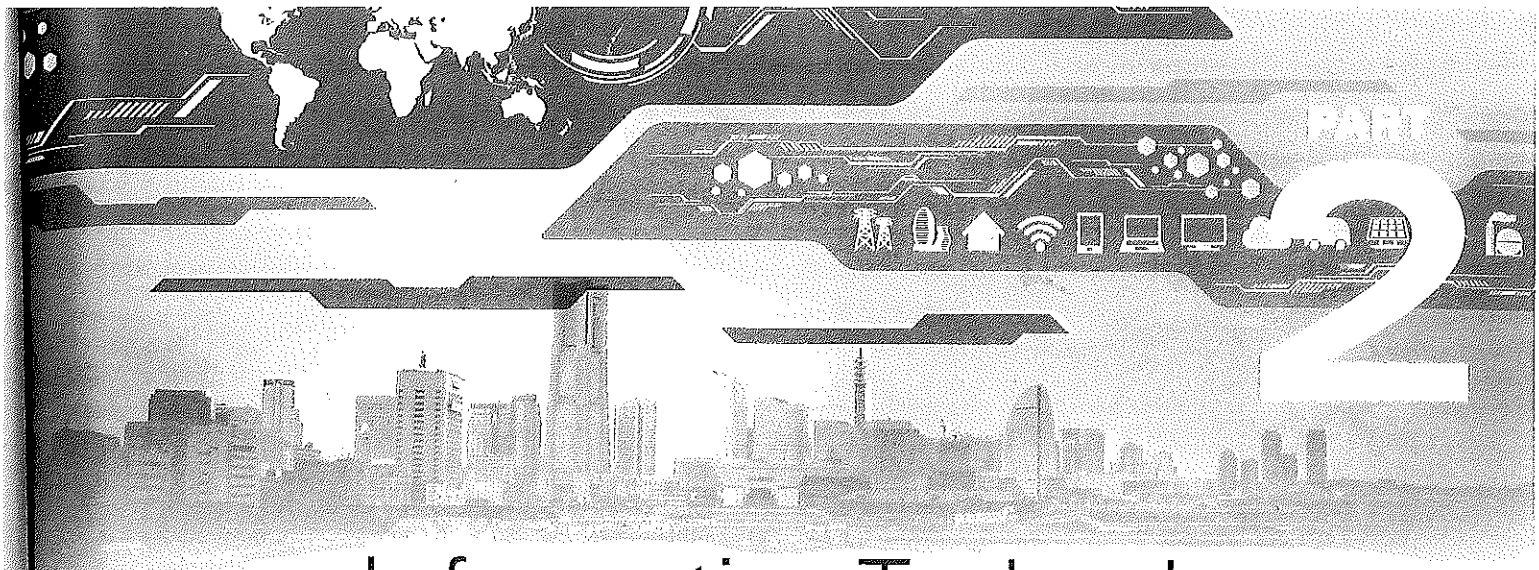


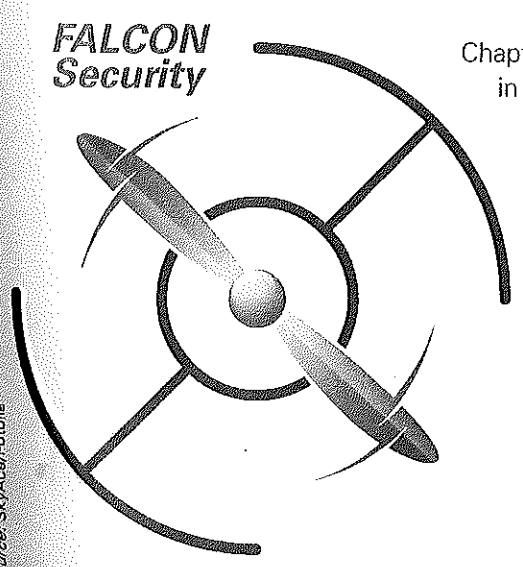
PART 2

Information Technology

The next three chapters address the technology that underlies information systems. You may think that such technology is unimportant to you as a business professional. However, as you will see, today's managers and business professionals work with information technology all the time as consumers, if not in a more involved way.

Chapter 4 discusses hardware, software, and open source alternatives and defines basic terms and fundamental computing concepts. It briefly touches on new developments in the Internet of Things, augmented reality, self-driving cars, and 3D printing. It also looks at the importance of Web applications and mobile systems.

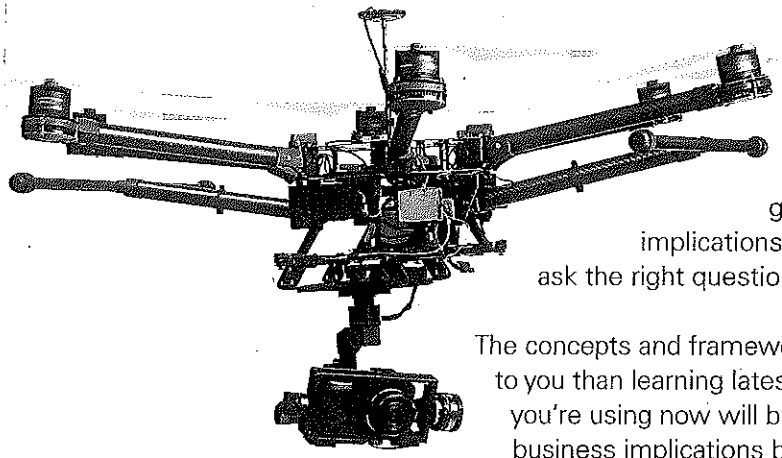
Chapter 5 addresses the data component of information systems by describing database processing. You will learn essential database terminology and will be introduced to techniques for processing databases. We will also introduce data modeling because you may be required to evaluate data models for databases that others develop for you.



Source: SkyAce/Fotolia

Chapter 6 continues the discussion of computing devices begun in Chapter 4 and describes data communications, Internet technologies, and cloud-based services. It looks at how organizations can use the cloud effectively and addresses potential security problems that may come from using the cloud.

The purpose of these three chapters is to teach technology sufficient for you to be an effective IT consumer, like Mateo, Joni, Cam, and Alexis at Falcon Security. You will learn basic terms, fundamental concepts, and useful frameworks so that you will have the knowledge to ask good questions and make appropriate requests of the information systems professionals who will serve you.



Source: Alexander Kolomietz/Fotolia

It's difficult to stay up to date on the latest technology changes because things are changing so quickly. Every year, a slew of new innovations come out. Some of them may represent real threats to your organization's strategy. Others may represent potential new opportunities for growth. It's important to be able to understand the strategic implications these new technologies represent. You need to be able to ask the right questions.

The concepts and frameworks presented in these chapters will be far more useful to you than learning latest technology trends. Trends come and go. The technology you're using now will be outdated in 10 years. Understanding how to assess the business implications behind any new innovation will be a benefit to you through your entire career.

CHAPTER 4

Hardware, Software, and Mobile Systems

Cam Forset, the operations manager of Falcon Security, asked Mateo Thomas, CEO, Joni Campbell, CFO, and Alexis Moore, head of sales, to come down to the small hangar bay to see how the testing of the new 3D-printed drone is coming along. Mateo asked Cam to investigate the possibility of using 3D-printed parts to make drones in-house rather than buy them from vendors. This could be a tremendous cost-savings opportunity and give the company greater flexibility in updating its current fleet of drones.

Cam waves to Mateo and Joni to come over and look at the screen that she and Alexis are looking at. The screen is showing a live video feed from the new drone as it flies around the perimeter of the building.

"Well, it works—sort of," Cam says to Mateo and Joni with a forced smile. "It's *pretty* stable, and we can get streaming video. I just wish it hadn't taken 2 weeks to get it running." Cam's voice has an undeniably displeased tone.

"That's OK. What was the total cost to make it?" Mateo asks.

"Well, this specific quad cost nearly nothing. We harvested all of the internals from a couple broken quads we had lying around. Everything else we printed." Cam points to a rack of dismantled quadcopters. "We found some free designs on the Web, but we had to make some changes so they would work with our internals."

"Well, that's good news, isn't it?" Mateo asks.

"Well, not really," Cam says with a skeptical tone. "If we wanted to build more drones, we'd need to harvest more parts from existing drones or buy generic parts and try to see if they'll work together."

Joni and Mateo both look confused. Mateo shakes his head and asks, "Well, why didn't you build it with generic parts in the first place?"

"Honestly, we weren't sure we could make it work even if we used existing internal components. I've never *made* a quadcopter before," Cam says flatly. "We ended up printing about 20 parts, but we still needed motors, a speed controller, a flight control board, a radio transmitter and receiver, propellers, batteries, and a charger."

"We also needed to make sure it could integrate with our internal systems. We didn't want to start experimenting with generic components until we knew we could actually make a quad that could fly," she adds.

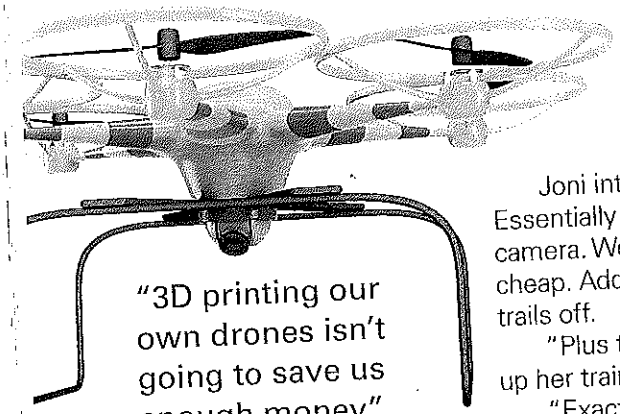
"So your next step is to take out the existing internal components and replace them with generic parts to see if they will work, right?" Mateo asks.

"Well..." Cam starts to say.

Joni interrupts, "It probably won't matter if the generic components work or not. Essentially we've just replaced the frame, skids, and a few other parts to hold the camera. We still have to buy the other nonprintable component parts. Those won't be cheap. Add in the additional labor costs to assemble and test each quad..." she trails off.

"Plus the time and labor to integrate them with our internal systems," Alexis picks up her train of thought. "It won't be easy or cheap."

"Exactly," Cam says. "3D printing our own drones isn't going to save us enough money. There aren't enough parts that can be replaced. Yes, the passive recharging platform we developed using 3D-printed parts was a huge success. It has allowed us to automate the recharging process and extend the reach of our drones. But I just don't think 3D printing our own drones is going reduce our hardware costs enough to justify us becoming a drone manufacturer."



"3D printing our own drones isn't going to save us enough money."

Image source: rommma/Fotolia

Study QUESTIONS

- **Q4-1** What do business professionals need to know about computer hardware?
- **Q4-2** How can new hardware affect competitive strategies?
- **Q4-3** What do business professionals need to know about software?
- **Q4-4** Is open source software a viable alternative?
- **Q4-5** What are the differences between native and Web applications?
- **Q4-6** Why are mobile systems increasingly important?
- **Q4-7** What are the challenges of personal mobile devices at work?
- **Q4-8** 2027?

Mateo looks disappointed. "Well, maybe you're right. I really wish there was some way to make it work. It just seems like we keep burning through cash buying dozens of drones that become obsolete in a few years. It's really frustrating being on the cutting edge."

"You mean the bleeding edge...right?" Joni says with a smirk.

Chapter PREVIEW

What would you do if you were Mateo? Or Joni? Would you go ahead and build your own customized drones? It might give you a unique competitive advantage down the road. You might be able to hire someone who is an expert at building drones and save a lot of money. Is Cam being too conservative? If you're wondering why, as a future business professional, you need to know about hardware and software, think about those questions. Those and others of greater complexity—most likely ones involving technology that will be invented between now and the time you start working—will come your way.

You don't need to be an expert. You don't need to be a hardware engineer or a computer programmer. You do need to know enough, however, to be an effective consumer. You need the knowledge and skills to ask important, relevant questions and understand the answers.

