Part II provides the technical foundation for understanding information systems by examining hardware, software, databases, networking technologies, and tools and techniques for security and control. This part answers questions such as these: What technologies and tools do businesses today need to accomplish their work? What do I need to know about these technologies to make sure they enhance the performance of my firm? How are these technologies likely to change in the future?
STUDENT LEARNING OBJECTIVES

After completing this chapter, you will be able to answer the following questions:

1. What are the components of IT infrastructure?
2. What are the major computer hardware, data storage, input, and output technologies used in business?
3. What are the major types of computer software used in business?
4. What are the most important contemporary hardware and software trends?
5. What are the principal issues in managing hardware and software technology?
CARS.COM’S IT INFRASTRUCTURE DRIVES RAPID BUSINESS GROWTH

If you’ve ever tried to research or buy a car online, you may have used Cars.com. It’s the number one destination for online car shoppers. With comprehensive pricing information, photo galleries, side-by-side comparison tools, videos, and a huge selection of new- and used-car inventory, Cars.com gives millions of car buyers the information they need to make confident buying decisions.

No wonder, then, that the company has experienced explosive growth. In 2008, Cars.com experienced record traffic and dealer leads. Unfortunately, its information systems were unable to keep pace with its aggressive business strategy and expansion. Cars.com’s was saddled with a haphazard collection of technologies that had evolved over 10 years that made it difficult to get much work done. It used multiple versions of the Linux operating system, including AGT Linux, which is no longer supported, as well as aging Hewlett-Packard and Sun Microsystems servers running BEA Java. According to the company’s Chief Technology Officer Manny Montejano, “Not only did we have multiple pieces of technology from multiple vendors and multiple sources,
but we had multiple versions within those.” As a result, Cars.com’s information systems staff was spending more time trying to integrate legacy software and systems rather than developing applications to meet new business demands.

Working with Perficient information technology consultants, Cars.com management decided that it would have to replace the firm’s entire IT infrastructure in order to achieve its business goals. The project began in January 2007. Cars.com standardized on an IBM platform and a service-oriented architecture (SOA). IBM’s WebSphere application server runs on four IBM Power series servers with the P5 chip set using AIX, IBM’s version of the Unix operating system. The IBM servers have significantly reduced Cars.com’s data center costs because they have lower power, cooling, and space requirements.

The Cars.com application on the application server is written in Java. The IBM Information Server combines data from end users and dealers so it can be integrated with the company’s applications. With millions of vehicles in Cars.com’s inventory, customers are able to precisely locate what they are looking for. IBM Rational software helps Cars.com programmers rapidly design, develop, and test Java applications. The SOA environment allows the company to build new applications and services more rapidly using plug-and-play technologies.

So far Cars.com’s investment in a new IT infrastructure has delivered strong returns. The company can develop new systems much more rapidly, and the information systems department now has the time and resources to take on projects that will help grow the business. For example, the new infrastructure allowed the company to participate in Super Bowl commercials because its systems were now capable of handling large spikes in traffic when its two 30-second ads appeared on TV. The infrastructure also allowed Cars.com become the exclusive provider of used-car listings and exclusive listing service for private-party sellers on Yahoo Autos. Dealer leads have increased 40 percent over 2007. Handling inventory of 2.7 million vehicles, thousands of dealers, and millions of unique Web site visitors each month, Cars.com’s new IT infrastructure is clearly up to the task.


Cars.com has an enviable track record as a successful online retail business. Unfortunately, its aggressive growth plans and daily operations were hampered by unmanageable and outdated technology. Cars.com’s management felt the best solution was to replace its antiquated IT infrastructure with new computer hardware and software technologies and to standardize on the technology of a single vendor—IBM. This case highlights the critical role that hardware and software investments can play in improving business performance.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Management decided that the best way to make technology promote business objectives was to overhaul and standardize its IT infrastructure. It now uses more powerful and efficient servers, and a series of IBM software tools along with a service oriented architecture (SOA) that makes it much easier to develop new applications and services. The entire infrastructure is easier to manage and capable of scaling to accommodate spikes in Web site traffic, growing transaction loads, and new business opportunities.
4.1 IT Infrastructure: Computer Hardware

If you want to know why American businesses spend about $2 trillion every year on computing and information systems, just consider what it would take for you personally to set up a business or manage a business today. Businesses require a wide variety of computing equipment, software, and communications capabilities simply to operate and solve basic business problems. Obviously, you need computers, and, as it turns out, a wide variety of computers are available, including desktops, laptops, and handhelds.

Do your employees travel or do some work from home? You will want to equip them with laptop computers (over half the computers sold in the U.S. are laptops). If you are employed by a medium to large business, you will also need larger server computers, perhaps an entire data center or server farm with hundreds or even thousands of servers. Google, for instance, is able to answer 300 million queries a day in the United States, most within one second, by using a massive network of over 1 million PC servers linked together to spread the workload.

You will also need plenty of software. Each computer will require an operating system and a wide range of application software capable of dealing with spreadsheets, documents, and data files. Unless you are a single-person business, you will most likely want to have a network to link all the people in your business together and perhaps your customers and suppliers. As a matter of fact, you will probably want several networks: a local-area network connecting employees in your office, and remote access capabilities so employees can share e-mail and computer files while they are out of the office. You will also want all your employees to have access to landline phone systems, cell phone networks, and the Internet. Finally, to make all this equipment and software work harmoniously, you will also need the services of trained people to help you run and manage this technology.

All of the elements we have just described combine to make up the firm’s information technology (IT) infrastructure, which we first defined in Chapter 1. A firm’s IT infrastructure provides the foundation, or platform, for supporting all the information systems in the business.

INFRASCTURE COMPONENTS

Today’s IT infrastructure is composed of five major components: computer hardware, computer software, data management technology, networking and telecommunications technology, and technology services (see Figure 4-1). These components must be coordinated with each other.
**Computer Hardware**
Computer hardware consists of technology for computer processing, data storage, input, and output. This component includes large mainframes, servers, desktop and laptop computers, and mobile devices for accessing corporate data and the Internet. It also includes equipment for gathering and inputting data, physical media for storing the data, and devices for delivering the processed information as output.

**Computer Software**
Computer software includes both system software and application software. System software manages the resources and activities of the computer. Application software applies the computer to a specific task for an end user, such as processing an order or generating a mailing list. Today, most system and application software is no longer custom programmed but rather is purchased from outside vendors. We describe these types of software in detail in Section 4.2.

**Data Management Technology**
In addition to physical media for storing the firm’s data, businesses need specialized software to organize the data and make them available to business users. Data management software organizes, manages, and processes business data concerned with inventory, customers, and vendors. Chapter 5 describes data management software in detail.

**Networking and Telecommunications Technology**
Networking and telecommunications technology provides data, voice, and video connectivity to employees, customers, and suppliers. It includes technology for running a company’s internal networks, services from telecommunications/telephone services companies, and technology for running Web sites and linking to other computer systems through the Internet. Chapter 6 provides an in-depth description of these technologies.

**Technology Services**
Businesses need people to run and manage the other infrastructure components we have just described and to train employees in how to use these technologies for their work. Chapter 2 described the role of the information systems department, which is the firm’s internal business unit set up for this purpose. Today, many businesses supplement their in-house
information systems staff with external technology consultants. Even large firms do not have the staff, the skills, the budget, or the necessary experience to implement and run the wide array of technologies that would be required. When businesses need to make major system changes or implement an entirely new IT infrastructure, they typically turn to external consultants to help them with systems integration.

Systems integration means ensuring that the new infrastructure works with the firm’s older, so-called legacy systems and that the new elements of the infrastructure work with one another. Legacy systems are generally older transaction processing systems created for older computers that continue to be used to avoid the high cost of replacing or redesigning them.

There are many thousands of technology vendors supplying IT infrastructure components and services and an equally large number of ways of putting them together. This chapter is about the hardware and software components of infrastructure you will need to run a business. Chapter 5 describes the data management component, and Chapter 6 is devoted to the networking and telecommunications technology component. Chapter 7 deals with hardware and software for ensuring that information systems are reliable and secure, and Chapter 8 discusses software for enterprise applications.

TYPES OF COMPUTERS

Business firms face many different challenges and problems that can be solved by computers and information systems. In order to be efficient, firms need to match the right computer hardware to the nature of the business challenge, neither overspending nor underspending for the technology.

Computers come in an array of sizes with differing capabilities for processing information, from the smallest handheld devices to the largest mainframes and supercomputers. If you’re working alone or with a few other people in a small business, you’ll probably be using a desktop or laptop personal computer (PC). You might carry around a mobile device with some computing capability, such as a BlackBerry, iPhone or Palm handheld, or other high-end cell phone. If you’re doing advanced design or engineering work requiring powerful graphics or computational capabilities, you might use a workstation, which fits on a desktop but has more powerful mathematical and graphics-processing capabilities than a PC.

If your business has a number of computers networked together or maintains a Web site, it will need a server. Server computers are specifically optimized to support a computer network, enabling users to share files, software, peripheral devices (such as printers), or other network resources.

Servers have become important components of firms’ IT infrastructures because they provide the hardware platform for electronic commerce. By adding special software, they can be customized to deliver Web pages, process purchase and sale transactions, or exchange data with systems inside the company. You will sometimes find many servers linked together to provide all the processing needs for large companies. If your company has to process millions of financial transactions or customer records, you will need multiple servers or a single large mainframe to solve these challenges.

Mainframe computers first appeared in the mid-1960s, and are still used by large banks, insurance companies, stock brokerages, airline reservation systems, and government agencies to keep track of hundreds of thousands, or even millions, of records and transactions. A mainframe is a large-capacity, high-performance computer that can process large amounts of data very rapidly. Airlines, for instance, use mainframes to process upwards of 3,000 reservation transactions per second.

IBM, the leading mainframe vendor, has repurposed its mainframe systems so they can be used as giant servers for large-scale enterprise networks and corporate Web sites. A single IBM mainframe can run enough instances of Linux or Windows server software to replace thousands of smaller Windows-based servers.
A **supercomputer** is a specially designed and more sophisticated computer that is used for tasks requiring extremely rapid and complex calculations with thousands of variables, millions of measurements, and thousands of equations. Supercomputers traditionally have been used in engineering analysis of structures, scientific exploration and simulations, and military work, such as classified weapons research and weather forecasting. A few private business firms use supercomputers. For instance, Volvo and most other automobile manufacturers use supercomputers to simulate vehicle crash tests.

If you are a long-term weather forecaster, such as the National Oceanic and Atmospheric Administration (NOAA), or the National Hurricane Center, and your challenge is to predict the movement of weather systems based on hundreds of thousands of measurements, and thousands of equations, you would want access to a supercomputer or a distributed network of computers called a grid.

**Grid computing** involves connecting geographically remote computers into a single network to create a “virtual supercomputer” by combining the computational power of all computers on the grid. Grid computing takes advantage of the fact that most computers in the United States use their central processing units on average only 25 percent of the time, leaving 75 percent of their capacity available for other tasks. By using the combined power of thousands of PCs and other computers networked together, the grid is able to solve complicated problems at supercomputer speeds at far lower cost.

Private firms are beginning to use computing grids because of their greater reliability than supercomputers, higher capacity, and lower cost. For example, Royal Dutch/Shell Group is using a scalable grid computing platform that improves the accuracy and speed of its scientific modeling applications to find the best oil reservoirs. This platform, which links 1,024 IBM servers running Linux, in effect creates one of the largest commercial Linux supercomputers in the world. The grid adjusts to accommodate the fluctuating data volumes that are typical in this seasonal business. Royal Dutch/Shell Group claims the grid has enabled the company to cut processing time for seismic data, while improving output quality and helping its scientists pinpoint problems in finding new oil supplies.

