At medical device maker Astra Tech, sales reps use their smartphones to access Salesforce.com customer relationship management (CRM) applications and sales data, checking data on sold and returned products and overall revenue trends before meeting with customers.