We begin with basic hardware concepts and how innovations in hardware could affect businesses. Next, we will discuss software concepts, open source software development, and the differences between native and Web applications. Following that, we'll discuss the importance of mobile systems and the challenges created when employees bring their computers to work. Finally, we'll wrap up by forecasting trends in hardware and software in 2027.

Q4-1 What Do Business Professionals Need to Know About Computer Hardware?

Most people think of computer hardware as a laptop, a desktop, a server, or maybe even a tablet. As time passes, the way we think of computer hardware is changing. Take phones as an example. Twenty-five years ago, they were strictly used for voice communication. No one would have considered a phone a piece of computer hardware.

Fast-forward to today. Smartphones have substantial processing power, the ability to connect to networks, internal memory, and virtual keyboards and can interconnect with other devices. Now a "phone" is essentially a powerful piece of computing hardware. Computing hardware is also being integrated into other devices such as watches, glasses, TVs, cars, and even toothbrushes.

Computer hardware consists of electronic components and related gadgetry that input, process, output, and store data according to instructions encoded in computer programs or software. All hardware today has more or less the same components, at least to the level that is important to us. We'll begin with those components, and then we'll quickly survey basic types of computers.

Hardware Components

Every computer has a **central processing unit (CPU)**, which is sometimes called "the brain" of the computer. Although the design of the CPU has nothing in common with the anatomy of animal brains, this description is helpful because the CPU does have the "smarts" of the machine.

The CPU selects instructions, processes them, performs arithmetic and logical comparisons, and stores results of operations in memory. Some computers have two or more CPUs. A computer with two CPUs is called a **dual-processor** computer. **Quad-processor** computers have four CPUs. Some high-end computers have 16 or more CPUs.

CPUs vary in speed, function, and cost. Hardware vendors such as Intel, Advanced Micro Devices, and National Semiconductor continually improve CPU speed and capabilities while reducing CPU costs (as discussed under Moore's Law in Chapter 1). Whether you or your department needs the latest, greatest CPU depends on the nature of your work.

The CPU works in conjunction with **main memory**. The CPU reads data and instructions from memory and then stores the results of computations in main memory. Main memory is sometimes called **RAM**, for random access memory.

All computers include **storage hardware**, which is used to save data and programs. Magnetic disks (also called hard disks) are the most common storage device. **Solid-state storage (SSD)** (or an SSD drive) is much faster than traditional magnetic storage because it stores information using nonvolatile electronic circuits. SSD drives are gaining in popularity but are several times more expensive than magnetic hard disks. USB flash drives are small, portable solid-state storage devices that can be used to back up data and transfer it from one computer to another. Optical disks such as CDs and DVDs are also popular portable storage media.

Types of Hardware

Figure 4-1 lists the basic types of hardware. **Personal computers** (PCs) are classic computing devices that are used by individuals. In the past, PCs were the primary computer used in business. Today, they are gradually being supplanted by tablets and other mobile devices. The Mac Pro is an example of a modern PC. Apple brought **tablets** to prominence with the iPad. In 2012, Microsoft announced Surface and Google announced the Nexus series, all tablets. Smartphones are cell phones with processing capability; the Samsung Galaxy S7 is a good example. Today, because it's hard to find a cell phone that isn't "smart," people often just call them phones.

A **server** is a computer that is designed to support processing requests from many remote computers and users. A server is essentially a PC on steroids. A server differs from a PC principally because of what it does. The relationship between PCs and servers is similar to the relationship between clients and servers at a typical restaurant. Servers take requests from clients and then bring them things. In restaurants this is food and silverware. In computing environments servers can send Web pages, email, files, or data to PCs. PCs, tablets, and smartphones that access servers are called **clients**. As of 2017, a good example of a server is the Dell PowerEdge server.

Finally, a **server farm** is a collection of, typically, thousands of servers. (See Figure 4-2.) Server farms are often placed in large truck trailers that hold 5,000 servers or more. Typically a trailer has two large cables coming out of it; one is for power, and the other is for data communications. The operator of the farm backs a trailer into a pre-prepared slab (in a warehouse or sometimes out in the open air), plugs in the power and communications cables, and, voilà, thousands of servers are up and running!

Hardware Type	Example (s)
Personal computer (PC) *Including desktops and laptops*	Apple Mac Pro
Tablet *Including e-book readers*	iPad, Microsoft Surface, Google Nexus, Kindle Fire
Smartphone	Samsung Galaxy, iPhone
Server	Dell PowerEdge Server
Server farm	Racks of servers (Figure 4-2)

FIGURE 4-1
Basic Types of Hardware

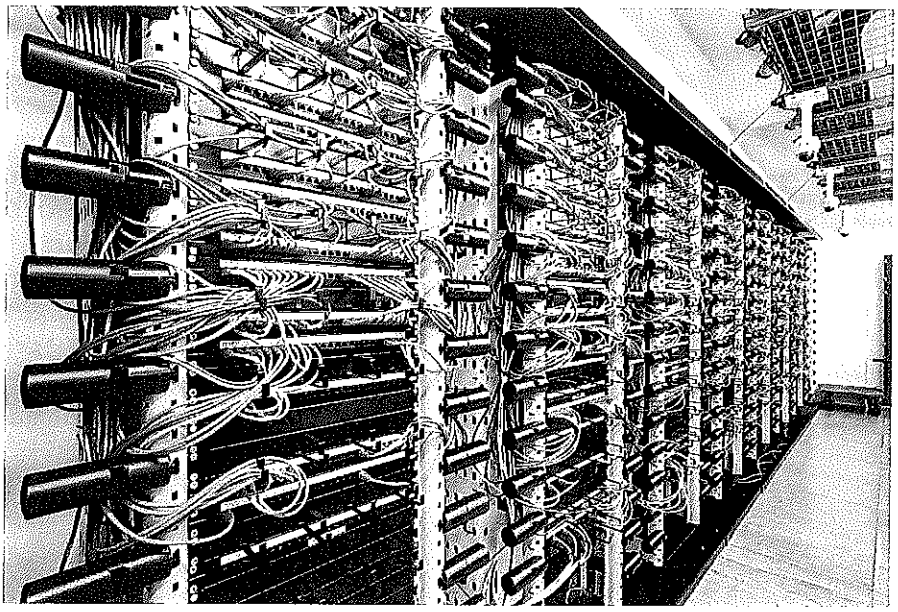


FIGURE 4-2
Server Farm
Source: © Andrew Twort/Alamy

Increasingly, server infrastructure is delivered as a service via the Internet that is often referred to as *the cloud*. We will discuss cloud computing in Chapter 6, after you have some knowledge of data communications.

The capacities of computer hardware are specified according to data units, which we discuss next.

Computer Data

Computers represent data using **binary digits**, called **bits**. A bit is either a zero or a one. Bits are used for computer data because they are easy to represent physically, as illustrated in Figure 4-3. A switch can be either closed or open. A computer can be designed so that an open switch represents zero and a closed switch represents one. Or the orientation of a magnetic field can represent a bit: magnetism in one direction represents a zero; magnetism in the opposite direction represents a one. Or, for optical media, small pits are burned onto the surface of the disk so that they will reflect light. In a given spot, a reflection means a one; no reflection means a zero.

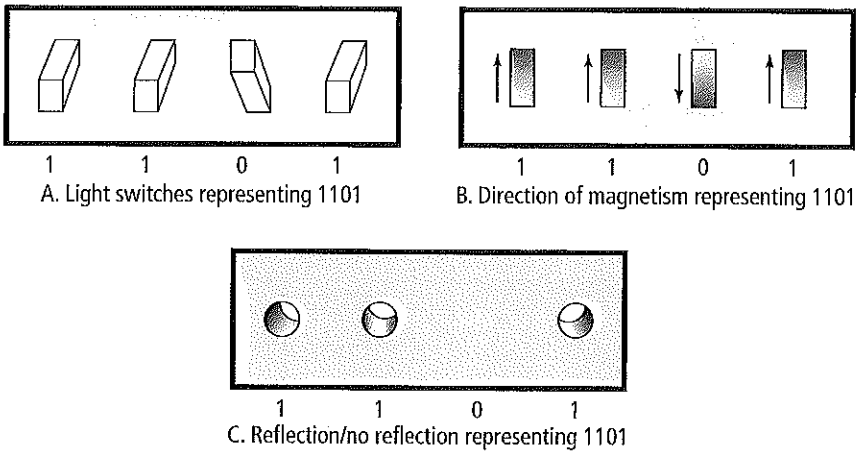


FIGURE 4-3
Bits Are Easy to Represent Physically

Computer Data Sizes

All forms of computer data are represented by bits. The data can be numbers, characters, currency amounts, photos, recordings, or whatever. All are simply a string of bits. For reasons that interest many but are irrelevant for future managers, bits are grouped into 8-bit chunks called **bytes**. For character data, such as the letters in a person's name, one character will fit into one byte. Thus, when you read a specification that a computing device has 100 million bytes of memory, you know that the device can hold up to 100 million characters.

Bytes are used to measure sizes of noncharacter data as well. Someone might say, for example, that a given picture is 100,000 bytes in size. This statement means the length of the bit string that represents the picture is 100,000 bytes or 800,000 bits (because there are 8 bits per byte).

The specifications for the size of main memory, disk, and other computer devices are expressed in bytes. Figure 4-4 shows the set of abbreviations that are used to represent data storage capacity. A **kilobyte**, abbreviated **KB**, is a collection of 1,024 bytes. A **megabyte**, or **MB**, is 1,024 kilobytes. A **gigabyte**, or **GB**, is 1,024 megabytes; a **terabyte**, or **TB**, is 1,024 gigabytes; a **petabyte**, or **PB**, is 1,024 terabytes; an **exabyte**, or **EB**, is 1,024 petabytes; and a **zettabyte**, or **ZB**, is 1,024 exabytes. Sometimes you will see these definitions simplified as 1KB equals 1,000 bytes and 1MB equals 1,000K, and so on. Such simplifications are incorrect, but they do ease the math.

To put these sizes in perspective consider that Walmart processes about 40 PB worth of customer data per day.[1] Facebook processes about 600 TB each day, in a 300PB data warehouse.[2] The super-secret NSA data center in Utah is estimated to hold about 12 EB of data.[3] And Cisco estimates that annual global Internet traffic volume will exceed 2.0 ZB by the end of 2019.[4]

Specifying Hardware with Computer Data Sizes

Computer disk capacities are specified according to the amount of data they can contain. Thus, a 500GB disk can contain up to 500GB of data and programs. There is some overhead, so it is not quite 500GB, but it's close enough.

You can purchase computers with CPUs of different speeds. CPU speed is expressed in cycles called *hertz*. In 2016, a slow personal computer had a speed of 3.0 Gigahertz. A fast personal computer had a speed of 3.5+ Gigahertz, with multiple processors. An employee who does only simple tasks such as word processing does not need a fast CPU; a 2.0 Gigahertz CPU will be fine. However, an employee who processes large, complicated spreadsheets or who manipulates large database files or edits large picture, sound, or video files needs a fast computer like a dual processor with 3.5 Gigahertz or more. Employees whose work requires them to use many large applications at the same time need 12 GB or more of RAM. Others can do with less.

One last comment: The cache and main memory are **volatile**, meaning their contents are lost when power is off. Magnetic and optical disks are **nonvolatile**, meaning their contents survive when power is off. If you suddenly lose power, the contents of unsaved memory—say, documents

Term	Definition	Abbreviation
Byte	Number of bits to represent one character	
Kilobyte	1,024 bytes	KB
Megabyte	1,024 KB = 1,048,576 bytes	MB
Gigabyte	1,024 MB = 1,073,741,824 bytes	GB
Terabyte	1,024 GB = 1,099,511,627,776 bytes	TB
Petabyte	1,024 TB = 1,125,899,906,842,624 bytes	PB
Exabyte	1,024 PB = 1,152,921,504,606,846,976 bytes	EB
Zettabyte	1,024 EB = 1,180,591,620,717,411,303,424 bytes	ZB

FIGURE 4-4
Important Storage-Capacity Terminology

that have been altered—will be lost. Therefore, get into the habit of frequently (every few minutes or so) saving documents or files that you are changing. Save your documents before your roommate trips over the power cord.