**Computer Networks and Client/Server Computing**

Unless you are in a small business with a stand-alone computer, you’ll be using networked computers for most processing tasks. The use of multiple computers linked by a communications network for processing is called **distributed processing**. Centrally processing, in which all processing is accomplished by one large central computer, is much less common.

One widely used form of distributed processing is **client/server computing**. Client/server computing splits processing between “clients” and “servers.” Both are on the network, but each machine is assigned functions it is best suited to perform. The **client** is the user point of entry for the required function and is normally a desktop or laptop computer. The user generally interacts directly only with the client portion of the application. The server provides the client with services. Servers store and process shared data and also perform functions such as managing printers, backup storage, and network activities such as security, remote access, and user authentication. Figure 4-2 illustrates the client/server computing concept. Computing on the Internet uses the client/server model (see Chapter 6).
Figure 4-2 illustrates the simplest client/server network, consisting of a client computer networked to a server computer, with processing split between the two types of machines. This is called a two-tiered client/server architecture. Whereas simple client/server networks can be found in small businesses, most corporations have more complex, multitiered (often called N-tier) client/server architectures, in which the work of the entire network is balanced over several different levels of servers, depending on the kind of service being requested (see Figure 4-3).

For instance, at the first level a Web server will serve a Web page to a client in response to a request for service. Web server software is responsible for locating and managing stored Web pages. If the client requests access to a corporate system (a product list or price information, for instance), the request is passed along to an application server. Application server software handles all application operations between a user and an organization’s back-end business systems. The application server may reside on the same computer as the Web server or on its own dedicated computer. Chapters 5 and 6 provide more detail on other pieces of software that are used in multitiered client/server architectures for e-commerce and e-business.

**STORAGE, INPUT, AND OUTPUT TECHNOLOGY**

In addition to hardware for processing data, you will need technologies for data storage, and input and output. Storage and input and output devices are called peripheral devices because they are outside the main computer system unit.

**Secondary Storage Technology**

Electronic commerce and electronic business, and regulations such as Sarbanes-Oxley, have made storage a strategic technology. The amount of data that companies now need to store is doubling every 12 to 18 months. The principal storage technologies are magnetic disks, optical disc, magnetic tape, and storage networks.

**Magnetic Disks** The most widely used secondary storage medium today is the magnetic disk. PCs have hard drives, and large mainframe or midrange computer systems have multiple hard disk drives because they require immense disk storage capacity in the gigabyte and terabyte range. Some older PCs use floppy disks, but they have been largely supplanted by USB flash drives, also known as USB drives. A USB flash drive provides portable flash memory storage by plugging into a computer’s USB port. It can provide up to 256 gigabytes of portable storage capacity and is small enough to fit into a pocket.
Servers and computers with large storage requirements use a disk technology called **RAID (Redundant Array of Inexpensive Disks)**. RAID devices package more than 100 disk drives, a controller chip, and specialized software into a single, large unit delivering data over multiple paths simultaneously.

**Optical Discs** These discs use laser technology to store large quantities of data, including sound and images, in a highly compact form. They are available for both PCs and large computers. CD-ROM (compact disk read-only memory) for PCs is a 4.75-inch compact disc that can store up to 660 megabytes. CD-ROM is read-only storage, but CD-RW (CD-ReWritable) discs are rewritable. **Digital video discs (DVDs)** are optical discs the same size as CD-ROMs but of even higher capacity, storing a minimum of 4.7 gigabytes of data. DVDs are now the favored technology for storing video and large quantities of text, graphics, and audio data, and rewritable (DVD-RW) discs are widely used in personal computer systems.

**Magnetic Tape** Some companies still use **magnetic tape**, an older storage technology that is used for secondary storage of large quantities of data that are needed rapidly but not instantly. It stores data sequentially and is relatively slow compared to the speed of other secondary storage media.

**Storage Networking** Large firms are turning to network-based storage technologies to deal with the complexity and cost of mushrooming storage requirements. **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 (see Figure 4-4).

**Input and Output Devices**
Human beings interact with computer systems largely through input and output devices. **Input devices** gather data and convert them into electronic form for use by the computer, whereas **output devices** display data after they have been processed. Table 4.1 describes the principal input and output devices.

---

**Figure 4-4**
A Storage Area Network (SAN)
A typical SAN consists of a server, storage devices, and networking devices, and is used strictly for storage. The SAN stores data on many different types of storage devices, providing data to the enterprise. The SAN supports communication between any server and the storage unit as well as between different storage devices in the network.
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. We look at six trends: the emerging mobile digital platform, nanotechnology, cloud computing, autonomic computing, virtualization, and multicore processors.

### TABLE 4.1
Input and Output Devices

<table>
<thead>
<tr>
<th>Input Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard</td>
<td>Principal method of data entry for text and numerical data.</td>
</tr>
<tr>
<td>Computer mouse</td>
<td>Handheld device with point-and-click capabilities that is usually connected to the computer by a cable. The computer user can move the mouse around on a desktop to control the cursor's position on a computer display screen, pushing a button to select a command. Trackballs and touch pads often are used in place of the mouse as pointing devices on laptop PCs.</td>
</tr>
<tr>
<td>Touch screen</td>
<td>Device that allows users to interact with a computer by touching the surface of a sensitized display screen. Used in kiosks in airports, retail stores, and restaurants and in multitouch smartphones such as the iPhone.</td>
</tr>
<tr>
<td>Optical character recognition</td>
<td>Device that can translate specially designed marks, characters, and codes into digital form. The most widely used optical code is the bar code, which is used in point-of-sale systems in supermarkets and retail stores. The codes can include time, date, and location data in addition to identification data.</td>
</tr>
<tr>
<td>Magnetic ink character recognition (MICR)</td>
<td>Technology used primarily in check processing for the banking industry. Characters on the bottom of a check identify the bank, checking account, and check number and are preprinted using special magnetic ink. A MICR reader translates these characters into digital form for the computer.</td>
</tr>
<tr>
<td>Pen-based input</td>
<td>Handwriting-recognition devices, such as pen-based tablets, notebooks, and notepads, that convert the motion made by an electronic stylus pressing on a touch-sensitive tablet screen into digital form.</td>
</tr>
<tr>
<td>Digital scanner</td>
<td>Device that translates images, such as pictures or documents, into digital form; essential component of image-processing systems.</td>
</tr>
<tr>
<td>Audio input</td>
<td>Voice input devices that convert spoken words into digital form for processing by the computer. Microphones and tape cassette players can serve as input devices for music and other sounds.</td>
</tr>
<tr>
<td>Sensors</td>
<td>Devices that collect data directly from the environment for input into a computer system. For instance, today's farmers can use sensors to monitor the moisture of the soil in their fields to help them with irrigation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor</td>
<td>Display screen consisting of a flat-panel display or (in older systems) a cathode ray tube (CRT).</td>
</tr>
<tr>
<td>Printers</td>
<td>Devices that produce a printed hard copy of information output. They include impact printers (such as dot matrix printers) and nonimpact printers (such as laser, inkjet, and thermal transfer printers).</td>
</tr>
<tr>
<td>Audio output</td>
<td>Voice output devices that convert digital output data back into intelligible speech. Other audio output, such as music, can be delivered by speakers connected to the computer.</td>
</tr>
</tbody>
</table>

### CONTEMPORARY HARDWARE 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. We look at six trends: the emerging mobile digital platform, nanotechnology, cloud computing, autonomic computing, virtualization, and multicore processors.
The Emerging Mobile Digital Platform

Chapter 1 pointed out that new mobile digital computing platforms have emerged as alternatives to PCs and larger computers. Communication devices such as cell phones, and smartphones such as the iPhone and BlackBerry, 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, and digital e-book readers such as Amazon’s Kindle with some Web access capabilities.

More and more business computing is moving 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 AstraTech, 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. Kraft Foods employees use iPhones for e-mail and contacts and for accessing project-related documents, wikis, and blogs on the company’s Microsoft SharePoint server.

Nanotechnology

Over the years, microprocessor manufacturers have been able to exponentially increase processing power while shrinking chip size by finding ways to pack more transistors into less space. They are now turning to nanotechnology to shrink the size of transistors down to the width of several atoms. Nanotechnology uses individual atoms and molecules to create computer chips and other devices that are thousands of times smaller than current technologies permit. IBM and other research labs have created transistors from nanotubes and other electrical devices and have developed a manufacturing process for producing nanotube processors economically (Figure 4-5).
Cloud Computing

Cloud computing refers to a model of computing in which firms and individuals obtain computing resources and software applications over the Internet (also referred to as “the cloud”). Thousands or even hundreds of thousands of computers are located in cloud data centers, where they can be accessed by desktop computers, notebooks, netbooks, entertainment centers, mobile devices, and other client machines linked to the Internet. IBM, HP, Sun Microsystems, Dell, and Amazon operate huge, scalable cloud computing centers that provide both computing power, data storage, and high-speed Internet connections to firms that want to maintain their IT infrastructures remotely. Software firms such as Google, Microsoft, SAP, Oracle, and Salesforce.com sell software applications as services delivered over the Internet. Figure 4-6 illustrates the cloud computing concept.

Cloud computing consists of three different types of services:

- **Cloud infrastructure as a service:** Customers use processing, storage, networking, and other computing resources from cloud service providers to run their information systems. For example, Amazon uses the spare capacity of its IT infrastructure to provide a broadly based cloud environment selling IT infrastructure services. These include its Simple Storage Service (S3) for storing customers’ data and its Elastic Compute Cloud (EC2) service for running their applications. Users pay only for the amount of computing and storage capacity they actually use.

- **Cloud platform as a service:** Customers use infrastructure and programming tools hosted by the service provider to develop their own applications. For example, Sun Microsystems offers a Sun Storage Cloud and a Sun Compute Cloud to help software developers, students, and start-ups test and develop new applications over the Internet using Sun’s hardware. IBM has a similar Smart Business Application Development & Test service for software development and testing in the cloud.
• **Cloud software as a service**: Customers use software hosted by the vendor. Leading examples are Google Apps, which provides common business applications online and Salesforce.com, which leases CRM and related software services over the Internet. Both charge users an annual subscription fee, although Google Apps also has a pared-down free version. Users access these applications from a Web browser, and the data and software are maintained on the providers’ remote servers. You can find out more about Salesforce.com and its services in the chapter-ending case study. We will discuss cloud-based software services in greater detail later in this chapter and cloud platform services in Chapter 11.

Since organizations using cloud computing generally do not own the infrastructure, they do not have to make large investments in their own hardware and software. Instead, they purchase their computing services from remote providers and pay only for the amount of computing power they actually use (utility computing) or are billed on a monthly or annual subscription basis. The term *on-demand computing* has also been used to describe such services.

Cloud computing has some drawbacks. Unless users make provisions for storing their data locally, the responsibility of data storage and control is in the hands of the provider. Some companies worry about the security risks related to entrusting their critical data and systems to an outside vendor that also works with other companies. There are also questions of system reliability. Companies expect their systems to be available 24/7 and do not want to suffer any loss of business capability if their IT infrastructures malfunction. When Amazon’s cloud went down in July 2008, subscribers were unable to use their systems for eight hours. Another limitation of cloud computing is the possibility of making users dependent on the cloud computing provider.

There are some who believe that cloud computing represents a sea change in the way computing will be performed by corporations as business computing shifts out of private data centers into “the cloud” (Carr, 2008). This remains a matter of debate. Cloud computing is more immediately appealing to small and medium-sized businesses that lack resources to purchase and own their own hardware and software. However, large corporations have huge investments in complex proprietary systems supporting unique business processes, some of which give them strategic advantages. For them, the most likely scenario is a hybrid computing model where firms use their own infrastructure for their most essen-
tial core activities and adopt cloud computing for less-critical systems or for additional processing capacity during peak business periods. Cloud computing will gradually shift firms from having a fixed infrastructure capacity toward a more flexible infrastructure, some of it owned by the firm, and some of it rented from giant computer centers owned by computer hardware vendors.