Q4-2 How Can New Hardware Affect Competitive Strategies?

Organizations are interested in new hardware because they represent potential opportunities, or threats, to their ability to generate revenue. It's important to keep an eye on new tech hardware for the same reason you watch the weather forecast. You care about how the future will affect you.

Below we will look at four new hardware developments that have the potential to disrupt existing organizations.

Internet of Things

The first disruptive force that has the power to change business is the **Internet of Things (IoT)**. This is the idea that objects are becoming connected to the Internet so they can interact with other devices, applications, or services. Everyday objects are being embedded with hardware capable of sensing, processing, and transmitting data. Objects can then connect to a network and share data with any other application, service, or device.

Take your mobile phone, for example; it's probably a smartphone. But it wasn't always "smart." It started out as a simple device that just handled voice calls. Over time it became a **smart device** by adding more processing power, more memory, Internet access, Wi-Fi connectivity, and the ability to interconnect with other devices and applications (Figure 4-5). People began to use their mobile phones much differently than before. It also changed the way businesses operate. In 2015, *Amazon.com* reported that more than 70 percent of its customers shopped using a mobile device.[5]

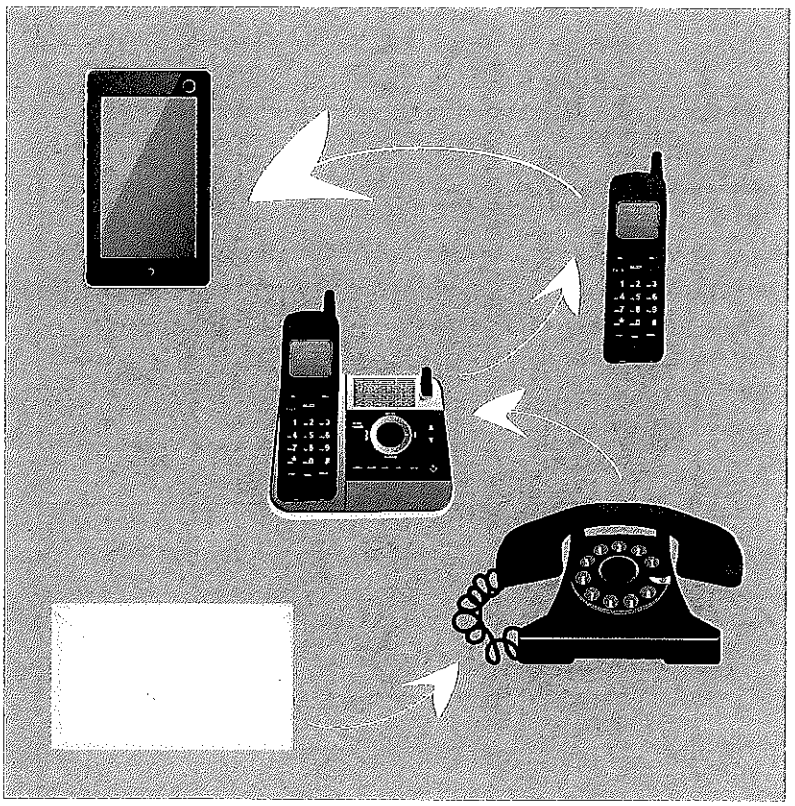


FIGURE 4-5
Smartphone Development
Source: Grgroup/Fotolia

What happens when other devices become smart? How would your life change if you had access to a smart car, smart home appliances, or an entire smart building? Within a few short decades it's possible that you could interact with nearly every object around you from your smartphone. In fact, your devices will be able to talk to other devices, anticipate your actions, make changes, and configure themselves.

This shift away from "dumb" devices to interconnected smart devices is not lost on businesses. Consumers like smart devices and are willing to pay more for them. Businesses want to improve the existing devices they manufacture into a smart devices and then sell them for twice as much. If they don't, someone else will.

The iPhone, for example, was introduced by Apple Inc., a computing hardware and software company. The mobile phone market was already mature. Industry leaders could have created a smartphone, but they didn't. Apple's success with portable audio players (iPod) and mobile phones (iPhone) was a shot across the bow of other hardware manufacturers. A wave of smart devices is coming.

Impact of the Internet of Things

The impact of IoT will be felt by many different high-tech industries. Smart devices need microprocessors, memory, wireless network connections, a power source, and new software. These devices will also need new protocols, more bandwidth, and tighter security, and they will consume more energy.

A good example of this push toward smart devices is General Electric's (GE) Industrial Internet.[6] GE's Industrial Internet is a broad program focused on creating smart devices, analyzing the data from these devices, and then making changes that increase efficiencies, reduce waste, and improve decision making. GE sees the greatest potential for smart devices in hospitals, power grids, railroads, and manufacturing plants.

GE estimates that an average airline using smart devices in its jet aircraft could save an average of 2 percent in fuel consumption. The resulting fuel and carbon dioxide savings would be the equivalent of removing 10,000 cars from the road.[7]

Microsoft has also made tremendous gains using smart devices. Microsoft has created a network of 125 smart buildings spread over 500 acres in Redmond, Washington (Figure 4-6).[8]

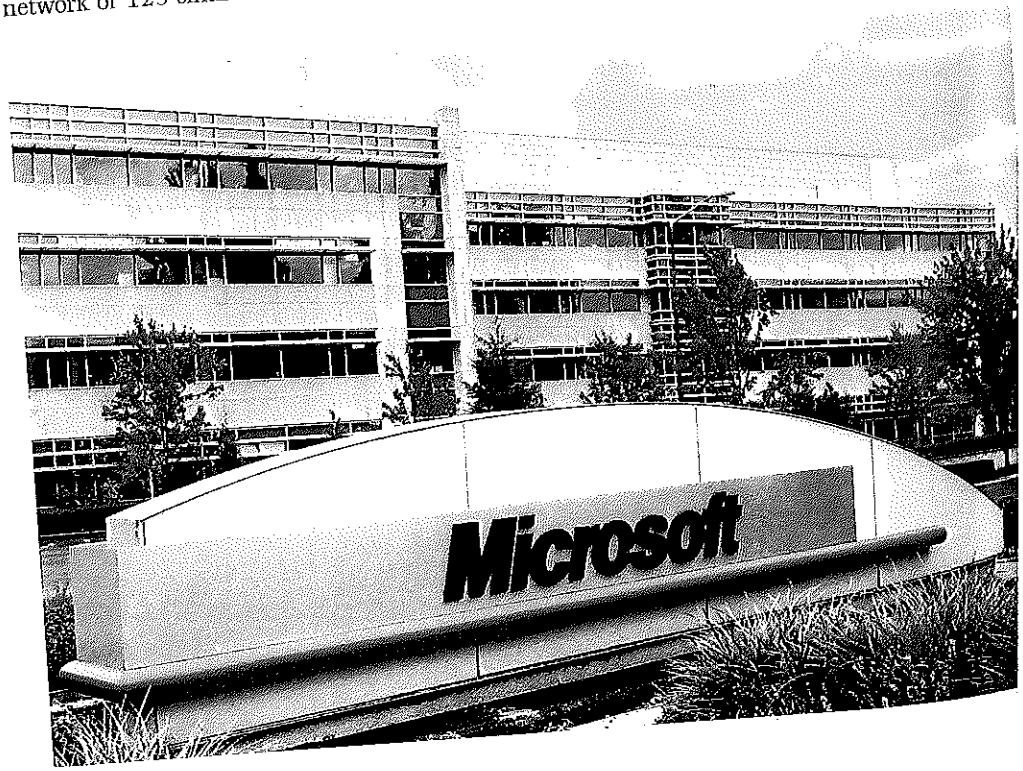


FIGURE 4-6
Microsoft's Redmond, WA, Campus
Source: Ian Dagnall/Alamy

Its operations center processes 500 million data transactions every day from 30,000 devices, including heaters, air conditioners, lights, fans, and doors.

Microsoft engineers were able to reduce energy costs by 6 percent to 10 percent a year by identifying problems like wasteful lighting, competing heating and cooling systems, and rogue fans. For Microsoft, that's millions of dollars. What if every corporate building were a smart building? When you consider that 40 percent of the world's energy is consumed in corporate buildings, you can start to get an idea of the immense financial cost savings. Indirectly, this would also have a huge environmental and economic impact worldwide.

Digital Reality Devices

The second disruptive force that has the power to change business is digital reality devices. Digital reality devices are an emerging technology with tremendous potential to revolutionize our daily lives. Much like the emergence of the Internet in the mid-1990s, these devices will create entirely new types of companies and change the way people live, work, shop, and entertain themselves. It's estimated that the digital reality market will be $150 billion by 2020.[9]

There are different levels of digital reality on a continuum from completely *real* environments to completely **virtual** environments, or simulated nonphysical environments. Before you start to think about how digital reality devices will affect business, you need to understand how the levels of digital reality differ. First, **reality** is the state of things as they actually exist. If you're reading the paper version of this textbook with your eyes, contact lenses, or glasses, you're seeing the real world without any digital alteration. You are (hopefully) experiencing reality.

Next comes augmented reality. **Augmented reality (AR)** is the altering of reality by overlaying digital information on real-world objects. Examples of AR devices include Google Glass ($1,250), Epson's Moverio Smart Glasses ($700), and Daqri Smart Helmet (est. $5,000 to $15,000). Essentially, these devices work like heads-up displays, giving users information about the real world they're experiencing. For example, an AR device could provide users directions in the form of virtual arrows being displayed on the roadway. Users could also read virtual emails displayed in the air or see virtual health data projected in front of them as they exercise.

The next step on the digital reality continuum, as shown in Figure 4-7, is mixed reality. **Mixed reality (MR)** is the combination of the real physical world with interactive virtual images or objects. Microsoft (HoloLens, $3,000) and Meta (Meta 2, $949) released their MR devices in early 2016. Both companies are marketing these devices to developers interested in creating digital reality applications. MR devices are generally perceived as having greater potential than AR devices due to their ability to interact with virtual objects in real time.

For example, using AR you could view a 2D virtual weather forecast projected on your wall. But with MR you would see a real-time 3D virtual model of your city created on your coffee table (Figure 4-8). It would show a virtual tornado moving toward the city, and you could interact with the 3D weather application to see its projected path. And this is just one example. Imagine watching sporting events live in high-definition 3D in the middle of your room.

There's one problem when discussing AR and MR devices. Currently, the term *augmented reality* isn't applied consistently. It's common to hear AR used to describe both AR and MR devices.[10]

	Reality	Augmented Reality	Mixed Reality	Virtual Reality
Example	Glasses	Google Glass	Microsoft HoloLens	Facebook's Oculus Rift
Virtual Information	No	Yes	Yes	Yes
Virtual Objects	No	No	Yes	Yes
Virtual World	No	No	No	Yes

FIGURE 4-7
Levels of Digital Reality

But this is normal for emerging technologies. Terms are created, refined, and stored in common speech as the technology develops. So don't be surprised to hear AR used to describe both types of digital reality.

The last step on the digital reality continuum is **virtual reality (VR)**, or a completely computer-generated virtual world with interactive digital objects. Here you'll find devices like Facebook's Oculus Rift ($599), Sony's PlayStation VR ($399), and Samsung Gear VR ($99). These are completely immersive experiences that try to create a strong **sense of presence**, or the illusion that a virtual experience is real. In other words, if a device were able to create a strong sense of presence, you'd lean back and hold on tight if you were on a virtual roller coaster about to go off the track.