**Autonomic Computing**

With large systems encompassing many thousands of networked devices, computer systems have become so complex today that some experts believe they may not be manageable in the future. One approach to dealing with this problem from a computer hardware perspective is to employ autonomic computing. **Autonomic computing** is an industry-wide effort to develop systems that can configure themselves, optimize and tune themselves, heal themselves when broken, and protect themselves from outside intruders and self-destruction. Imagine, for instance, a desktop PC that could know it was invaded by a computer virus. Instead of blindly allowing the virus to invade, the PC would identify and eradicate the virus or, alternatively, turn its workload over to another processor and shut itself down before the virus destroyed any files.

You can glimpse some of these capabilities in your desktop system. For instance, virus and firewall protection software can detect viruses on PCs, automatically defeat the viruses, and alert operators. These programs can be updated automatically as the need arises by connecting to an online virus protection service such as McAfee. You can see autonomic computing occur nearly every day on your computer as Microsoft, Apple, and Sun automatically update their users’ computers when they are connected to the Internet.

**Virtualization and Multicore Processors**

As companies deploy hundreds or thousands of servers, many are spending almost as much on electricity to power and cool their systems as they did on purchasing the hardware. The U.S. Environmental Protection Agency estimated that data centers will use more than 2 percent of all U.S. electrical power by 2011. Information technology is believed to contribute about 2 percent of the world’s greenhouse gases. Cutting power consumption in data centers has become both a serious business and environmental challenge. The Interactive Session on Organizations examines this problem. As you read this case, try to identify the alternative solutions for this problem and the advantages and disadvantages of each.

This Interactive Session describes organizations curbing hardware proliferation and power consumption by using virtualization to reduce the number of computers required for processing. **Virtualization** presents a set of computing resources (such as computing power or data storage) so that they can all be accessed in ways that are not restricted by physical configuration or geographic location. Server virtualization enables companies to run more than one operating system at the same time on a single machine. Most servers run at just 10 to 15 percent of capacity, and virtualization can boost server utilization rates to 70 percent or higher. Higher utilization rates translate into fewer computers required to process the same amount of work.

For example, the Christus Health network of hospitals and healthcare facilities in the southern and western United States and in Mexico was formerly managing more than 2,000 servers in eight data centers, with 70 percent in the San Antonio data center. In that location, 97 percent of the systems were using 20 percent or less of their processing power, and only 29 percent of available memory. The health care organization used virtualization to consolidate the work of 824 servers onto 83 blade servers, saving $1.8 million, including reductions in electrical power.

Server virtualization software runs between the operating system and the hardware, masking server resources, including the number and identity of physical servers, processors, and operating systems, from server users. VMware is the leading server virtualization software vendor for Windows and Linux systems. Microsoft has built virtualization capabilities into the newest version of Windows Server.
Computer rooms are becoming too hot to handle. Data-hungry tasks such as video on demand, music downloads, exchanging photos, and maintaining Web sites require more and more power-hungry machines. Between 2000 and 2007, the total annual cost of electricity for data center servers jumped from $1.3 billion to $2.7 billion in the United States, and from $3.2 billion to $7.2 billion across the world. If this trend persists, the total electricity used by servers in 2010 might be 76 percent higher than 2005, according to a study by Jonathan Kooney, a staff scientist at the Lawrence Berkeley National Laboratory. Gartner Group consultants believe that energy bills, which traditionally accounted for 10 percent of information technology budgets, could soon account for more than 50 percent.

The heat generated from rooms full of servers is causing equipment to fail. Firms are forced to spend even more on cooling their data centers or finding other solutions. Some organizations spend more money to keep their data centers cool than they spend to lease the property itself. It’s a vicious cycle, as companies must pay to power their servers, and then pay again to keep them cool and operational. Cooling a server requires roughly the same number of kilowatts of energy as running one. All this additional power consumption has a negative impact on the environment and as well as corporate operating costs.

Some of the world’s most prominent firms are tackling their power consumption issues with one eye toward saving the environment and the other toward saving dollars. Google, Microsoft, and HSBC are all building data centers that will take advantage of hydroelectric power. Hewlett-Packard is working on a series of technologies to reduce the carbon footprint of data centers by 75 percent and develop new software and services to measure energy use and carbon emissions. It reduced its power costs by 20 to 25 percent through a consolidation of servers and data centers.

Microsoft’s San Antonio data center deploys sensors that measure nearly all power consumption, recycles water used in cooling, and uses internally-developed power management software. Microsoft is also trying to encourage energy-saving software practices by charging business units by the amount of power they consume in the data center rather than the space they take up on the floor.

None of these companies claim that their efforts will save the world, but they do demonstrate recognition of a growing problem and the commencement of the green computing era. And since these companies’ technology and processes are more efficient than most other companies, using their online software services in place of in-house software may also count as a green investment.

PCs typically stay on more than twice the amount of time they are actually being used each day. According to a report by the Alliance to Save Energy, a company with 10,000 desktop PCs will spend more than $165,000 per year in electricity bills if these machines are left on all night. The group estimates that this practice is wasting about $1.7 billion each year in the United States alone.

Although many companies establish default PC power management settings, about 70 percent of employees turn these settings off. PC power management software from BigFix, 1E NightWatchman, and Verdiem locks PC power settings and automatically powers PCs up right before employees arrive for work in the morning.

Miami-Dade County public schools cut the time its PCs were on from 21 hours to 10.3 hours daily by using BigFix to centrally control PC power settings. City University of New York adopted Verdiem’s Surveyor software to turn off its 20,000 PCs when they are inactive at night. Surveyor has trimmed 10 percent from CUNY’s power bills, creating an annual savings of around $320,000.

Virtualization is a highly effective tool for more cost-effective greener computing because it reduces the number of servers and storage resources in the firm’s IT infrastructure. Fulton County, Georgia, which provides services for 988,000 citizens, scrutinizes energy usage when purchasing new information technology. It used VMware virtualization software and a new Fujitsu blade server platform to consolidate underutilized legacy servers so that one machine now performs the work that was formerly performed by eight, saving $44,000 per year in power costs. These efforts also created a more up-to-date IT infrastructure.

Virtualization also encourages the consolidation of people and processes. According to a 2006 International Data Center study, management and administrative expenditures are growing three times faster than expenditures on computing equipment. Virtualization facilitates launching new applications on existing servers, and reduces problems associated with a specific physical server. There are fewer servers to oversee, although they must still be carefully managed and monitored.

Experts note that it’s important for companies to measure their energy use and inventory and track their information technology assets both before and after
they start their green initiatives. Commonly used metrics used by Microsoft and other companies include power usage effectiveness (PUE), data center infrastructure efficiency (DCIE), and average data center efficiency (ADCE). Health insurer Highmark initially wanted to increase its CPU utilization by 10 percent while reducing power use by 5 percent and eventually by 10 percent. When the company inventoried all of its information technology assets, it found that its information systems staff were hanging onto “dead” servers that served no function but continued to consume power.

Programs to educate employees in energy conservation may also be necessary. In addition to using energy-monitoring tools, Honda Motor Corporation trains its data center administrators how to be more energy efficient. For example, it taught them to decommission unused equipment quickly and to use management tools to ensure servers are being optimized.


In addition to reducing hardware and power expenditures, virtualization allows businesses to run their legacy applications on older versions of an operating system on the same server as newer applications. Virtualization also facilitates centralization of hardware administration.

Multicore Processors Another way to reduce power requirements and hardware sprawl is to use multicore processors. A multicore processor is an integrated circuit to which two or more processors have been attached for enhanced performance, reduced power consumption, and more efficient simultaneous processing of multiple tasks. This technology enables two processing engines with reduced power requirements and heat dissipation to perform tasks faster than a resource-hungry chip with a single processing core. Today you will find dual-core processors in PCs and quad-core processors in servers. Sun Microsystems’s UltraSparc T2 chip for managing Internet workloads has 8 processors, and Intel is working on an 80-processor chip.

In order to use computer hardware, you will need software, which provides the detailed instructions that direct the computer’s work. System software and application software are interrelated and can be thought of as a set of nested boxes, each of which must interact

CASE STUDY QUESTIONS

1. What business and social problems does data center power consumption cause?
2. What solutions are available for these problems? Which are environment-friendly?
3. What are the business benefits and costs of these solutions?
4. Should all firms move toward green computing? Why or why not?

MIS IN ACTION

Perform an Internet search on the phrase “green computing” and then answer the following questions:

1. How would you define green computing?
2. Who are some of the leaders of the green computing movement? Which corporations are leading the way? Which environmental organizations are playing an important role?
3. What are the latest trends in green computing? What kind of impact are they having?
4. What can individuals do to contribute to the green computing movement? Is the movement worthwhile?
The system software that manages and controls the computer’s activities is called the **operating system**. Other system software consists of computer language translation programs that convert programming languages into machine language that can be understood by the computer and utility programs that perform common processing tasks, such as copying, sorting, or computing a square root.

The operating system is the computer system’s chief manager, enabling the system to handle many different tasks and users at the same time. The operating system allocates and assigns system resources, schedules the use of computer resources and computer jobs, and monitors computer system activities. The operating system provides locations in primary memory for data and programs, and controls the input and output devices, such as printers, terminals, and telecommunication links. The operating system also coordinates the scheduling of work in various areas of the computer so that different parts of different jobs can be worked on at the same time. Finally, the operating system keeps track of each computer job and may also keep track of who is using the system, of what programs have been run, and of any unauthorized attempts to access the system.

**PC, Server, and Mobile Operating Systems**

The operating system controls the way users interact with the computer. Contemporary PC operating systems and many types of contemporary application software use a **graphical user interface**, often called a GUI, which makes extensive use of icons, buttons, bars, and boxes to perform tasks.

New interface technologies are emerging for both business and home systems. One promising interface technology is **multitouch**, which has been popularized by the iPhone. The Interactive Session on Technology explores multitouch interfaces as alternatives to the GUI. As you read this case, try to identify the problems to be solved by touch interfaces and the people, organization, and technology issues the solution should address.

Table 4.2 compares leading PC and server operating systems. These include the Windows family of operating systems (Windows 7, Windows Vista, Windows Server 2008), UNIX, Linux, and the Macintosh operating system.
The Microsoft Windows family of operating systems has both client and server versions and a streamlined GUI. Windows systems can perform multiple programming tasks simultaneously and have powerful networking capabilities, including the ability to access information from the Internet. Windows 7 is the latest Windows version. Its improvements over Windows Vista and the earlier Windows XP include enhanced usability, faster performance, a new taskbar, support for multitouch interfaces, and additional security enhancements. There are versions for home, small business, and enterprise users. Windows 7 has added a Starter version for small notebook PCs and netbooks that lack the processing capacity and memory for more full-featured versions.

Windows operating systems for network servers provide network management functions, including tools for creating and operating Web sites and other Internet services. Windows Server 2008 has multiple versions for small, medium, and large businesses, including those with massive computer centers and processing requirements. UNIX is a multiuser, multitasking operating system developed by Bell Laboratories in 1969 to connect various machines together and is highly supportive of communications and networking. UNIX is often used on workstations and servers, and provides the reliability and scalability for running large systems on high-end servers. UNIX can run on many different kinds of computers and can be easily customized. Application programs that run under UNIX can be ported from one computer to run on a different computer with little modification. Graphical user interfaces have been developed for UNIX. Vendors have developed different versions of UNIX that are incompatible, thereby limiting software portability.
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.

The iPhone’s multitouch 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.

Other companies are bringing products with multitouch to the market. 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 recently unveiled its Surface computer that runs 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. Surface technology is likely to be integrated into consumer PCs. 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 BlackBerry Storm multitouch screen uses something called “haptic touch,” so when you press a button on the screen or on the virtual keyboard it feels as if you’re actually pressing on that specific spot. It’s tactile, which provides more peace of mind if you’re hearing-impaired. If you’re visually impaired, this makes typing and clicking a lot easier.

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. When you can put your finger directly on the screen, you don’t need a cursor to show where you are pointing. 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—leaving written, video, or audio memos for family members, quickly searching for directions before leaving the house, putting on music while preparing dinner. 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. Touch systems might allow customers to connect, select, and interact with vendors and each other. Customers might use touch to place orders with a retailer, conduct virtual video service calls, or to teach or utilize social networking for business.

Microsoft’s new 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 you would place two fingers on the screen of a multitouch-compatible PC and spread them apart. To right-click a file, touch it with one finger and tap the screen with a second.

It’s too early to know if the new multitouch interface will ever be as big as the mouse-driven graphical user interface. Although putting your 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.


CASE STUDY QUESTIONS

1. What problems does multitouch technology solve?
2. What are the advantages and disadvantages of multitouch interfaces? How useful are they? Explain.
3. Describe three business applications that would benefit from a multitouch interface.
4. What people, 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?
2. Do a search on “touch computers.” and identify additional applications of touch computer screens beyond smartphones. Make a list of these applications and describe the kinds of situations where touch computers are used.

**Linux** is a UNIX-like operating system that can be downloaded from the Internet free of charge or purchased for a small fee from companies that provide additional tools for the software. It is free, reliable, compactly designed, and capable of running on many different hardware platforms, including servers, handheld computers, and consumer electronics.

Linux has become popular as a robust low-cost alternative to UNIX and the Windows operating systems. For example, E*Trade Financial saves $13 million annually with improved computer performance by running Linux on a series of small inexpensive IBM servers instead of large expensive Sun Microsystems servers running Sun’s proprietary version of UNIX.

Linux plays a major role in the back office, running Web servers and local-area networks in about 25 percent of the U.S. server market. Its use in desktop computers is growing steadily. IBM, HP, Intel, Dell, and Sun have made Linux a central part of their offerings to corporations, and major software vendors are starting to provide versions of their products that can run on Linux. Both IBM and Sun offer Linux-based office tools for free or a minimal fee.

Linux is an example of open source software, which provides all computer users with free access to its program code, so they can modify the code to fix errors or to make improvements. Open source software is not owned by any company or individual. A global network of programmers and users manages and modifies the software, usually without being paid to do so. Open source software is by definition not restricted to any specific operating system or hardware technology, although most open source software is currently based on a Linux or UNIX.
In addition to these operating systems, new systems for mobile digital devices and cloud-connected computers are emerging. Google’s Chrome OS serves as a lightweight computer operating system for users who do most of their computing on the Internet and runs on computers ranging from netbooks to desktop computers. It has a minimalist design to take advantage of the Web and cloud computing. Android is a mobile operating system initially developed by Google and later the Open Handset Alliance as a flexible, upgradeable mobile device platform. It may eventually be used in small computers. Microsoft has introduced a cloud operating system called Windows Azure for its cloud services and platform.

APPLICATION SOFTWARE AND DESKTOP PRODUCTIVITY TOOLS

Today, businesses have access to an array of tools for developing their application software. These include traditional programming languages, fourth-generation languages, application software packages, and desktop productivity tools; software for developing Internet applications; and software for enterprise integration. It is important to know which software tools and programming languages are appropriate for the work your business wants to accomplish.

Application Programming Languages for Business

For business applications, the most important programming languages have been C, C++, Visual Basic, and COBOL. C is a powerful and efficient language developed in the early 1970s that combines machine portability with tight control and efficient use of computer resources. C is used primarily by professional programmers to create operating systems and application software, especially for PCs. C++ is a newer version of C that has all the capabilities of C plus additional features for working with software objects. Unlike traditional programs, which separate data from the actions to be taken on the data, a software object combines data and procedures. Chapter 11 describes object-oriented software development in detail. Visual Basic is a widely used visual programming tool and environment for creating applications that run on Microsoft Windows operating systems. A visual programming language allows users to manipulate graphic or iconic elements to create programs. COBOL (COmmon Business Oriented Language) was developed in the early 1960s for processing large data files with alphanumeric characters (mixed alphabetic and numeric data) and for business reporting. You’ll find it today primarily in large legacy business systems.

Fourth-Generation Languages

Fourth-generation languages consist of a variety of software tools that enable end users to develop software applications with minimal or no technical assistance or that enhance professional programmers’ productivity. Fourth-generation languages tend to be nonprocedural, or less procedural, than conventional programming languages. Procedural languages require specification of the sequence of steps, or procedures, that tell the computer what to do and how to do it. Nonprocedural languages need only specify what has to be accomplished rather than provide details about how to carry out the task. Some of these nonprocedural languages are natural languages that enable users to communicate with the computer using conversational commands resembling human speech.

Table 4.3 shows that there are six categories of fourth-generation languages: PC software tools, query languages, report generators, graphics languages, application generators, and application software packages. The table lists the tools in order of ease of use by nonprogramming end users. End users are most likely to work with PC software tools and query languages. Query languages are software tools that provide immediate online answers to requests for information that are not predefined, such as “Who are the highest-performing sales representatives?” Query languages are often tied to data management software (described later in this section) and to database management systems (see Chapter 5).
Much of the software used in businesses today is not custom programmed but consists of application software packages and desktop productivity tools. A software package is a prewritten, precoded, commercially available set of programs that eliminates the need for individuals or organizations to write their own software programs for certain functions.

There are software packages for system software, but most package software is application software.

Software packages that run on mainframes and larger computers usually require professional programmers for their installation and support. Desktop productivity software packages for word processing, spreadsheets, data management, presentation graphics, and Web browsers are the most widely used software tools among business and consumer users.

Word Processing Software If you work in an office or attend school, you probably use word processing software every day. Word processing software stores text data electronically as a computer file rather than on paper. The word processing software allows the user to make changes in the document electronically, with formatting options to make changes in line spacing, margins, character size, and column width. Microsoft Word and WordPerfect are popular word processing packages.

Most word processing software has advanced features that automate other writing tasks: spelling checkers, style checkers (to analyze grammar and punctuation), thesaurus...
programs, mail merge programs (which link letters or other text documents with names and addresses in a mailing list), and capabilities for creating and accessing Web pages.

Businesses that need to create highly professional looking brochures, manuals, or books will likely use desktop publishing software for this purpose. Desktop publishing software provides more control over the placement of text, graphics, and photos in the layout of a page than does word processing software. Adobe InDesign and QuarkXpress are two professional publishing packages.

**Spreadsheet Software** Spreadsheets are valuable for applications in which numerous calculations with pieces of data must be related to each other. Spreadsheet software organizes data into a grid of columns and rows. When you change a value or values, all other related values on the spreadsheet will be automatically recomputed.

You will often see spreadsheets in applications that require modeling and “what-if” analysis. After the user has constructed a set of mathematical relationships, the spreadsheet can be recalculated instantaneously using a different set of assumptions. Spreadsheet packages include graphics functions to present data in the form of line graphs, bar graphs, or pie charts, and the ability to read and create Web files. The most popular spreadsheet package is Microsoft Excel. Figure 4-8 illustrates the output from a spreadsheet for a break-even analysis and its accompanying graph.

**Data Management Software** Although spreadsheet programs are powerful tools for manipulating quantitative data, data management software, which we defined earlier in this chapter, is more suitable for creating and manipulating lists and for combining information from different files. PC database management packages have programming features and easy-to-learn menus that enable nonspecialists to build small information systems.

Data management software typically has facilities for creating files and databases and for storing, modifying, and manipulating data for reports and queries. Popular database manage-

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**Figure 4-8**

**Spreadsheet Software**

Spreadsheet software organizes data into columns and rows for analysis and manipulation. Contemporary spreadsheet software provides graphing abilities for a clear, visual representation of the data in the spreadsheets. This sample break-even analysis is represented as numbers in a spreadsheet as well as a line graph for easy interpretation.

<table>
<thead>
<tr>
<th>Total fixed cost</th>
<th>19,000.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable cost per unit</td>
<td>3.00</td>
</tr>
<tr>
<td>Average sales price</td>
<td>17.00</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>14.00</td>
</tr>
<tr>
<td>Break-even point</td>
<td>1,357</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units sold</th>
<th>0.00</th>
<th>679</th>
<th>1,357</th>
<th>2,036</th>
<th>2,714</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>0</td>
<td>11,536</td>
<td>23,071</td>
<td>34,607</td>
<td>46,143</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>19,000</td>
<td>19,000</td>
<td>19,000</td>
<td>19,000</td>
<td>19,000</td>
</tr>
<tr>
<td>Variable cost</td>
<td>0</td>
<td>2,036</td>
<td>4,071</td>
<td>6,107</td>
<td>8,143</td>
</tr>
<tr>
<td>Total cost</td>
<td>19,000</td>
<td>21,036</td>
<td>23,071</td>
<td>25,107</td>
<td>27,143</td>
</tr>
<tr>
<td>Profit/Loss</td>
<td>(19,000)</td>
<td>(9,500)</td>
<td>0</td>
<td>9,500</td>
<td>19,000</td>
</tr>
</tbody>
</table>

**Custom Neckties Pro Forma Income Statement**

- **Units Sold**
  - 0.00
  - 679
  - 1,357
  - 2,036
  - 2,714

- **Revenue**
  - 0
  - 11,536
  - 23,071
  - 34,607
  - 46,143

- **Fixed Cost**
  - 19,000
  - 19,000
  - 19,000
  - 19,000
  - 19,000

- **Variable Cost**
  - 0
  - 2,036
  - 4,071
  - 6,107
  - 8,143

- **Total Cost**
  - 19,000
  - 21,036
  - 23,071
  - 25,107
  - 27,143

- **Profit/Loss**
  - (19,000)
  - (9,500)
  - 0
  - 9,500
  - 19,000

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ment software for the personal computer includes Microsoft Access, which has been enhanced
to publish data on the Web. We discuss data management software in greater detail in Chapter 5.

**Presentation Graphics** Users can create professional-quality graphics presentations with
**presentation graphics software.** This software can convert numeric data into charts and
other types of graphics and can include multimedia displays of sound, animation, photos,
and video clips. The leading presentation graphics packages include capabilities for com-
puter-generated slide shows and translating content for the Web. Microsoft PowerPoint and
Lotus Freelance Graphics are popular presentation graphics packages.

**Software Suites** Typically, the major office productivity tools are bundled together as a soft-
ware suite. Microsoft Office is an example. There are a number of different versions of
Office for home and business users, but the core office tools include Word word processing
software, Excel spreadsheet software, Access database software, PowerPoint presentation
graphics software, and Outlook, a set of tools for e-mail, scheduling, and contact manage-
ment. Microsoft **Office 2010** is the latest version of this suite. Microsoft has added a Web-
based option called Office Web Apps available to businesses and consumers on both a free
and subscription basis. Office Web Apps delivers lightweight online versions of Office tools
such as Word, Excel, PowerPoint, and One Note via standard Web browsers to PCs, mobile
phones, and other Web-enabled devices. Microsoft stores users’ data for these online appli-
cations and allows some sharing of documents and files.

Competing with Microsoft Office are low-cost office productivity suites such as Sun
Microsystems’ OpenOffice (which can be downloaded for free over the Internet) and its
StarOffice (downloadable for $34.95). However, the real challenge to Microsoft is coming
from the cloud. Web-based versions of desktop productivity software are becoming popular
because of their convenience, flexibility, and low cost. There are over two million businesses
of all sizes using Google Apps, which we introduced in our discussion of collaboration tools
in Chapter 2. This online suite includes tools for word processing, spreadsheets, presenta-
tions, contact management, messaging, and e-mail) and is available for free or as a more
full-featured Premier edition charging businesses $50.