Impact of Digital Reality Devices

Digital reality devices are developing in much the same way cellular phones developed over the past 20 years. In fact, it's entirely possible that the AR market could disrupt the smartphone market. Imagine taking calls, browsing the Web, messaging friends, and watching a movie without ever taking your smartphone out of your pocket.

The application of digital reality devices extends beyond personal use as well. Organizations are currently building digital reality applications for education, training, collaboration, new product design, "holoportation," gaming, sports, advertising, tourism, and shopping. For example, Lowe's new Holoroom allows customers to design and visualize their ideal room before they commit to major changes. Case Western Reserve University has partnered with Microsoft to develop 3D mixed-reality applications to teach anatomy in an interactive environment.[11]

The full impact of digital reality devices won't be understood for years—we just don't know how they'll be used. Even experts in the field are just starting to understand the implications of how digital reality devices will change organizations. The shift from 2D flat screens to a 3D virtual world is like changing vocations from being a painter to being a sculptor. It requires new skills, processes, tools, and ways of thinking. Digital reality devices are truly one of the most transformative innovations in hardware to come along in the past 20 years.

Self-driving Cars

The third disruptive force that could change the way businesses operate is self-driving cars. A **self-driving car** (also known as a driverless car) uses a variety of sensors to navigate like a traditional car but without human intervention. It will be full of advanced hardware and integrated software

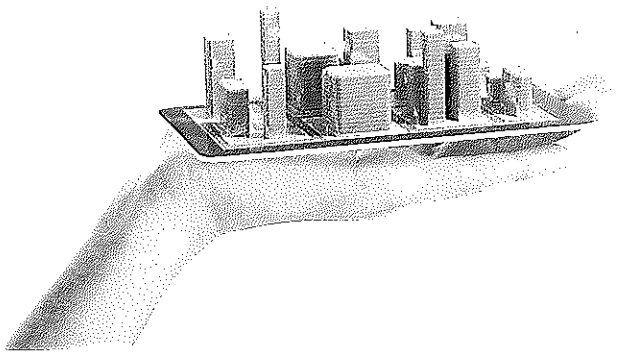


FIGURE 4-8
Digital Reality Applications

Source: © Peshkov/Fotolia

and is the epitome of a mobile system. In fact, it will be so mobile that it will be able to move without anyone being in the car (Figure 4-9). Yes, self-driving cars are in your very near future.

A recent report by KPMG indicates that self-driving cars will be a reality as soon as 2020, with full adoption by 2040.[12] Most auto manufacturers (Mercedes-Benz, Nissan, Audi, and BMW) say they will have self-driving cars by 2020.[13] Google recently announced that it is partnering with Fiat Chrysler to make 100 driverless minivans.[14] Google's existing two-seater cars have logged more than 1.5 million miles. The Mercedes-Benz F 015 was the hit of the CES 2015 show when it drove itself onstage and opened its saloon-style doors, revealing passenger seats facing each other. It looks like the race to develop self-driving cars is heating up. The competition will be fierce.

Self-driving cars will make things easier, cheaper, and safer. They'll also disrupt well-established industries.

Self-driving Cars Make Things Easier

Imagine how a self-driving car will change the lives of a typical family. A self-driving car could allow Dad to review sales reports while "driving" to work. He's much less stressed out—and more productive—during his commute than he was with his old car. The self-driving car could then drop off the kids at school—without Dad in the car—and return home to take Mom to work.

After work the family goes shopping and is dropped off curbside at the store. No need to park anymore. It's safer too. While shopping, Dad gets a message from his college-aged daughter that she needs the car sent to pick her up from the airport. Dad's glad he won't have to drive all the way out there.

Dad remembers when he had to drive himself. It was a long and painful process. Now the car plans the route for him, fills itself up with gas, communicates with intersections so he never gets a

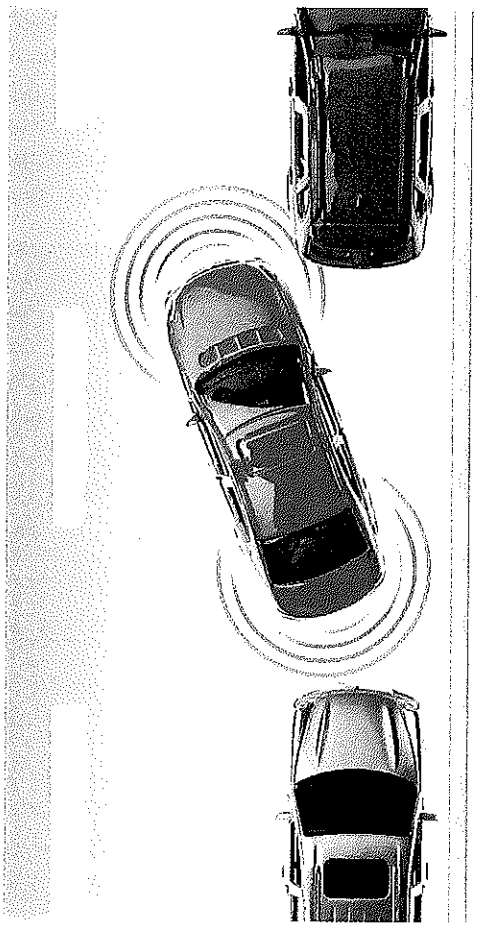


FIGURE 4-9
Future Cars Will Drive Themselves
Source: Dan Race/Fotolia

red light, and reroutes itself if there's an accident or traffic. Most importantly, he doesn't get mad at other drivers. Traveling is just easier now.

Later the family plans a vacation to a distant locale. Taking the self-driving car is the way to go. No airport security lines, family members don't have to get frisked by overzealous TSA agents, they get comfortable seats that face each other, they don't have to pay for their bags, and they don't have to rent a car when they get there. Plus, they can leave anytime they like.

Sometimes it's nice to leave for vacation at night and sleep while you're "driving." Driving isn't bad when you don't actually drive.

Self-driving Cars Make Things Cheaper

You've seen how a self-driving car can make your life easier. But what about cost? Will it be more expensive or less expensive than the car you have now?

Self-driving cars will probably be much less expensive over time than your current car. Early adopters will pay a premium when self-driving cars first hit the market, but that's true of most new products.

Cost savings will show up in several ways. In the above scenario, you may have noticed that the family had only one car. Self-driving cars will be used more effectively than cars are used now. Most cars sit dormant for 22 hours a day. Sharing a self-driving car could eliminate the need to have multiple cars. That's a big cost savings.

You'll see more cost savings because a self-driving car will drive better than you. You'll save on fuel because it will drive more efficiently (less braking, revving the engine, and street racing!). You will avoid costly traffic tickets, parking tickets, and DUI citations.

Your car insurance will drop dramatically. It may be so low that you won't even need it anymore. In a report about the effect of self-driving cars on the insurance industry KPMG estimated that accident frequency will drop by 80 percent by the year 2040. Subsequently, the personal automobile industry will shrink to 40 percent of its current size.[15]

They're probably right. Self-driving cars will probably take a big chunk out of the $150B, paid each year in car insurance premiums. And they should. Your future self-driving car will be safer because its crash avoidance systems will apply the brakes before you're even aware of a problem. It will be able to know the exact locations, velocities, and routes of all cars within the vicinity. Automobile accidents may become a thing of the past.

Self-driving Cars Will Make Things Safer

Yes, you read that right—safer. Currently, 90 percent of motor vehicle crashes are caused by human error.[16] Motor vehicle crashes are the leading cause of death for people ages 3 to 33. Spending time driving may be the most dangerous thing you do all day.

Your car will be able to see better than you, react more quickly than you, and have better information about your driving environment. It will be able to communicate with other cars around it, dynamically analyze traffic patterns, avoid construction sites, and contact emergency services if needed.

Self-driving cars will mean safer driving, fewer accidents, fewer drunk drivers, fewer road-rage incidents, and fewer auto–pedestrian accidents. Cars will be able to go faster with fewer accidents. In the future, manual driving may be a risky and expensive hobby.

Self-driving Cars Will Disrupt Businesses

Self-driving cars have the potential to disrupt well-established industries. Self-driving cars may mean fewer cars on the road. Fewer cars on the road may mean fewer cars sold (transportation), fewer auto loans written (finance), fewer automobile insurance policies underwritten (insurance), fewer auto parts sold due to fewer accidents (manufacturing), and fewer parking lots (real estate). If they didn't have to drive, consumers might take more trips by car than by plane or train (transportation).

The production of self-driving cars will mean more jobs for engineers, programmers, and systems designers. There will be more computer hardware, sensors, and cameras in the vehicle. Corporations may not completely see the far-reaching effects of self-driving cars on existing industries.

How will self-driving cars disrupt your personal life? Suppose you get married in a few years and have a child. Will your child ever drive a car? Will driving a "manual" car be too costly? Your potential offspring may never learn how to drive a car. But that may not be too strange. Do you know how to ride a horse? Your ancestors did.

3D Printing

The fourth disruptive force that has the power to change businesses is 3D printing. As you learned in Chapter 3, 3D printing will not only change the competitive landscape, but it may change the nature of businesses themselves. Think back to the Falcon Security case at the start of this chapter. The Falcon Security team chose not to make its own drones because doing so wasn't going to save the company enough money. It didn't want to use 3D printing to become a drone manufacturer.

While manufacturing wasn't right for Falcon, it is a viable option for some companies. Consider how Nike has used 3D printing to improve the way it designs and creates shoes. It recently used a 3D printer to create the world's first 3D-printed cleat plate for a shoe called the Nike Vapor Laser Talon.[17] Nike chose to use a 3D printer to produce the cleat because it could create the optimal geometric shapes for optimal traction. Using a 3D printer, it could design and produce a lighter and stronger cleat much more quickly than before. In fact, Nike did just that when it produced a pair of custom-designed sprinting shoes (the Nike Zoom Superfly Flyknit) for gold-medal Olympian Allyson Felix to be worn at the 2016 Olympic games in Rio.[18]

3D printers have the potential to affect a broad array of industries beyond sporting equipment. You can get an idea of the scope of change when you realize that 3D printers can print in more than just plastics (Figure 4-10). They can print in metals, ceramics, foods, and biological material too.

At CES 2015, industry leader MakerBot announced that it will begin selling composite filaments that can be used in its 3D printers. These new composite filaments combine traditional PLA (polylactic acid) thermoplastic with materials like wood, bronze, iron, and limestone. While each

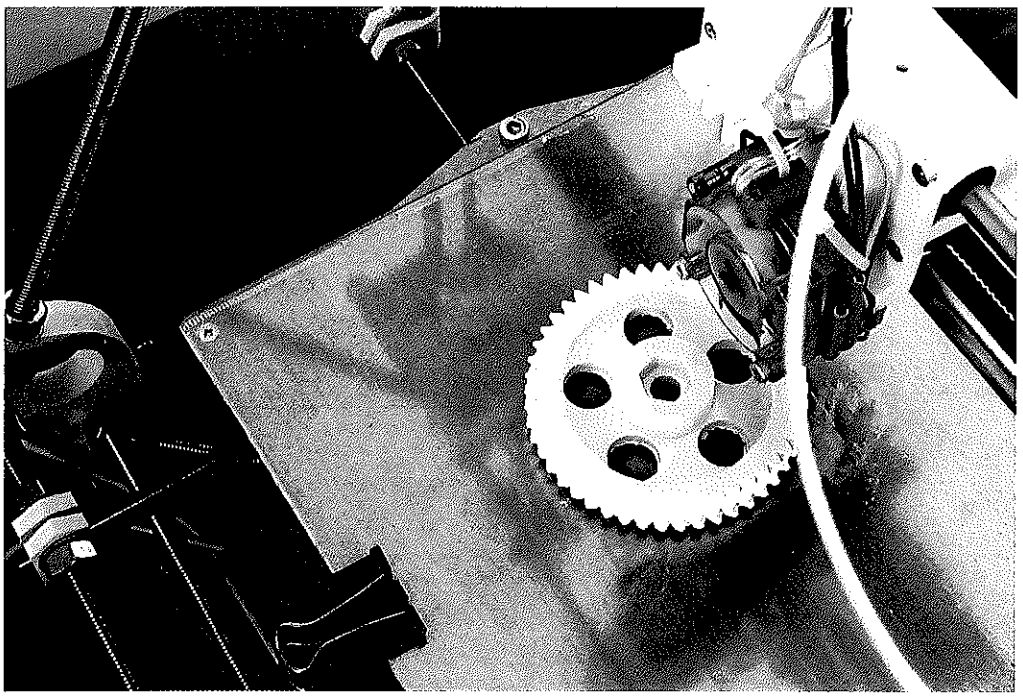


FIGURE 4-10
3D Printer
Source: Seraficus/iStock/Getty Images

type of composite filament will require a new 3D print head, the printed objects will look and behave like their real-world counterparts.