**Web Browsers** Web browsers Easy-to-use software tools called **web browsers** are used for
displaying Web pages and for accessing the Web and other Internet resources. Browsers can
display or present graphics, audio, and video information, as well as traditional text, and
they allow you to click (or touch) on-screen buttons or highlighted words to link to related
Web sites. Web browsers have become the primary interface for accessing the Internet or for
using networked systems based on Internet technology. The leading Web browsers today are
Microsoft Internet Explorer, Mozilla Firefox, Apple Safari, and Google Chrome. Mobile
handhelds have their own specialized Web browsers.

**SOFTWARE FOR THE WEB: JAVA, AJAX, AND HTML**

There are a number of software tools that that businesses use to build Web sites and applica-
tions that run on the Web. Java and Ajax are used for building applications that run on the
Web, and HTML is used for creating Web pages.

**Java**

**Java** is an operating system-independent, processor-independent, object-oriented
programming language that has become a leading interactive programming environment for
the Web. Java enables users to work with data on networked systems using Web browsers,
reducing the need to write specialized software. At the enterprise level, Java is used for more
complex e-commerce and e-business applications that require communication with an
organization’s back-end transaction processing systems.

Nearly all Web browser software has a Java platform built in. The Java platform has
migrated into cell phones, automobiles, music players, game machines, and, finally, into
set-top cable television systems serving interactive content.
Java software is designed to run on any computer or computing device, regardless of the specific microprocessor or operating system the device uses. Java achieves this neat trick by using a Java virtual machine built for each type of computer and operating system. The virtual machine enables it to run Java applications. A Macintosh PC, an IBM PC running Windows, a Sun server running UNIX, and even a smart cell phone or PDA can share the same Java application, reducing the costs of software development and creating the same user experience regardless of what kind of computer the user is working with.

In network environments, such as the Internet, Java is used to create miniature programs called *applets* that are designed to reside on centralized network servers. The network delivers to client computers only the applets required for a specific function. With Java applets residing on a network, a user can download only the software functions and data that he or she needs to perform a particular task, such as analyzing the revenue from one sales territory. The user does not need to maintain large software programs or data files on his or her desktop machine.

**Ajax**

Have you ever filled out a Web order form, made a mistake, and then had to start all over again after a long wait for a new order form page to appear on your computer screen? Or visited a map site, clicked the North arrow once, and waited some time for an entire new page to load? *Ajax* (Asynchronous JavaScript and XML) is another Web development technique for creating interactive Web applications that prevents all of this inconvenience.

Ajax allows a client and server to exchange small pieces of data behind the scene so that an entire Web page does not have to be reloaded each time the user requests a change. So if you click North on a map site, such as Google Maps, the server downloads just that part of the application that changes with no wait for an entirely new map. You can also grab maps in map applications and move the map in any direction without forcing a reload of the entire page. Ajax uses JavaScript programs downloaded to your client to maintain a near-continuous conversation with the server you are using, making the user experience more seamless.

**Hypertext Markup Language (HTML)**

_Hypertext Markup Language (HTML)_ is a page description language for specifying how text, graphics, video, and sound are placed on a Web page and for creating dynamic links to other Web pages and objects. Using these links, a user need only point at a highlighted keyword or graphic, click on it, and immediately be transported to another document. Table 4.4 illustrates some sample HTML statements.

HTML programs can be custom written, but they also can be created using the HTML authoring capabilities of Web browsers or of popular word processing, spreadsheet, data management, and presentation graphics software packages. HTML editors, such as Adobe Dreamweaver, are more powerful HTML authoring tool programs for creating Web pages.

**WEB SERVICES**

Web services refer to a set of loosely coupled software components that exchange information with each other using universal Web communication standards and languages. They can exchange information between two different systems regardless of the operating systems or

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**TABLE 4.4**

Examples of HTML

<table>
<thead>
<tr>
<th>Plain English</th>
<th>HTML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcompact</td>
<td><code>&lt;TITLE&gt;Automobile&lt;/TITLE&gt;</code></td>
</tr>
<tr>
<td>4 passenger</td>
<td><code>&lt;LI&gt;4 passenger&lt;/LI&gt;</code></td>
</tr>
<tr>
<td>$16,800</td>
<td><code>&lt;LI&gt;$16,800&lt;/LI&gt;</code></td>
</tr>
</tbody>
</table>
programming languages on which the systems are based. They can be used to build open-standard, Web-based applications linking systems of two different organizations, and they can be used to create applications that link disparate systems within a single company. Web services are not tied to any one operating system or programming language, and different applications can use them to communicate with each other in a standard way without time-consuming custom coding.

The foundation technology for Web services is **XML**, which stands for **Extensible Markup Language**. This language was developed in 1996 by the World Wide Web Consortium (W3C, the international body that oversees the development of the Web) as a more powerful and flexible markup language than HTML for Web pages. Whereas HTML is limited to describing how data should be presented in the form of Web pages, XML can perform presentation, communication, and storage of data. In XML, a number is not simply a number; the XML tag specifies whether the number represents a price, a date, or a zip code. Table 4.5 illustrates some sample XML statements.

By tagging selected elements of the content of documents for their meanings, XML makes it possible for computers to manipulate and interpret their data automatically and perform operations on the data without human intervention. Web browsers and computer programs, such as order processing or enterprise resource planning (ERP) software, can follow programmed rules for applying and displaying the data. XML provides a standard format for data exchange, enabling Web services to pass data from one process to another.

Web services communicate through XML messages over standard Web protocols. **SOAP**, which stands for **Simple Object Access Protocol**, is a set of rules for structuring messages that enables applications to pass data and instructions to one another. **WSDL** stands for **Web Services Description Language**; it is a common framework for describing the tasks performed by a Web service and the commands and data it will accept so that it can be used by other applications. **UDDI**, which stands for **Universal Description, Discovery, and Integration**, enables a Web service to be listed in a directory of Web services so that it can be easily located. Companies discover and locate Web services through this directory much as they would locate services in the Yellow Pages of a telephone book. Using these protocols, a software application can connect freely to other applications without custom programming for each different application with which it wants to communicate. Everyone shares the same standards.

The collection of Web services that are used to build a firm’s software systems constitutes what is known as a service-oriented architecture. A **service-oriented architecture (SOA)** is set of self-contained services that communicate with each other to create a working software application. Business tasks are accomplished by executing a series of these services. Software developers reuse these services in other combinations to assemble other applications as needed.

<table>
<thead>
<tr>
<th>Plain English</th>
<th>XML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcompact</td>
<td>&lt;AUTOMOBILETYPE=&quot;Subcompact&quot;/&gt;</td>
</tr>
<tr>
<td>4 passenger</td>
<td>&lt;PASSENGERUNIT=&quot;PASS&quot;&gt;4&lt;/PASSENGER&gt;</td>
</tr>
<tr>
<td>$16,800</td>
<td>&lt;PRICE CURRENCY=&quot;USD&quot;&gt;$16,800&lt;/PRICE&gt;</td>
</tr>
</tbody>
</table>

**Table 4.5** Examples of XML
Dollar without leaving the airline’s Web site. Instead of struggling to get Dollar’s reservation system to share data with Southwest’s information systems, Dollar used Microsoft .NET Web services technology as an intermediary. Reservations from Southwest are translated into Web services protocols, which are then translated into formats that can be understood by Dollar’s computers.

Other car rental companies have linked their information systems to airline companies’ Web sites before. But without Web services, these connections had to be built one at a time. Web services provide a standard way for Dollar’s computers to “talk” to other companies’ information systems without having to build special links to each one. Dollar is now expanding its use of Web services to link directly to the systems of a small tour operator and a large travel reservation system as well as a wireless Web site for mobile phones and PDAs. It does not have to write new software code for each new partner’s information systems or each new wireless device (see Figure 4-9).

**SOFTWARE TRENDS**

Today there are many more sources for obtaining software and many more capabilities for users to create their own customized software applications. Expanding use of open source software and cloud-based software tools and services exemplify this trend.

**Open Source Software**

Arguably the most influential software trend is the movement towards open source software. As noted earlier, open source software is developed by a community of programmers around the world, who make their programs available to users under one of several different licensing schemes. Essentially, users of the software can use the software as is, modify it at will, and even include it in for-profit software applications.

The open source movement started out small in 1983 (when it was called “hippie software”), but it has since grown to be a major part of corporate computing infrastructure, as the foundation for programs such as Linux, and Apache, the most widely used Web server

**Figure 4-9**

How Dollar Rent-A-Car Uses Web Services

Dollar Rent-A-Car uses Web services to provide a standard intermediate layer of software to “talk” to other companies’ information systems. Dollar Rent-A-Car can use this set of Web services to link to other companies’ information systems without having to build a separate link to each firm’s systems.
software. Today you can find thousands of open source computer programs to accomplish everything from e-commerce shopping carts and funds clearance to sales force management. Some of the cloud computing applications described in this chapter, such as Google’s Chrome Web browser, are based on open source code.

**Cloud-Based Software Tools and Services**

In the past, software such as Microsoft Word or Adobe Illustrator came in a box and was designed to operate on a single machine. Today, you’re more likely to download the software from the vendor’s Web site to your computer or, increasingly, to use the software as a cloud service delivered over the Internet.

Cloud-based software and the data they use are hosted on powerful servers in massive data centers, and can be accessed by anyone with an Internet connection and standard Web browser. Google’s numerous Web-based applications, which we described earlier in this chapter and in Chapter 2, are a leading example. Besides Office Web Apps, Microsoft offers other cloud software services, such as its Business Productivity Online Standard Suite for messaging and collaboration.

**Mashups and Widgets**

The software you use for both personal and business tasks may consist of large, self-contained programs, or it may be composed of interchangeable components that integrate freely with other applications on the Internet. Individual users and entire companies mix and match these software components to create their own customized applications and to share information with others. The resulting software applications are called **mashups**. You have performed a mashup if you’ve ever personalized your Facebook profile or your blog with a capability to display videos or slide shows.

The idea is to take different sources and produce a new work that is “greater than” the sum of its parts. Part of the movement called Web 2.0 (see Chapter 6), and in the spirit of musical mashups, Web mashups combine the capabilities of two or more online applications to create a hybrid that provides more customer value than the original sources alone. For instance, Faceforce integrates Facebook profile information with Salesforce data in real time, providing an instant 360-degree view of customers, prospects, and business associates and a single place to view and manage all contacts.

One area of great innovation is the mashup of mapping software with local content. Google, Yahoo!, and Microsoft now offer tools to allow other applications to pull in information from their map and satellite images with relatively little programming. For example, ZipRealty uses Google Maps and data provided by online real estate community Zillow.com to display a complete list of multiple listing service (MLS) real estate listings for any zip code specified by the user. BidNearBy uses Google Maps and data from eBay’s Craigslist to search local auctions and classified listings and display their location on a map view.

The small pieces of software code that enable users to embed content from one site into a Web page or another Web site are called widgets. **Widgets** are small software programs that can be added to Web pages or placed on the desktop (or mobile digital device) to provide additional functionality. For example, the Flixster widget on Facebook profiles transports users to a place where they can list the films they’ve seen along with their ratings and reviews, view their friends’ ratings and reviews, and what’s playing in theaters. The iPhone Atom widget delivers news feeds from Google to the iPhone, and there are widgets for displaying Twitter updates on your blog.

Web widgets run inside a Web page or blog. Desktop widgets integrate content from an external source into the user’s desktop to provide services such as a calculator, dictionary, or display of current weather conditions. The Yahoo! Weather widget, Apple’s Dashboard TV, and Google Desktop Gadgets are examples of desktop widgets.

Widgets can also provide storefront windows for advertising and selling products and services. Amazon and Wal-Mart have toolbar widgets that enable users to search their Web stores while staying on a different Web page. Widgets have become so powerful and useful that Facebook and Google launched programs to attract developers of widgets for their Web sites.
**Software As a Service (SaaS)** In addition to free or low-cost tools for individuals and businesses provided by Google, Microsoft, or Yahoo!, enterprise software and other complex business functions are available as services from the major commercial software vendors. Instead of buying and installing software programs, subscribing companies rent the same functions from these services, with users paying either on a subscription or per-transaction basis. Services for delivering and providing access to software remotely as a Web-based service are now referred to as software as a service (SaaS).

A leading example is Salesforce.com, which provides on-demand software services for customer relationship management, including sales force automation, partner relationship management, marketing, and customer service. It includes tools for customization, integrating its software with other corporate applications, and creating new applications. You will find out more about Salesforce.com in the chapter-ending case study.

### 4.3 Managing Hardware and Software Technology

Selection and use of computer hardware and software technology has a profound impact on business performance. We now describe the most important issues you will face when managing hardware and software technology: capacity planning and scalability; determining the total cost of technology assets; determining whether to own and maintain your own hardware, software, and other infrastructure components or lease them from an external technology service provider; and managing mobile platforms and software localization.

#### CAPACITY PLANNING AND SCALABILITY

E-commerce and e-business are placing heavy new demands on hardware technology. Much larger processing and storage resources are required to process and store the surging digital transactions flowing between different parts of the firm, and between the firm and its customers and suppliers. Many people using a Web site simultaneously place great strains on a computer system, as does hosting large numbers of interactive Web pages with data-intensive graphics or video.

Managers and information systems specialists now need to pay more attention to hardware capacity planning and scalability than before. From an IT perspective, capacity planning is the process of predicting when a computer hardware system becomes saturated. It considers factors such as the maximum number of users that the system can accommodate at one time, the impact of existing and future software applications, and performance measures, such as minimum response time for processing business transactions. Capacity planning ensures that the firm has enough computing power for its current and future needs. For example, the Nasdaq Stock Market performs ongoing capacity planning to identify peaks in the volume of stock trading transactions and to ensure it has enough computing capacity to handle large surges in volume when trading is very heavy.

Although information systems specialists perform capacity planning, input from business managers is essential. Business managers need to determine acceptable levels of computer response time and availability for the firm’s mission-critical systems to maintain the level of business performance they expect. New applications, mergers and acquisitions, and changes in business volume all impact computer workload and must be considered when planning hardware capacity.

**Scalability** refers the ability of a computer, product, or system to expand to serve a large number of users without breaking down. Electronic commerce and electronic business both call for scalable IT infrastructures that have the capacity to grow with the business as the size of a Web site and number of visitors increase. Organizations must make sure they have sufficient computer processing, storage, and network resources to handle surging volumes of digital transactions and to make such data immediately available online.
TOTAL COST OF OWNERSHIP (TCO) OF TECHNOLOGY ASSETS

When you calculate how much your hardware and software cost, their purchase price is only the beginning. You must also consider ongoing administration costs for hardware and software upgrades, maintenance, technical support, training, and even utility and real estate costs for running and housing the technology. The **total cost of ownership (TCO)** model can be used to analyze these direct and indirect costs to help determine the actual cost of owning a specific technology. Table 4.6 describes the most important TCO components to consider in a TCO analysis.

When all these cost components are considered, the TCO for a PC might run up to three times the original purchase price of the equipment. “Hidden costs” for support staff, downtime, and additional network management can make distributed client/server architectures—especially those incorporating handheld computers and wireless devices—more expensive than centralized mainframe architectures.

Many large firms are saddled with redundant, incompatible hardware and software because of poor planning. These firms could reduce their TCO through greater centralization and standardization of their hardware and software resources. Companies could reduce the size of the information systems staff required to support their infrastructure if the firm minimized the number of different computer models and pieces of software that employees are allowed to use.

## USING TECHNOLOGY SERVICE PROVIDERS

Some of the most important questions facing managers are “How should we acquire and maintain our technology assets? Should we build software applications ourselves or outsource them to an external contractor? Should we purchase and run them ourselves or rent them from external service providers?” In the past, most companies ran their own computer facilities and developed their own software. Today, more and more companies are obtaining their hardware and software technology from external service vendors.

**Outsourcing**

A number of firms are **outsourcing** the maintenance of their IT infrastructures and the development of new systems to external vendors. They may contract with an external service provider to run their computer center and networks, to develop new software, or to manage all of the components of their IT infrastructures, as did Procter & Gamble (P&G). P&G agreed to pay HP $3 billion to manage its IT infrastructure, computer center opera-

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**TABLE 4.6**

<table>
<thead>
<tr>
<th>Total Cost of Ownership (TCO) Cost Components</th>
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<tr>
<td><strong>Hardware acquisition</strong></td>
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<td><strong>Software acquisition</strong></td>
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<td><strong>Installation</strong></td>
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<td><strong>Training</strong></td>
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<td><strong>Support</strong></td>
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<td><strong>Maintenance</strong></td>
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<td><strong>Infrastructure</strong></td>
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<td><strong>Downtime</strong></td>
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<td><strong>Space and energy</strong></td>
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tions, desktop and end-user support, network management, and applications development and maintenance for global operations in 160 countries.

Specialized Web hosting services are available for companies that lack the financial or technical resources to operate their own Web sites. A Web hosting service maintains a large Web server, or a series of servers, and provides fee-paying subscribers with space to maintain their Web sites. The subscribing companies may create their own Web pages or have the hosting service, or a Web design firm, create them. Some services offer co-location, in which the firm actually purchases and owns the server computer housing its Web site but locates the server in the physical facility of the hosting service.

Firms often retain control over their hardware resources but outsource custom software development or maintenance to outside firms, frequently firms that operate offshore in low-wage areas of the world. When firms outsource software work outside their national borders, the practice is called offshore software outsourcing. Until recently, this type of software development involved lower-level maintenance, data entry, and call center operations, but with the growing sophistication and experience of offshore firms, particularly in India, more and more new program development is taking place offshore. Chapter 11 discusses offshore software outsourcing in greater detail.

In order to manage their relationship with an outsourcer or technology service provider, firms will need a contract that includes a service level agreement (SLA). The SLA is a formal contract between customers and their service providers that defines the specific responsibilities of the service provider and the level of service expected by the customer. SLAs typically specify the nature and level of services provided, criteria for performance measurement, support options, provisions for security and disaster recovery, hardware and software ownership and upgrades, customer support, billing, and conditions for terminating the agreement.

Using Cloud Services

Firms now have the option of maintaining their own IT infrastructures or using cloud-based hardware and software services. There are many factors that go into the decision of whether to keep IT infrastructure in-house or turn it over to an external provider. Companies considering the cloud computing model need to carefully assess the costs and benefits of external services, weighing all people, organizational, and technology issues, including the level of service and performance that is acceptable for the business.

Small businesses that typically lack the resources for maintaining their own hardware and software may find it much easier to “rent” infrastructure from another firm and avoid the expense and difficulty of installing, operating, and maintaining hardware and software on their own. For larger businesses, the cost and business advantages are less clear-cut. These firms will have to consider not only the up-front and long-term costs of moving to the cloud but whether cloud computing capabilities are sufficiently secure or reliable for their most critical systems. At the moment, most large companies are likely to maintain most of their infrastructure internally but gradually move non-essential work to cloud services.

One emerging pattern is to off-load peak demand for computing power to remote, large-scale data centers. In this manner, firms reduce their technology expenditures by investing just enough to handle average processing loads and paying for only as much additional computing power as the market demands. This arrangement enables firms to have a more flexible infrastructure, some of it owned by the firm, and some of it rented from giant computer centers run by technology specialists.

The software offered by cloud providers may be suitable for basic desktop functions but not for running large corporate systems with many unique and complex business processes. In some instances, the cost of renting software adds up to more than purchasing and maintaining an application in-house. Yet there may be benefits to using software as a service (SaaS) if it allows the company to focus on core business issues instead of technology challenges.
Managing Mobile Platforms

A large firm may have many thousands of wireless devices to configure and monitor, similar to a desktop environment. It will be a challenge to integrate this new platform with the firm’s existing IT infrastructure and applications. Central coordination and oversight are essential. Firms will need to inventory all of their mobile devices and develop policies and tools for tracking, updating, and securing them and for controlling the data and applications that run on them.

Gains in productivity and efficiency from equipping employees with mobile computing devices must be balanced against increased costs from integrating these devices into the firm’s IT infrastructure and from providing technical support. Other cost components include fees for wireless airtime, end-user training, help desk support, and software for special applications.

Although the cost of a wireless handheld for a corporate employee may run several hundred dollars, the TCO for each device is much higher, ranging from $1,000 to $3,000, according to various consultant estimates. Costs are higher if the mobile devices run many different applications or need to be integrated into back-end systems such as enterprise applications.

MANAGING SOFTWARE LOCALIZATION FOR GLOBAL BUSINESS

If you are operating a global company, all of the management issues we have just described will be affected by the need to create systems that can be realistically used by multiple business units in different countries. Although English has become a kind of standard business language, this is truer at higher levels of companies and not throughout the middle and lower ranks. Software may have to be built with local language interfaces before a new information system can be successfully implemented worldwide.

These interfaces can be costly and messy to build. Menu bars, commands, error messages, reports, queries, online data entry forms, and system documentation may need to be translated into all the languages of the countries where the system will be used. To be
truly useful for enhancing productivity of a global workforce, the software interfaces must be easily understood and mastered quickly. The entire process of converting software to operate in a second language is called software localization.

Global systems must also consider differences in local cultures and business processes. Cross-functional systems such as enterprise and supply chain management systems are not always compatible with differences in languages, cultural heritages, and business processes in other countries.

In a global systems environment, all of these factors add to the TCO and will influence decisions about whether to outsource or use technology service providers.

### 4.4 Hands-On MIS Projects

The projects in this section give you hands-on experience in developing solutions for managing IT infrastructures and IT outsourcing, using spreadsheet software to evaluate alternative desktop systems, and using Web research to budget for a sales conference.

#### MANAGEMENT DECISION PROBLEMS

1. The University of Pittsburgh Medical Center (UPMC) relies on information systems to operate 19 hospitals, a network of other care sites, and international and commercial ventures. Demand for additional servers and storage technology was growing by 20 percent each year. UPMC was setting up a separate server for every application, and its servers and other computers were running a number of different operating systems, including several versions of Unix and Windows. UPMC had to manage technologies from many different vendors, including Hewlett-Packard (HP), Sun Microsystems, Microsoft, and IBM. Assess the impact of this situation on business performance. What factors and management decisions must be considered when developing a solution to this problem?

2. Quantas Airways, Australia’s leading airline, faces cost pressures from high fuel prices and lower levels of global airline traffic. To remain competitive, the airline must find ways to keep costs low while providing a high level of customer service. Quantas had a 30-year-old data center. Management had to decide whether to replace its IT infrastructure with newer technology or outsource it. What factors should be considered by Quantas management when deciding whether to outsource? If Quantas decides to outsource, list and describe points that should be addressed in a service level agreement.

#### IMPROVING DECISION MAKING: USING A SPREADSHEET TO EVALUATE HARDWARE AND SOFTWARE OPTIONS

Software skills: Spreadsheet formulas
Business skills: Technology pricing

In this exercise, you will use spreadsheet software to calculate the cost of alternative desktop systems.