Take the ability to 3D-print in a variety of materials and look for opportunities across the aerospace, defense, automotive, entertainment, and healthcare industries. What happens when it becomes feasible to 3D-print extra-large objects like cars,[19] planes, boats, houses, and drones?

Below are three examples of nontraditional 3D printing. Consider how disruptive each one would be to its respective industry:

- 3D Systems new ChefJet™ Pro can print complex sugary structures in flavors like chocolate, vanilla, mint, cherry, sour apple, and watermelon.[20] With a ChefJet, even a culinary novice could produce intricate, beautiful, and fully customized deserts.
- Researchers at the Harvard School of Engineering and Applied Sciences were able to print a 3D biological structure with blood vessels that could deliver nutrients and remove waste.[21] This development means doctors will be able to print fully functional replacements for damaged tissues by simply pressing print. Not only could this save lives, but it could also lower insurance premiums and the overall cost of health care.
- Professor Behrokh Khoshnevis of the University of Southern California has built a large-scale 3D printer that can print an entire house in 24 hours.[22] This 3D home printer would create more stable and better insulated structures, use less materials, reduce workplace injuries, automatically install heating and plumbing, and produce the home at a fraction of the cost.

Q4-3 What Do Business Professionals Need to Know About Software?

Innocuous-looking applications can be custom-made for malicious purposes. Read the Security Guide on pages 148–149 to learn more.

As a future manager or business professional, you need to know the essential terminology and software concepts that will enable you to be an intelligent software consumer. To begin, consider the basic categories of software shown in Figure 4-11.

Every computer has an **operating system (OS)**, which is a program that controls that computer's resources. Some of the functions of an operating system are to read and write data, allocate main memory, perform memory swapping, start and stop programs, respond to error conditions, and facilitate backup and recovery. In addition, the operating system creates and manages the user interface, including the display, keyboard, mouse, and other devices.

Although the operating system makes the computer usable, it does little application-specific work. If you want to check the weather or access a database, you need application programs such as an iPad weather application or Oracle's customer relationship management (CRM) software.

Both client and server computers need an operating system, though they need not be the same. Further, both clients and servers can process application programs. The application's design determines whether the client, the server, or both process it.

You need to understand two important software constraints. First, a particular version of an operating system is written for a particular type of hardware. For example, Microsoft Windows

	Operating System	Application Programs
Client	Programs that control the client computer's resources	Applications that are processed on client computers
Server	Programs that control the server computer's resources	Applications that are processed on server computers

FIGURE 4-11
Categories of Computer Software

works only on processors from Intel and companies that make processors that conform to the Intel instruction set (the commands that a CPU can process). With other operating systems, such as Linux, many versions exist for many different instruction sets.

Second, two types of application programs exist. **Native applications** are programs that are written to use a particular operating system. Microsoft Access, for example, will run only on the Windows operating system. Some applications come in multiple versions. For example, there are Windows and Macintosh versions of Microsoft Word. But unless you are informed otherwise, assume that a native application runs on just one operating system. Native applications are sometimes called **thick-client applications**.

A **Web application** (also known as a **thin-client application**) is designed to run within a computer browser such as Firefox, Chrome, Opera, or Edge (formerly Internet Explorer). Web applications run within the browser and can run on any type of computer. Ideally, a Web application can also run within any browser, though this is not always true as you will learn.

Consider next the operating system and application program categories of software.

What Are the Major Operating Systems?

The major operating systems are listed in Figure 4-12. Consider each.

FIGURE 4-12
Major Operating Systems

Category	Operating System	Used for	Remarks
Nonmobile Clients	Windows	Personal computer clients	Most widely used operating system in business. Current version is Windows 10. Includes a touch interface.
	Mac OS	Macintosh clients	First used by graphic artists and others in arts community; now used more widely. First desktop OS to provide a touch interface. Current version is the macOS Sierra.
	Unix	Workstation clients	Popular on powerful client computers used in engineering, computer-assisted design, architecture. Difficult for the nontechnical user. Almost never used by business clients.
	Linux	Just about anything	Open source variant of Unix. Adapted to almost every type of computing device. On a PC, used with Libre Office application software. Rarely used by business clients.
Mobile Clients	Symbian	Nokia, Samsung, and other phones	Popular worldwide, but less so in North America.
	BlackBerry OS	Research in Motion BlackBerries	Device and OS developed for use by business. Very popular in beginning, but losing market share to iOS and Android.
	iOS	iPhone, iPod Touch, iPad	Rapidly increasing installed base with success of the iPhone and iPad. Based on Mac OS X.
	Android	Samsung, Google, HTC, and Sony smartphones; tablets	Linux-based phone/tablet operating system from Google. Rapidly increasing market share.
	Windows 10 (mobile)	Nokia and Microsoft Surface	Windows 10 tailored specifically for mobile devices. Full Windows 10 on Surface Pro.
Servers	Windows Server	Servers	Businesses with a strong commitment to Microsoft.
	Unix	Servers	Fading from use. Replaced by Linux.
	Linux	Servers	Very popular. Aggressively pushed by IBM.

Nonmobile Client Operating Systems

Nonmobile client operating systems are used on personal computers. The most popular is **Microsoft Windows**. Some version of Windows resides on more than 85 percent of the world's desktops, and, if we consider just business users, the figure is more than 95 percent. The most recent version of Windows is Windows 10. Net Applications estimates that overall market share of Windows as of 2016 is Windows 10 at 15.3 percent, Windows 8.1 at 9.9 percent, Windows 8 at 3.2 percent, Windows 7 at 47.8 percent, Windows Vista at 1.4 percent, and Windows XP at 10.6 percent.[23] It's interesting to note that Microsoft dropped support for Windows XP in 2014 despite the fact that it is still more popular than Windows Vista, Windows 8, and Windows 8.1.

Windows 8 was a major rewrite of prior versions. Windows 8 was distinguished by what Microsoft calls **modern-style applications**.[24] These applications, now carried over into Windows 10, are touch-screen oriented and provide context-sensitive, pop-up menus. They can also be used with a mouse and keyboard. Microsoft claims that modern-style applications work just as well on portable, mobile devices, such as tablet computers, as they do on desktop computers. One key feature of modern-style applications is the minimization of menu bars, status lines, and other visual overhead. Figure 4-13 shows an example of a modern-style version of searching for images in Windows Explorer.

Apple Computer, Inc., developed its own operating system for the Macintosh, **Mac OS**. The current version is macOS Sierra. Apple touts it as the world's most advanced desktop operating system, and, until Windows 8, it was without doubt. Windows 10 now gives it a run for the money in terms of that title.

Until recently, Mac OS was used primarily by graphic artists and workers in the arts community. But for many reasons, Mac OS has made headway into the traditional Windows market. According to Net Applications, as of 2016, desktop operating system market share was divided between versions of Windows (88.8 percent), Mac OS X (9.6 percent), and Linux (1.6 percent).[25]

Mac OS was designed originally to run the line of CPU processors from Motorola, but today a Macintosh with an Intel processor is able to run both Windows and the Mac OS.

Unix is an operating system that was developed at Bell Labs in the 1970s. It has been the workhorse of the scientific and engineering communities since then. Unix is seldom used in business.

Linux is a version of Unix that was developed by the open source community. This community is a loosely coupled group of programmers who mostly volunteer their time to contribute code to

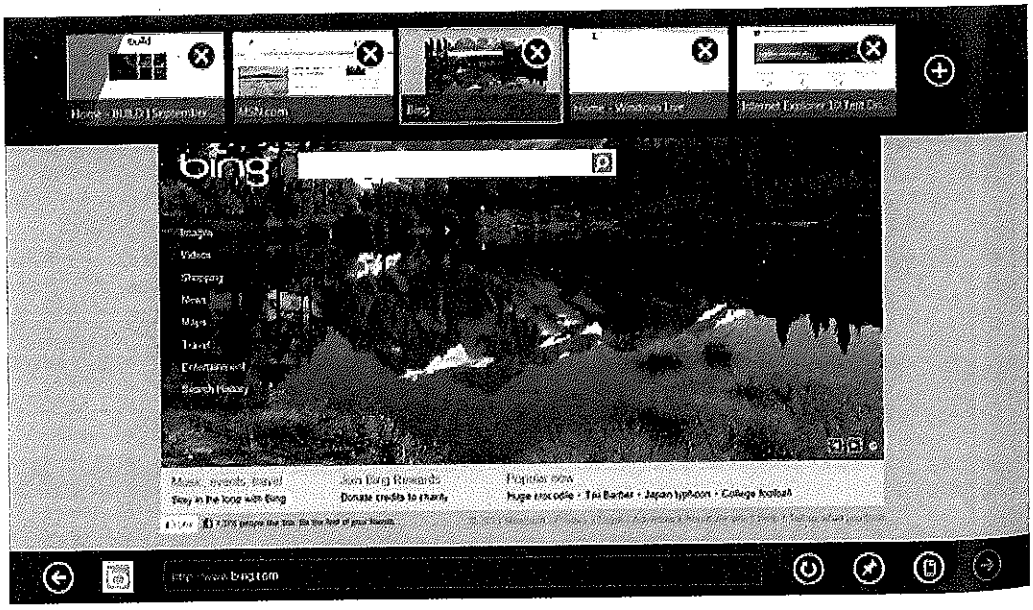


FIGURE 4-13
Example of the Modern-Style Interface
Source: Windows 10, Microsoft Corporation.

develop and maintain Linux. The open source community owns Linux, and there is no fee to use it. Linux can run on client computers, but usually only when budget is of paramount concern. By far, Linux is most popular as a server OS. According to *DistroWatch.com*, the top five most popular versions of Linux as of 2016 were Linux Mint, Debian GNU/Linux, Ubuntu, openSUSE, and Fedora.[26]

Mobile Client Operating Systems

Figure 4-12 also lists the five principal mobile operating systems. **Symbian** is popular on phones in Europe and the Far East, but less so in North America. **BlackBerry OS** was one of the most successful early mobile operating systems and was used primarily by business users on BlackBerry devices. It has lost market share to iOS, Android, and Windows 10.

iOS is the operating system used on the iPhone, iPod Touch, and iPad. When first released, it broke new ground with its ease of use and compelling display, features that are now being copied by the BlackBerry OS and Android. With the popularity of the iPhone and iPad, Apple has been increasing its market share of iOS, and, according to Net Applications, it is used on 28 percent of mobile devices.[27] The current version of iOS is iOS 9.

Android is a mobile operating system licensed by Google. Android devices have a very loyal following, especially among technical users. Net Applications estimates Android's market share to be nearly 62 percent.

Most industry observers would agree that Apple has led the way, both with the Mac OS and the iOS, in creating easy-to-use interfaces. Certainly, many innovative ideas have first appeared in a Macintosh or iSomething and then later were added, in one form or another, to Android and Windows.

Users who want Windows 10 on mobile devices will get either **Windows 10 (mobile)** on smartphones or a full version of Windows 10 on Surface Pro devices. Windows garners about 4 percent of the mobile OS market share.

The smartphone market has always been huge, but recently, e-book readers and tablets have substantially increased the market for mobile client operating systems. As of 2015, 68 percent of Americans owned a smartphone, and 45 percent owned a tablet in addition to their smartphone.[28]

Server Operating Systems

The last three rows of Figure 4-12 show the three most popular server operating systems. **Windows Server** is a version of Windows that has been specially designed and configured for server use. It has much more stringent and restrictive security features than other versions of Windows and is popular on servers in organizations that have made a strong commitment to Microsoft.

Unix can also be used on servers, but it is gradually being replaced by Linux.

Linux is frequently used on servers by organizations that want, for whatever reason, to avoid a server commitment to Microsoft. IBM is the primary proponent of Linux and in the past has used it as a means to better compete against Microsoft. Although IBM does not own Linux, IBM has developed many business systems solutions that use Linux. By using Linux, neither IBM nor its customers have to pay a license fee to Microsoft.

Virtualization

Virtualization is the process by which one physical computer hosts many different virtual (not literal) computers within it. One operating system, called the **host operating system**, runs one or more operating systems as applications. Those hosted operating systems are called **virtual machines (vm)**. Each virtual machine has disk space and other resources allocated to it. The host operating system controls the activities of the virtual machines it hosts to prevent them from interfering with one another. With virtualization, each vm is able to operate exactly the same as it would if it were operating in a stand-alone, nonvirtual environment.

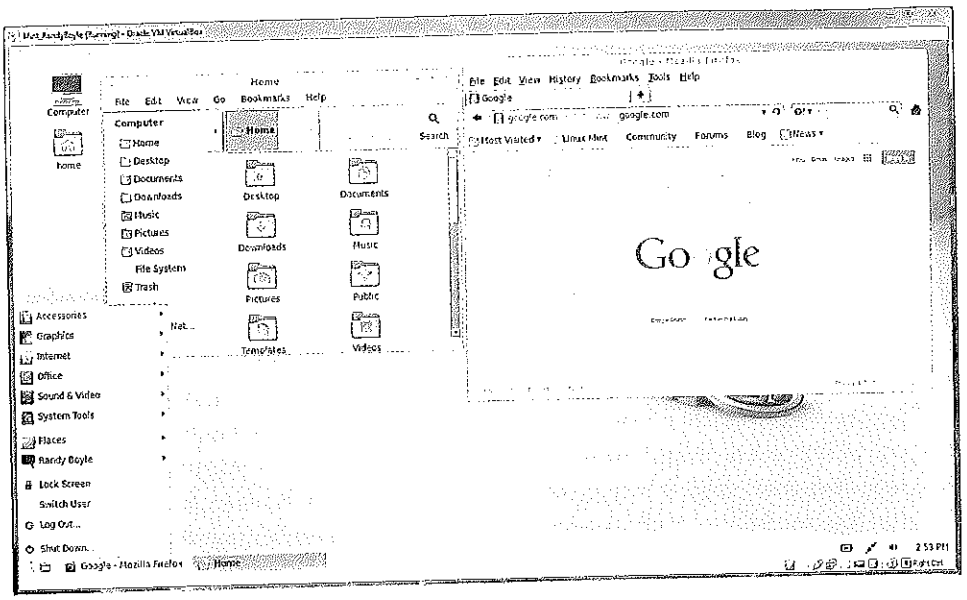


FIGURE 4-14
Linux Mint Virtual Machine Running in Microsoft Windows 7 Professional
Source: Windows 10, Microsoft Corporation.

Three types of virtualization exist:

- PC virtualization
- Server virtualization
- Desktop virtualization

With **PC virtualization**, a personal computer, such as a desktop or laptop, hosts several different operating systems. Say a user needs to have both Linux and Windows running on a computer for a training or development project. In that circumstance, the user can load software like Oracle VirtualBox or VMWare Workstation on the host operating system in order to create Linux and Windows virtual machines. The user can run both systems on the same hardware at the same time if the host operating system has sufficient resources (i.e., memory and CPU power) as shown in Figure 4-14.

With **server virtualization**, a server computer hosts one or more other server computers. In Figure 4-15, a Windows Server computer is hosting two virtual machines. Users can log on to either of those virtual machines, and they will appear as normal servers. Figure 4-16 shows how virtual machine VM3 appears to a user of that server. Notice that a user of VM3 is running a browser that is accessing SharePoint. In fact, this virtual machine was used to generate many of the SharePoint figures in Chapter 2. Server virtualization plays a key role for cloud vendors, as you'll learn in Chapter 6.

PC virtualization is interesting as well as quite useful, as you will learn in Chapter 6. Desktop virtualization, on the other hand, has the potential to be revolutionary. With **desktop**

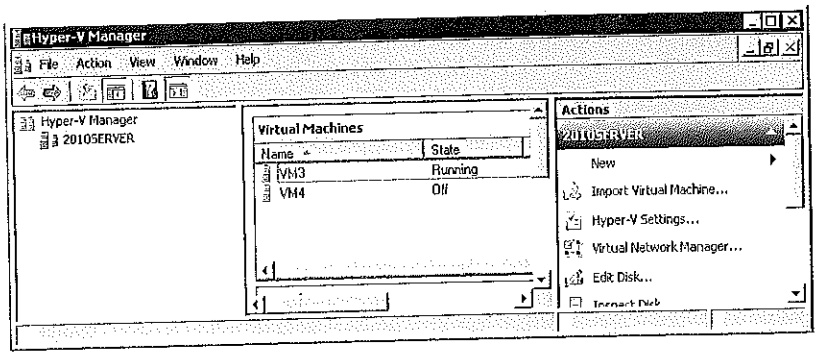


FIGURE 4-15
Windows Server Computer Hosting Two Virtual Machines
Source: Windows 10, Microsoft Corporation.

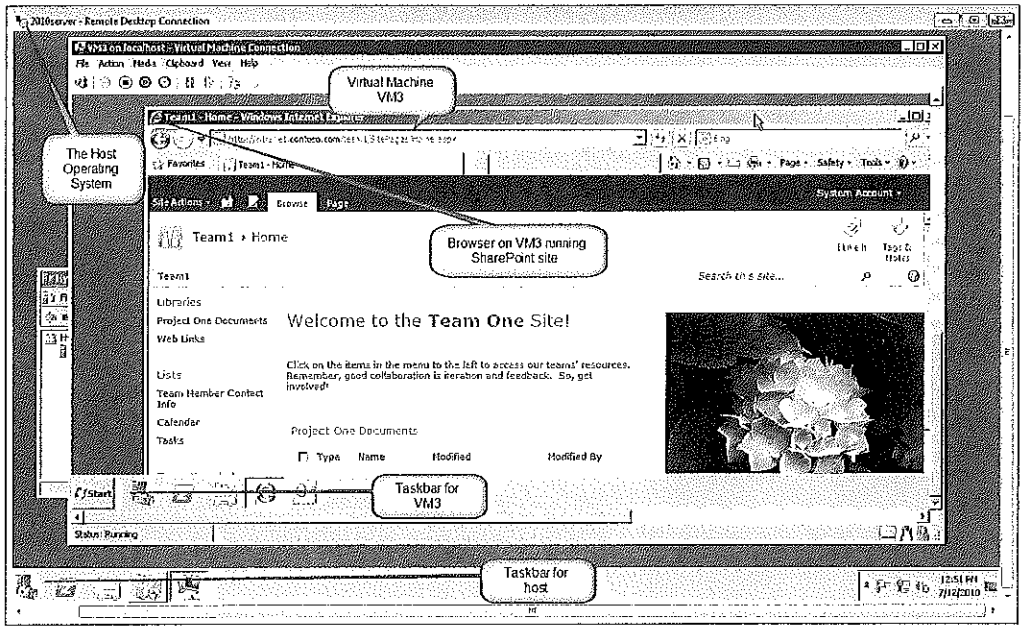


FIGURE 4-16
Virtual Machine Example
Source: Windows 10, Microsoft Corporation.

virtualization, a server hosts many versions of desktop operating systems. Each of those desktops has a complete user environment and appears to the user to be just another PC. However, the desktop can be accessed from any computer to which the user has access. Thus, you could be at an airport and go to a terminal computer and access your virtualized desktop. To you, it appears as if that airport computer is your own personal computer. Using a virtual desktop also means that you wouldn't have to worry about losing a corporate laptop or confidential internal data. Meanwhile, many other users could have accessed the computer in the airport, and each thought he or she had his or her personal computer.

Desktop virtualization is in its infancy, but it might have major impact during the early years of your career.

Own Versus License

When you buy a computer program, you are not actually buying that program. Instead, you are buying a **license** to use that program. For example, when you buy a Mac OS license, Apple is selling you the right to use Mac OS. Apple continues to own the Mac OS program. Large organizations do not buy a license for each computer user. Instead, they negotiate a **site license**, which is a flat fee that authorizes the company to install the product (operating system or application) on all of that company's computers or on all of the computers at a specific site.

In the case of Linux, no company can sell you a license to use it. It is owned by the open source community, which states that Linux has no license fee (with certain reasonable restrictions). Large companies such as IBM and smaller companies such as RedHat can make money by *supporting* Linux, but no company makes money selling Linux licenses.

What Types of Applications Exist, and How Do Organizations Obtain Them?

Some applications are designed to be free but gather data about the people who use them. Read the Ethics Guide on pages 142–143 about how this is done.

Application software performs a service or function. Some application programs are general purpose, such as Microsoft Excel or Word. Other application programs provide specific functions. QuickBooks, for example, is an application program that provides general ledger and other accounting functions. We begin by describing categories of application programs and then describe sources for them.

Horizontal-market application software provides capabilities common across all organizations and industries. Word processors, graphics programs, spreadsheets, and presentation programs are all horizontal-market application software.

Examples of such software are Microsoft Word, Excel, and PowerPoint. Examples from other vendors are Adobe's Acrobat, Photoshop, and PageMaker and Jasc Corporation's Paint Shop Pro. These applications are used in a wide variety of businesses across all industries. They are purchased off the shelf, and little customization of features is necessary (or possible). They are the automobile equivalent of a sedan. Everybody buys them and then uses them for different purposes.

Read more about how software is developed and managed in the Career Guide on pages 150–151.

Vertical-market application software serves the needs of a specific industry. Examples of such programs are those used by dental offices to schedule appointments and bill patients, those used by auto mechanics to keep track of customer data and customers' automobile repairs, and those used by parts warehouses to track inventory, purchases, and sales. If horizontal-market applications are sedans, then vertical-market applications would be construction vehicles, like an excavator. They meet the needs of a specific industry.

Vertical applications usually can be altered or customized. Typically, the company that sold the application software will provide such services or offer referrals to qualified consultants who can provide this service.

One-of-a-kind application software is developed for a specific, unique need. The U.S. Department of Defense develops such software, for example, because it has needs that no other organization has.

You can think of one-of-a-kind application software as the automotive equivalent of a military tank. Tanks are developed for a very specific and unique need. Tanks cost more to manufacture than sedans, and cost overruns are common. They take longer to make and require unique hardware components. However, tanks are highly customizable and fit the requirements of a heavy-duty battle vehicle very well.

If you're headed into battle, you wouldn't want to be driving a four-door sedan. Sometimes paying for a custom vehicle, while expensive, is warranted. It all depends on what you're doing. Militaries, for example, purchase sedans, construction vehicles, and tanks. Each vehicle fills its own need. You can buy computer software in exactly the same ways: **off-the-shelf software**, **off-the-shelf with alterations software**, or **custom-developed software**.

Organizations develop custom application software themselves or hire a development vendor. Like buying a tank, such development is done in situations where the needs of the organization are so unique that no horizontal or vertical applications are available. By developing custom software, the organization can tailor its application to fit its requirements.

Custom development is difficult and risky. Staffing and managing teams of software developers is challenging. Managing software projects can be daunting. Many organizations have embarked on application development projects only to find that the projects take twice as long—or longer—to finish than planned. Cost overruns of 200 percent and 300 percent are not uncommon. We will discuss such risks further in Chapter 12.