You have been asked to obtain pricing information on hardware and software for an office of 30 people. Using the Internet, get pricing for 30 PC desktop systems (monitors, computers, and keyboards) manufactured by Lenovo, Dell, and HP/Compaq as listed at their respective corporate Web sites. (For the purposes of this exercise, ignore the fact that desktop systems usually come with preloaded software packages.) Also obtain pricing on 15 black and white laser printers manufactured by HP and by Xerox. Each desktop system must satisfy the minimum specifications shown in the following table:
Each desktop printer must satisfy the minimum specifications shown in the following table:

<table>
<thead>
<tr>
<th>Minimum Laser Printer Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print speed</td>
</tr>
<tr>
<td>Print resolution</td>
</tr>
<tr>
<td>Network ready?</td>
</tr>
<tr>
<td>Maximum price/unit</td>
</tr>
</tbody>
</table>

After pricing the desktop systems and printers, obtain pricing on 30 copies of the most recent versions of Microsoft Office and Sun StarOffice desktop productivity packages, and on 30 copies of Microsoft Windows 7 Professional. The application software suite packages come in various versions, so be sure that each package contains programs for word processing, spreadsheet analysis, database analysis, graphics preparation, and e-mail.

Prepare a spreadsheet showing your research results for the desktop systems, for the printers, and for the software. Use your spreadsheet software to determine the desktop system, printer, and software combination that will offer both the best performance and pricing per worker. Because every two workers will share one printer (15 printers/30 systems), assume only half a printer cost per worker in the spreadsheet. Assume that your company will take the standard warranty and service contract offered by each product’s manufacturer.

**IMPROVING DECISION MAKING: USING WEB RESEARCH TO BUDGET FOR A SALES CONFERENCE**

Software skills: Internet-based software
Business skills: Researching transportation and lodging costs

In this exercise, you will use software at various online travel sites to arrange transportation and lodging for a large sales force to attend a sales conference at two alternative locations. You will use that information to calculate total travel and lodging costs and decide where to hold the conference.

The Foremost Composite Materials Company is planning a two-day sales conference for October 19–20, starting with a reception on the evening of October 18. The conference
consists of all-day meetings that the entire sales force, numbering 125 sales representatives and their 16 managers, must attend. Each sales representative requires his or her own room, and the company needs two common meeting rooms, one large enough to hold the entire sales force plus a few visitors (200) and the other able to hold half the force. Management has set a budget of $110,000 for the representatives’ room rentals. The hotel must also have such services as overhead and computer projectors, as well as business center and banquet facilities. It also should have facilities for the company reps to be able to work in their rooms and to enjoy themselves in a swimming pool or gym facility. The company would like to hold the conference in either Miami or Marco Island, Florida.

Foremost usually likes to hold such meetings in Hilton- or Marriott-owned hotels. Use the Hilton and Marriott Web sites to select a hotel in whichever of these cities that would enable the company to hold its sales conference within its budget.

Link to the two sites’ home pages, and search them to find a hotel that meets Foremost’s sales conference requirements. Once you have selected the hotel, locate flights arriving the afternoon prior to the conference because the attendees will need to check in the day before and attend your reception the evening prior to the conference. Your attendees will be coming from Los Angeles (54), San Francisco (32), Seattle (22), Chicago (19), and Pittsburgh (14). Determine costs of each airline ticket from these cities. When you are finished, create a budget for the conference. The budget will include the cost of each airline ticket, the room cost, and $60 per attendee per day for food.

- What was your final budget?
- Which did you select as the best hotel for the sales conference and why?

**LEARNING TRACKS**

The following Learning Tracks provide content relevant to topics covered in this chapter:

1. How Computer Hardware Works
2. How Computer Software Works
3. Service Level Agreements
4. Cloud Computing
5. The Open Source Software Initiative
6. Evolution of IT Infrastructure
7. Technology Drivers of IT Infrastructure Evolution
8. IT Infrastructure; Management Opportunities, Challenges, and Solutions

**Review Summary**

1. **What are the components of IT infrastructure?** IT infrastructure consists of the shared technology resources that provide the platform for the firm’s specific information system applications. Major IT infrastructure components include computer hardware, software, data management technology, networking and telecommunications technology, and technology services.
2 What are the major computer hardware, data storage, input, and output technologies used in business? Computers are categorized as mainframes, midrange computers, PCs, workstations, or supercomputers. Mainframes are the largest computers, midrange computers are servers, PCs are desktop or laptop machines, workstations are desktop machines with powerful mathematical and graphic capabilities, and supercomputers are sophisticated, powerful computers that can perform massive and complex computations rapidly. Computing power can be further increased by creating a computational grid that combines the computing power of all the computers on a network. In the client/server model of computing, computer processing is split between “clients” and “servers” connected via a network. The exact division of tasks between client and server depends on the application.

The principal secondary storage technologies are magnetic disk, optical disc, and magnetic tape. Optical CD-ROM and DVD discs can store vast amounts of data compactly and some types are rewritable. Storage area networks (SANs) connect multiple storage devices on a separate high-speed network dedicated to storage. The principal input devices are keyboards, computer mice, touch screens, magnetic ink and optical character recognition devices, pen-based instruments, digital scanners, sensors, audio input devices, and radio-frequency identification devices. The principal output devices are display monitors, printers, and audio output devices.

3 What are the major types of computer software used in business? The two major types of software are system software and application software. System software coordinates the various parts of the computer system and mediates between application software and computer hardware. Application software is used to develop specific business applications.

The system software that manages and controls the activities of the computer is called the operating system. Leading PC and server operating systems include Windows Vista, Windows 7, Windows Server 2008, UNIX, Linux, and the Macintosh operating system. Linux is a powerful, resilient open source operating system that can run on multiple hardware platforms and is used widely to run Web servers.

The principal programming languages used in business application software include COBOL, C, C++, and Visual Basic. Fourth-generation languages are less procedural than conventional programming languages and enable end users to perform many software tasks that previously required technical specialists. They include popular PC and cloud-based desktop productivity tools, such as word processing, spreadsheet, data management, presentation graphics, and Web browser software. Java is an operating-system- and hardware-independent programming language that is the leading interactive programming environment for the Web. HTML is a page description language for creating Web pages.

Web services are loosely coupled software components based on XML and open Web standards that can work with any application software and operating system. They can be used as components of Web-based applications to link the systems of two different organizations or to link disparate systems of a single company.

4 What are the most important contemporary hardware and software trends? Increasingly, computing is taking place on a mobile digital platform. Cloud computing provides hardware and software resources as services delivered over the Internet. In automatic computing, computer systems have capabilities for automatically configuring and repairing themselves. Open source software is proliferating because it allows users to modify the software at will and use it as a platform for new derivative applications. Mashups and widgets are the building blocks of new software applications and services using the cloud computing model. Software as a service (SaaS) delivers software remotely as an on-demand Web-based service.
What are the principal issues in managing hardware and software technology?
Managers and information systems specialists need to pay special attention to hardware capacity planning and scalability to ensure that the firm has enough computing power for its current and future needs. Businesses also need to balance the costs and benefits of building and maintaining their own hardware and software versus outsourcing or using an on-demand computing model. The total cost of ownership (TCO) of the organization’s technology assets includes not only the original cost of computer hardware and software but also costs for hardware and software upgrades, maintenance, technical support, and training, including the costs for managing and maintaining mobile devices. Companies with global operations need to manage software localization.

Key Terms

<table>
<thead>
<tr>
<th>Technology</th>
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<tbody>
<tr>
<td>Ajax</td>
<td>138</td>
</tr>
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</tr>
<tr>
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<td>118</td>
</tr>
<tr>
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<td>127</td>
</tr>
<tr>
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<td>134</td>
</tr>
<tr>
<td>C++</td>
<td>134</td>
</tr>
<tr>
<td>Capacity planning</td>
<td>142</td>
</tr>
<tr>
<td>CD-ROM (compact disc read-only memory)</td>
<td>122</td>
</tr>
<tr>
<td>Centralized processing</td>
<td>120</td>
</tr>
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<td>Client</td>
<td>120</td>
</tr>
<tr>
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<td>121</td>
</tr>
<tr>
<td>Cloud computing</td>
<td>125</td>
</tr>
<tr>
<td>Data management software</td>
<td>118</td>
</tr>
<tr>
<td>Digital video disc (DVD)</td>
<td>122</td>
</tr>
<tr>
<td>Distributed processing</td>
<td>120</td>
</tr>
<tr>
<td>Extensible Markup Language (XML)</td>
<td>139</td>
</tr>
<tr>
<td>Fourth-generation languages</td>
<td>134</td>
</tr>
<tr>
<td>Graphical user interface (GUI)</td>
<td>130</td>
</tr>
<tr>
<td>Grid computing</td>
<td>120</td>
</tr>
<tr>
<td>Hypertext Markup Language (HTML)</td>
<td>138</td>
</tr>
<tr>
<td>Input devices</td>
<td>122</td>
</tr>
<tr>
<td>Java</td>
<td>137</td>
</tr>
<tr>
<td>Legacy systems</td>
<td>119</td>
</tr>
<tr>
<td>Linux</td>
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</tr>
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</tr>
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<td>Magnetic tape</td>
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<td>Mainframe</td>
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<tr>
<td>Nanotechnology</td>
<td>124</td>
</tr>
<tr>
<td>Netbooks</td>
<td>124</td>
</tr>
<tr>
<td>N-tier client/server architectures</td>
<td>121</td>
</tr>
<tr>
<td>Object</td>
<td>134</td>
</tr>
<tr>
<td>Office 2010</td>
<td>137</td>
</tr>
<tr>
<td>Offshore software outsourcing</td>
<td>144</td>
</tr>
<tr>
<td>On-demand computing</td>
<td>126</td>
</tr>
<tr>
<td>Open-source software</td>
<td>133</td>
</tr>
<tr>
<td>Operating system</td>
<td>130</td>
</tr>
<tr>
<td>Output devices</td>
<td>122</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>143</td>
</tr>
<tr>
<td>Personal computer (PC)</td>
<td>119</td>
</tr>
<tr>
<td>Presentation graphics software</td>
<td>137</td>
</tr>
<tr>
<td>Query languages</td>
<td>132</td>
</tr>
<tr>
<td>SaaS (software as a service)</td>
<td>142</td>
</tr>
<tr>
<td>Scalability</td>
<td>142</td>
</tr>
<tr>
<td>Server</td>
<td>119</td>
</tr>
<tr>
<td>Service level agreement (SLA)</td>
<td>144</td>
</tr>
<tr>
<td>Service-oriented architecture (SOA)</td>
<td>139</td>
</tr>
<tr>
<td>Software package</td>
<td>135</td>
</tr>
<tr>
<td>Spreadsheet software</td>
<td>136</td>
</tr>
<tr>
<td>Storage area networks (SANs)</td>
<td>122</td>
</tr>
<tr>
<td>Supercomputer</td>
<td>120</td>
</tr>
<tr>
<td>System software</td>
<td>118</td>
</tr>
<tr>
<td>Total cost of ownership (TCO)</td>
<td>143</td>
</tr>
<tr>
<td>UNIX</td>
<td>131</td>
</tr>
<tr>
<td>Virtualization</td>
<td>127</td>
</tr>
<tr>
<td>Visual Basic</td>
<td>134</td>
</tr>
<tr>
<td>Visual programming language</td>
<td>134</td>
</tr>
<tr>
<td>Web browsers</td>
<td>137</td>
</tr>
<tr>
<td>Web hosting service</td>
<td>144</td>
</tr>
<tr>
<td>Web server</td>
<td>121</td>
</tr>
<tr>
<td>Web services</td>
<td>138</td>
</tr>
<tr>
<td>Widget</td>
<td>141</td>
</tr>
<tr>
<td>Windows 7</td>
<td>131</td>
</tr>
<tr>
<td>Windows Vista</td>
<td>131</td>
</tr>
<tr>
<td>Word processing software</td>
<td>135</td>
</tr>
<tr>
<td>Workstation</td>
<td>119</td>
</tr>
</tbody>
</table>

Review Questions

1. What are the components of IT infrastructure?
   - Define information technology (IT) infrastructure and describe each of its components.