In addition, every application program needs to be adapted to changing needs and changing technologies. The adaptation costs of horizontal and vertical software are amortized over all the users of that software, perhaps thousands or millions of customers. For custom-developed software, however, the using organization must pay all of the adaptation costs itself. Over time, this cost burden is heavy.

Because of the risk and expense, custom development is the last-choice alternative, used only when there is no other option. Figure 4-17 summarizes software sources and types.

What Is Firmware?

Firmware is computer software that is installed into devices such as printers, print servers, and various types of communication devices. The software is coded just like other software, but it is installed into special, read-only memory of the printer or other device. In this way, the program becomes part of the device's memory; it is as if the program's logic is designed into the device's

Software Type	Software Source: Off-the-shelf	Off-the-shelf and then customized	Custom-developed
Horizontal applications			
Vertical applications			
One-of-a-kind applications			

FIGURE 4-17
Software Sources and Types

circuitry. Therefore, users do not need to load firmware into the device's memory. Firmware can be changed or upgraded, but this is normally a task for IS professionals.

Q4-4 Is Open Source Software a Viable Alternative?

To answer this question, you first need to know something about the open source movement and process. Most computer historians would agree that Richard Matthew Stallman is the father of the movement. In 1983, he developed a set of tools called **GNU** (a self-referential acronym meaning *GNU Not Unix*) for creating a free Unix-like operating system. Stallman made many other contributions to open source, including the **GNU general public license (GPL) agreement**, one of the standard license agreements for open source software. Stallman was unable to attract enough developers to finish the free Unix system but continued making other contributions to the open source movement.

In 1991 Linus Torvalds, working in Helsinki, began work on another version of Unix, using some of Stallman's tools. That version eventually became Linux, the high-quality and very popular operating system discussed previously.

The Internet proved to be a great asset for open source, and many open source projects became successful, including:

- LibreOffice (default office suite in Linux distributions)
- Firefox (a browser)
- MySQL (a DBMS, see Chapter 5)
- Apache (a Web server, see Chapter 6)
- Ubuntu (a Windows-like desktop operating system)
- Android (a mobile device operating system)
- Cassandra (a NoSQL DBMS, see Chapter 5)
- Hadoop (a BigData processing system, see Chapter 9)

Why Do Programmers Volunteer Their Services?

To a person who has never enjoyed writing computer programs, it is difficult to understand why anyone would donate his or her time and skills to contribute to open source projects. Programming is, however, an intense combination of art and logic, and designing and writing a complicated computer program can be exceedingly pleasurable (and addictive). Many programmers joyfully write computer programs—day after day. If you have an artistic and logical mind, you ought to try it.

The first reason that people contribute to open source is that it is great fun! Additionally, some people contribute to open source because it gives them the freedom to choose the projects they work on. They may have a programming day job that is not terribly interesting—say, writing a program to manage a computer printer. Their job pays the bills, but it's not fulfilling.

In the 1950s, Hollywood studio musicians suffered as they recorded the same style of music over and over for a long string of uninteresting movies. To keep their sanity, those musicians would

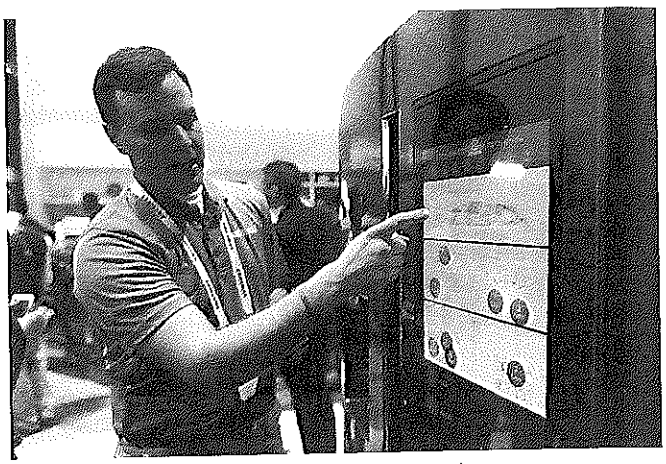
SO WHAT?

NEW FROM CES 2016

What's new in hardware? It's the Consumer Electronics Show (CES) held in Las Vegas every January: 3,600 exhibitors and 170,000 hardware-gawking attendees whipped to frenzy by loud music, screaming video, and hyperventilating media. It's a show that only Las Vegas can do!

What's hot this year? How about:

1. **Transparent and Flexible TVs:** New TV developments are a perennial CES favorite. Why? Because everyone watches TV, and hardware geeks are prime buyers, spending big money for the latest gee-whiz features. UHD (Ultra High Definition) TVs that display 4K (2160p) and 8K (4320p) were commonplace at CES this year. But Panasonic's prototype transparent display looks like a typical HD TV when it's showing a movie, then turns into a normal piece of tinted glass when you're done. LG's new 18-inch flexible display was also a hit. It rolls up just like a sheet of paper when you're done watching your favorite show.
2. **DietSensor:** The winner of the coveted CES 2016 Best of Innovation Award was DietSensor. This small, handheld device pairs with your smartphone and scans the food you're about to eat. It determines the amount of carbohydrates, fats, and proteins in the food using a "molecular sensor." Once the scan is complete, you set the amount of that food you plan to eat, and the DietSensor calculates the calories. If you're on a diet and counting calories, DietSensor makes it easy to stay on track.
3. **"it" Smart Bed:** You will spend about one-third of your life sleeping–that's roughly 26 years. Sleep Number intends to make your sleep more informative. The company's new "it" bed uses biometric sensors to track your heart rate, breathing, sleeping patterns, and movement. Based on the data collected, the bed suggests adjustments to the level of firmness, comfort, and support. It can also be linked with other cloud services to provide insights into factors that might affect your sleep. For example, data from the "it" bed can be combined with temperature data gathered in your bedroom. It can then analyze your sleep patterns over a range of temperatures to determine the optimal room temperature for your best night's sleep. Getting a better night's rest may not seem like a big deal now, but over 26 years it adds up.



Source: Dpa picture alliance/Alamy Stock Photo

4. **Family Hub Smart Refrigerator:** Samsung's new Wi-Fi–enabled smart fridge has cameras inside that display its contents to any linked mobile device. Suppose you're shopping at the grocery store and can't remember if you have enough lemons for your famous lemon meringue pie. Just tap the fridge app on your smartphone and you can immediately see the contents of your refrigerator. The smart fridge can also display shared calendars, photos, and notes from your mobile device; stream music directly from Internet using apps like Pandora; or even stream video from your smart TV.

Questions

1. What trends do you see pushing innovation in televisions? Why are these important to consumers?
2. What types of sensors like DietSensor might be useful for other IoT devices?
3. Why might doctors and nutritionists be interested in a device like DietSensor?
4. How could a smart bed benefit from being paired with a smartphone?
5. What other devices do you think could benefit from becoming "smart" devices? Why?
6. What security or privacy concerns might be associated with a smart fridge?

gather on Sundays to play jazz, and a number of high-quality jazz clubs resulted. That's what open source is to programmers: a place where they can exercise their creativity while working on projects they find interesting and fulfilling.

Another reason for contributing to open source is to exhibit one's skill, both for pride and to find a job or consulting employment. A final reason is to start a business selling services to support an open source product.

How Does Open Source Work?

The term **open source** means that the source code of the program is available to the public. **Source code** is computer code as written by humans and understandable by humans. Figure 4-18 shows a portion of the computer code written for the ARES project (see Chapter 7 opener).

Source code is compiled into **machine code** that is processed by a computer. Machine code is, in general, not understandable by humans and cannot be modified. When a user accesses a Web site, the machine code version of the program runs on the user's computer. We do not show machine code in a figure because it would look like this:

```
1101001010010111111001110111100100011100000111111011101111100111...
```

In a **closed source** project, say, Microsoft Office, the source code is highly protected and only available to trusted employees and carefully vetted contractors. The source code is protected like gold in a vault. Only those trusted programmers can make changes to a closed source project.

With open source, anyone can obtain the source code from the open source project's Web site. Programmers alter or add to this code depending on their interests and goals. In most cases,

FIGURE 4-18
Source Code Sample

```
/// <summary>
/// Allows the page to draw itself.
/// </summary>
private void OnDraw(object sender, GameTimerEventArgs e)
{
    SharedGraphicsDeviceManager.Current.GraphicsDevice.Clear(Color.CornflowerBlue);

    SharedGraphicsDeviceManager.Current.GraphicsDevice.Clear(Color.Black);

    // Render the Silverlight controls using the UIElementRenderer.
    elementRenderer.Render();

    // Draw the sprite
    spriteBatch.Begin();

    // Draw the rectangle in its new position
    for (int i = 0; i < 3; i++)
    {
        spriteBatch.Draw(texture[i], bikeSpritePosition[i], Color.White);
    }

    // Using the texture from the UIElementRenderer,

    // draw the Silverlight controls to the screen.
    spriteBatch.Draw(elementRenderer.Texture, Vector2.Zero, Color.White);

    spriteBatch.End();
}
```

programmers can incorporate code they find into their own projects. They may be able to resell those projects depending on the type of license agreement the project uses.

Open source succeeds because of collaboration. A programmer examines the source code and identifies a need or project that seems interesting. He or she then creates a new feature, redesigns or reprograms an existing feature, or fixes a known problem. That code is then sent to others in the open source project who evaluate the quality and merits of the work and add it to the product, if appropriate.

Typically, there is a lot of give and take. Or, as described in Chapter 2, there are many cycles of iteration and feedback. Because of this iteration, a well-managed project with strong peer reviews can result in very high quality code, like that in Linux.

So, Is Open Source Viable?

The answer depends on to whom and for what. Open source has certainly become legitimate. According to *The Economist*, "It is now generally accepted that the future will involve a blend of both proprietary and open-source software."[29] During your career, open source will likely take a greater and greater role in software. However, whether open source works for a particular situation depends on the requirements and constraints of that situation. You will learn more about matching requirements and programs in Chapter 12.

In some cases, companies choose open source software because it is "free." It turns out that this advantage may be less important than you'd think because in many cases support and operational costs swamp the initial licensing fee.

Q4-5 What Are the Differences Between Native and Web Applications?

Applications can be categorized as native applications that run on just one operating system or Web applications that run in browsers. In the latter case, the browser provides a more or less consistent environment for the application; the peculiarities of operating systems and hardware are handled by the browser's code and hidden from the Web application.

Figure 4-19 contrasts native and Web applications on their important characteristics. Consider the Native Applications column first.

Developing Native Applications

Native applications are developed using serious, heavy-duty, professional programming languages. Mac OS and iOS applications are constructed using Objective-C or the **Swift** programming language. Linux (Android) applications are constructed using Java, and Windows applications are constructed using C#, VB.NET, C++, and others. All of these languages are **object-oriented**, which means they can be used to create difficult, complex applications and, if used properly, will result in high-performance code that is easy to alter when requirements change. The particular characteristics of object-oriented languages are beyond the scope of this text.

Object-oriented languages can be used only by professional programmers who have devoted years to learning object-oriented design and coding skills. Typically, such developers were computer science majors in college.

The benefit of such languages is that they give programmers close control over the assets of the computing device and enable the creation of sophisticated and complex user interfaces. If the programs are well written, they perform fast and use memory efficiently. The limits on native applications are usually budgetary, not technological. As a businessperson, you can get just about any application you can afford.