2. What are the major computer hardware, data storage, input, and output technologies used in business?
   - List and describes the various type of computers available to businesses today.
   - Define the client/server model of computing, and describe the difference between a two-tiered and n-tier client/server architecture.
   - List the most important secondary storage media and the strengths and limitations of each.
   - List and describe the major computer input and output devices.
3. What are the major types of computer software used in business?
   • Distinguish between application software and system software, and explain the role played by the operating system of a computer.
   • List and describe the major PC and server operating systems.
   • Name and describe each category of fourth-generation software tools, and explain how fourth-generation languages differ from conventional programming languages.
   • Name and describe the major desktop productivity software tools.
   • Explain how Java and HTML are used in building applications for the Web.
   • Define Web services, describe the technologies they use, and explain how Web services benefit businesses.

4. What are the most important contemporary hardware and software trends?
   • Define and describe the mobile digital platform, nanotechnology, grid computing, cloud computing, autonomic computing, virtualization, and multicore processing.
   • Explain why open source software is so important today and its benefits for business.
   • List and describe cloud computing software services, mashups, and widgets, and explain how they benefit individuals and businesses.

5. What are the principal issues in managing hardware and software technology?
   • Explain why managers need to pay attention to capacity planning and scalability of technology resources.
   • Describe the cost components used to calculate the TCO of technology assets.
   • Identify the benefits and challenges of using outsourcing, cloud computing services, and mobile platforms.
   • Explain why software localization has become an important management issue for global companies.

Discussion Questions

1. Why is selecting computer hardware and software for the organization an important business decision? What people, organization, and technology issues should be considered when selecting computer hardware and software?

2. Should organizations use software service providers (including cloud services) for all their software needs? Why or why not? What people, organization, and technology factors should be considered when making this decision?

Video Cases

Video Cases and Instructional Videos illustrating some of the concepts in this chapter are available. Contact your instructor to access these videos.

Collaboration and Teamwork

Evaluating Server and Mobile Operating Systems

Form a group with three or four of your classmates. Choose server or mobile operating systems to evaluate. You might research and compare the capabilities and costs of Linux versus the most recent version of the Windows operating system for servers or versus UNIX. Alternatively, you could compare the capabilities of the Android mobile operating system with the Symbian operating system or either of these with the most recent version of the iPhone operating system (iPhone OS). If possible, use Google Sites to post links to Web pages, team communication announcements, and work assignments; to brainstorm; and to work collaboratively on project documents. Try to use Google Docs to develop a presentation of your findings for the class.
Salesforce.com Inc., one of the most disruptive technology companies of the past few years, has shaken up the software industry with its innovative business model and resounding success. Salesforce provides customer relationship management (CRM) and other application software solutions in the form of ‘software as a service’ (SaaS) leased over the Internet, as opposed to software bought and installed on machines locally.

The company was founded in 1999 by former Oracle executive Marc Benioff, and has since grown to 2,600 employees and generated $1.077 billion in revenue in 2009, making it one of the top 50 software companies in the world. Salesforce.com has over 55,000 corporate customers and over 1.5 million subscribers. Salesforce.com attributes its success to the many benefits of its on-demand model of software distribution.

The on-demand model eliminates the need for large up-front capital investments in systems and lengthy implementations on corporate computers. Subscriptions start as low as $9 per user per month for the pared-down Group version for small sales and marketing teams, with monthly subscriptions for more advanced versions for large enterprises starting around $65 per user.

For example, the Minneapolis-based Haagen-Dazs Shoppe owned by Nestle USA calculated it would have had to spend $65,000 for a custom-designed database to help management stay in contact with the company’s retail franchises. The company only had to pay $20,000 to establish service with Salesforce, plus a monthly charge of $125 per month for 20 users to use wireless handhelds or the Web to remotely monitor all the Haagen-Dazs franchises across the United States.

Salesforce.com implementations take three months at the longest, and usually less than a month. There is no hardware for subscribers to purchase, scale, and maintain. There are no operating systems, database servers, or application servers to install, no consultants and staff, and no expensive licensing and maintenance fees. The system is accessible via a standard Web browser, and Salesforce.com continually updates its software behind the scenes. There are tools for customizing some features of the software to support a company’s unique business processes. Subscribers do not have to make huge up-front hardware and software investments. They can leave if business turns sour or a better system comes along. If they lay people off, they can cut down on the number of Salesforce subscriptions they buy.

Salesforce faces significant challenges as it continues to grow and refine its business. The first challenge comes from increased competition, both from traditional industry leaders and new challengers hoping to replicate Salesforce’s success. Microsoft, SAP, and Oracle have rolled out subscription-based versions of their CRM products in response to Salesforce. Smaller competitors like NetSuite, Salesboom.com, and RightNow also have made some inroads against Salesforce’s market share.

Salesforce still has plenty of catching up to do to reach the size and market share of its larger competitors. As recently as 2007, SAP’s market share was nearly four times as large as Salesforce.com’s, and IBM’s customer base includes 9,000 software companies that run their applications on IBM software and that are likelier to choose a solution offered by IBM over Salesforce.com.

Salesforce needs to continually prove to customers that it is reliable and secure enough to remotely handle their corporate data and applications. The company has experienced a number of service outages, the most recent of which occurred in early 2009. On January 6, a core network device failed and prevented data in Europe, Japan, and North America from being processed for 38 minutes. Over 177 million transactions were affected. While most of Salesforce’s customers accept that IT services provided through the cloud are going to be available slightly less than full time, some customers and critics used the outage as an opportunity to question the soundness of the entire concept of cloud computing. In February, a similar outage occurred, affecting Europe and as well as North America a few hours later.

Thus far, Salesforce.com has experienced only one security breach. In November 2007, a Salesforce employee was the victim of a phishing attack and divulged his corporate password to scammers, exposing Salesforce’s customer list. Salesforce clients were subjected to a barrage of highly targeted scams and hacking attempts that appeared authentic. Although this incident raised a red flag, many customers reported that Salesforce’s handling of the situation was satisfactory. All of Salesforce’s major customers regularly send auditors to Salesforce to check security.

Another challenge for Salesforce.com is to expand its business model into other areas. Salesforce is currently used mostly by sales staff needing to keep track of leads and customer lists. One way the company is trying to provide additional functionality is through a partnership with Google and more specifically Google Apps. Salesforce.com is combining its services with Gmail, Google Docs, Google Talk, and Google Calendar to allow its customers to accomplish more tasks via the

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**BUSINESS PROBLEM-SOLVING CASE**

**Salesforce.Com: Cloud Software Services Go Mainstream**

Salesforce.com is combining its services with Gmail, Google Talk, and Google Calendar to provide additional functionality is through a partnership with Google and more specifically Google Apps. Salesforce.com is combining its services with Gmail, Google Docs, Google Talk, and Google Calendar to allow its customers to accomplish more tasks via the...
Web. Salesforce also introduced a development tool for integrating with Facebook’s social network. Customers are able to build applications that call functions at the Facebook site.

Salesforce has partnered with Apple to distribute its applications for use on its iPhone. The company hopes that it can tap into the large market of iPhone users, pitching the ability to use Salesforce applications anytime, anywhere.

The partnership between Salesforce.com and Google represents a united front against Microsoft, intended to cut into the popularity of Microsoft Office. Currently, Salesforce.com describes the partnership as “primarily a distribution deal,” but it could grow stronger based on the idea that businesses prefer to manage customer relationship management and related activities in one place. Salesforce.com and Google both hope that their Salesforce.com for Google Apps initiative will galvanize further growth in on-demand software.

In February 2009, rumors swirled that Oracle was poised to acquire Salesforce. Pundits speculated that the deal was a good one for Oracle because it would take too long to grow its SaaS offerings to the scale that Salesforce had already achieved. Thus far, no such deal has materialized, but some industry observers expect that at some point, Oracle will in fact end up buying Salesforce.

In order to grow its revenues to the levels that industry observers and Wall Street eventually expects, Salesforce will need to change its focus from selling a suite of software applications to providing a broader cloud computing “platform” on which many software companies can deliver applications. As CEO Marc Benioff put it, over the past decade, “we focused on software as a service.” In the next decade, Salesforce.com “will really be focused on the platform as a service.”

The company has intensified its efforts to provide cloud computing offerings to its customers. The new Salesforce.com Web site places much more emphasis on cloud computing, grouping products into three types of clouds: the Sales Cloud, the Service Cloud, and the Custom Cloud. The Sales and Service clouds consist of applications meant to improve sales and customer service, respectively, but the Custom Cloud is another name for the Force.com application development platform, where customers can develop their own applications for use within the broader Salesforce network.

Force.com provides a set of development tools and IT services that enable users to customize their Salesforce.com customer relationship management applications or to build entirely new applications and run them “in the cloud” on Salesforce.com’s data center infrastructure. Salesforce opened up Force.com to other independent software developers and listed their programs on its AppExchange.

Using AppExchange, small businesses can go online and easily download over 800 software applications, some add-ons to Salesforce.com and others that are unrelated, even in non-customer-facing functions such as human resources. Force.com Sites, based on the Force.com development environment, enables users to develop Web pages and register domain names. Pricing is based on site traffic.

Salesforce.com’s cloud infrastructure includes two data centers in the United States and a third in Singapore, with others in Europe and Japan planned for the future. Salesforce.com has additionally partnered with Amazon to enable Force.com customers to tap into Amazon’s cloud computing services (Elastic Compute Cloud and Simple Storage Service.) Amazon’s services handle “cloudburst computing” tasks of Force.com applications that require extra processing power or storage capacity.

Author Solutions, based in Bloomington, Minnesota, uses the Force.com platform to host the applications behind its operations and expand its library of ideas. Authors.com is the largest self-publishing company in the world and published 24,000 titles in 2008, with $100 million in annual revenue and 400 employees. This business is growing at a blistering rate, and had acquired several other companies. It was struggling to manage two databases, two e-commerce systems, and three workflow systems to support its three brands. Senior management decided to consolidate on a single platform.

Salesforce.com was selected for that platform. Author Solutions appreciated the cost savings of up to 75 percent from not having to maintain and manage its own data center and the ability to scale as the company mushroomed. Workflow modifications that once took 30 to 120 hours are accomplished in one-fourth the time. The time and cost for adding a new product, which used to take 120 to 240 hours (and cost $6,000 to $12,000) has been reduced by 75 percent. Within five months after signing with Salesforce, Author Solutions was running its new “publishing enterprise resource planning system,” which coordinates all of the processes involved in sourcing and publishing a book—lead tracking, handling of editorial submissions, and corrections. The new platform is able to handle 30 percent more work volume than the old systems with the same number of employees.

The question is whether the audience for Salesforce’s AppExchange and Force.com platforms will prove large enough to deliver the level of growth Salesforce wants. It still isn’t clear whether the company will generate the revenue it needs to provide cloud computing services on the same scale as Google
or Amazon, and also make its cloud computing investments pay off.

Some analysts believe the platform may not be attractive to larger companies for their application needs. Yet another challenge is providing constant availability. Salesforce.com subscribers depend on the service being available 24/7. But thanks to the previously described outages, many companies have rethought their dependency on SaaS. Salesforce.com provides tools to assure customers about its system reliability and also offers PC applications that tie into their services so users can work offline.

Still, a number of companies are reluctant to jump on the SaaS and cloud computing bandwagon. Moreover, it is still not clear whether software delivered over the Web will cost less in the long run. According to Gartner analyst Rob DiSisto, it may be less expensive to subscribe to Salesforce.com’s software services for the first few years, but what happens after that? Will the costs of upgrading and managing on-demand software exceed the savings from using Salesforce.com’s services?

Case Study Questions

1. What are the advantages and disadvantages of the cloud computing model?
2. What are some of the challenges facing Salesforce as it continues its growth? How well will it be able to meet those challenges?
3. What kinds of businesses could benefit from switching to Salesforce and why?
4. What factors would you take into account in deciding whether to use Salesforce.com for your business?