The downside of native applications is that they are, well, native. They only run on the operating system for which they are programmed. An iOS application must be completely recoded in

	Native Applications	Web Applications
Development Languages	Objective-C Java C#, C++, VB.NET, Swift (object-oriented languages)	html5 css3 JavaScript (scripting language)
Developed by	Professional programmers, only	Professional programmers and technically oriented Web developers and business professionals
Skill level required	High	Low to high
Difficulty	High	Easy to hard, depending on application requirements
Developer's Degree	Computer science	Computer science Information systems Graphics design
User Experience	Can be superb, depending on programming quality	Simple to sophisticated, depending on program quality
Possible applications	Whatever you can pay for...	Some limits prohibit very sophisticated applications
Dependency	iOS, Android, Windows	Browser differences, only
Cost	High. Difficult work by highly paid employees, multiple versions required.	Low to high ... easier work by lesser-paid employees, only multiple browser files necessary. Sophisticated applications may require high skill and pay.
Application distribution	Via application stores (e.g., Apple Store)	Via Web sites
Example	Vanguard iPad application (free in Apple's iTunes store)	Seafood Web site: *www.wildrhodyseafood.com* Picozu editor: *www.picozu.com/editor*

FIGURE 4-19
Characteristics of Native and Web Applications

order to run on Android and recoded again to run on Windows.[30] Thus, to reach all users, an organization will need to support and maintain three separate versions of the same application. It will also have to staff and manage three different development teams, with three different skill sets.

As a general rule, the cost of native applications is high. Many organizations reduce that cost by outsourcing development to India and other countries (see the introduction to Chapter 11), but native applications are still expensive relative to Web applications. The standard way to distribute native applications is via a company store, such as iTunes, owned by Apple. An excellent example of a native application is Vanguard's iPad application. It is easy to use, has complex functionality, and is highly secure, as you would expect. Companies such as Vanguard must and can afford to pay for exceedingly high-quality applications.

Developing Web Applications

The third column in Figure 4-19 summarizes Web application characteristics. Such applications run inside a browser such as Firefox, Chrome, Opera, or Edge. The browser handles the idiosyncrasies of the operating system and underlying hardware. In theory, an organization should be able to develop a single application and have it run flawlessly on all browsers on all devices. Unfortunately, there are some differences in the way that browsers implement the Web code. This means that some applications won't run correctly in some browsers.

As shown in the first row of Figure 4-19, Web development languages are html5, css3, and Javascript. html5 is the latest version of html, which you will learn about in Chapter 6. The

advantages of this version are support for graphics, animation, 2D animations, and other sophisticated user experiences. css3 is used with html5 to specify the appearance of content coded in html. JavaScript is a scripting programming language that is much easier to learn than native-client languages. It is used to provide the underlying logic of the application.

Web applications can be written by professional programmers, and, indeed, most are. However, it is possible for technically oriented Web developers and business professionals to develop them as well. The entry-level technical skill required is low, and simple applications are relatively easy to develop. But sophisticated user experiences are difficult. Web application developers may have degrees in computer science, information systems, or graphics design.

The user experience provided by a Web application varies considerably. Some are simply fancy Web-based brochures (*www.wildrhodyseafood.com*); others are quite sophisticated, such as SpiroCanvas in Figure 4-20 (*www.gethugames.in/*) or, even more impressive, *www.biodigital.com* in Figure 4-21.

Web applications are limited by the capabilities of the browser. While browsers are becoming increasingly sophisticated, they cannot offer the full capabilities of the underlying operating system and hardware. Thus, Web applications are unable to support very specialized and complex applications, though this becomes less true each year.

As stated, the major advantage of Web over native applications is that they will run on any operating system and device. There are some browser differences, but these differences are very minor when compared with the differences among iOS, Android, and Windows. In general, unlike native applications, you can assume that a Web application has one code base and one development team.

Because Web applications can be developed by less skilled, lesser-paid employees and because only one code base and one development team are necessary, they are considerably cheaper to develop than native applications. However, this statement assumes applications of equivalent complexity. A simple native application can be cheaper to develop than a complex Web application.

Users obtain Web applications via the Internet. For example, when you go to *www.picozu.com/editor* the required html5, css3, and JavaScript files are downloaded automatically over the Web. Updates to the application are automatic and seamless. You need not install (or reinstall) anything. This difference is an advantage to the user; it makes it more difficult, however, to earn money from your application. Amazon, for example, will sell your native application and pay you a royalty.

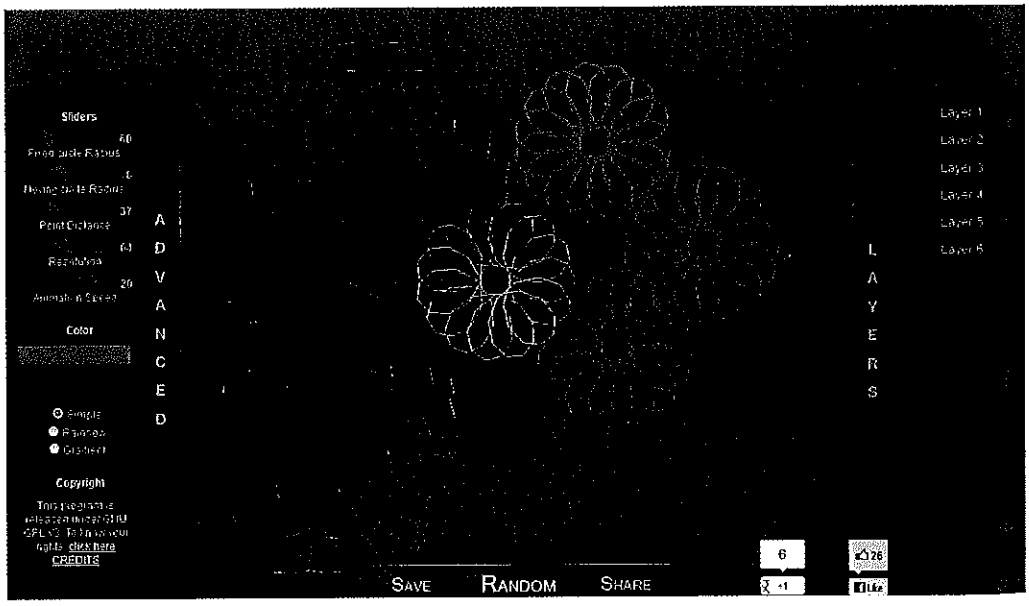


FIGURE 4-20
GethuGames' SpiroCanvas
Source: From www.gethugames.in/spirocanvas/.

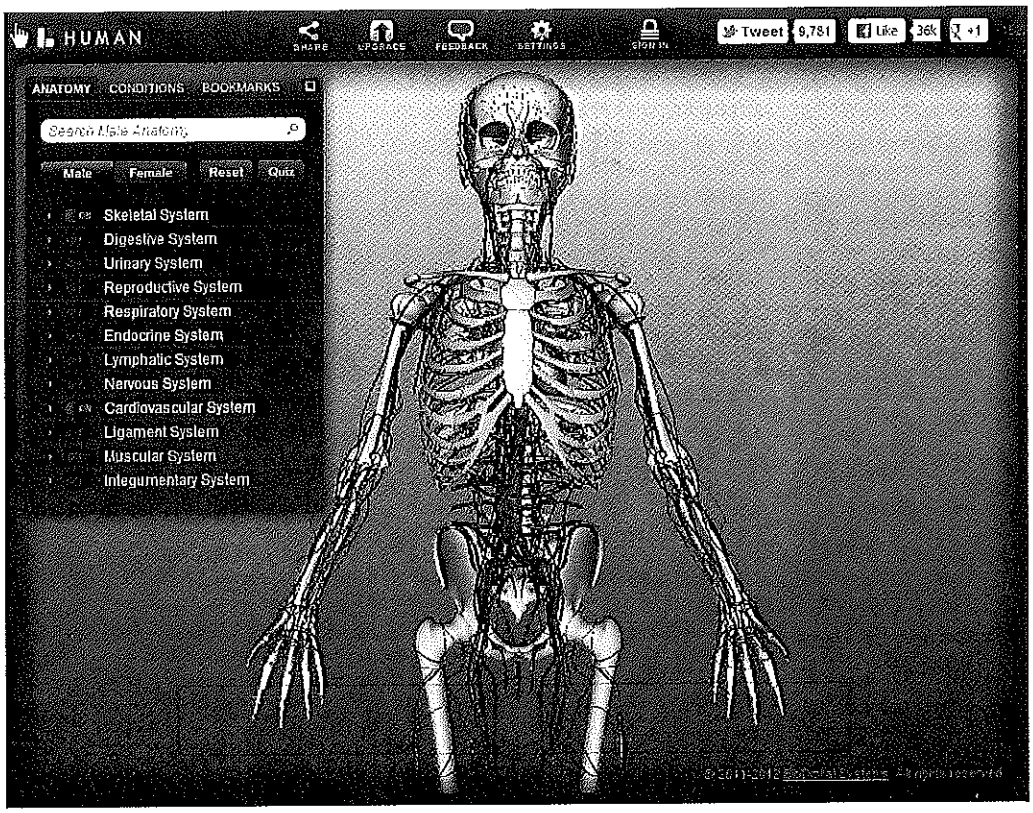


FIGURE 4-21
Sophisticated html5 Application
Source: Image created using the BioDigital Human (*www.biodigital.com*)

However, unless you require users to buy your Web application (which is possible but rare), you'll have to give it away.

Which Is Better?

You know the answer to that question. If it were clear-cut, we'd only be discussing one alternative. It's not. The choice depends on your strategy, your particular goals, the requirements for your application, your budget, your schedule, your tolerance for managing technical projects, your need for application revenue, and other factors. In general, Web applications are cheaper to develop and maintain, but they may lack the wow factor. You and your organization have to decide for yourselves!

Q4-6 Why Are Mobile Systems Increasingly Important?

Mobile systems are information systems that support users in motion. Mobile systems users access the system from *any place*—at home, at work, in the car, on the bus, or at the beach—using any smart device, such as a smartphone, tablet, or PC. The possibilities are endless.

Mobile systems users move not only geographically but also from device to device. The user who starts reading a book on an iPad on a bus, continues reading that book on a PC at work, and finishes it on a Kindle Fire at home is mobile both geographically and across devices.

As shown in Figure 4-22, the major elements in a mobile system are *users in motion, mobile devices, wireless connectivity,* and a *cloud-based resource.* A **mobile device** is a small, lightweight, power-conserving, computing device that is capable of wireless connectivity. Almost all mobile devices have a display and some means for data entry. Mobile devices include smartphones, tablets,

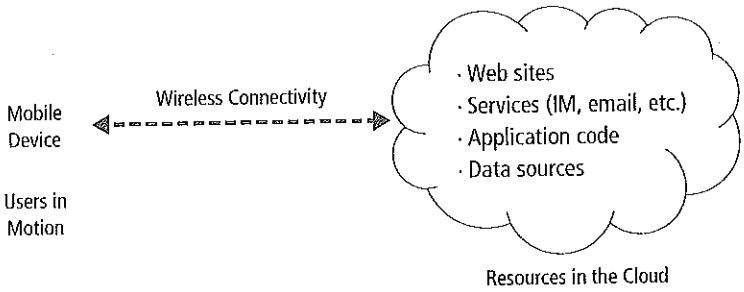


FIGURE 4-22
Elements of a Mobile Information System

smartwatches, and small, light laptops. Desktop computers, Xboxes, and large, heavy, power-hungry laptops are not mobile devices.

You will learn about wireless connectivity and the cloud in Chapter 6. For now, just assume that the cloud is a group of servers on the other end of a connection with a mobile device. When downloading a book for a Kindle, for example, the cloud is one or more servers on the other end that store that book and download a copy of it to your device.

The major reason for the importance of mobile systems is the size of their market. According to Cisco, at the end of 2015 there were 7.9 billion mobile devices generating 3.7 exabytes of traffic per month.[31] By 2020, this will jump to 11.6 billion mobile devices generating more than 30.6 exabytes per month. That's 1.5 devices for every person on the planet. Smartphones will account for nearly 72 percent of global mobile traffic.[32]

It took seven years after the launch of the first iPhone (2007–2014) for smartphones to achieve mainstream use by 70 percent of the U.S. market.[33] That's faster than any other technology except television in the early 1950s, which tied the smartphone adoption rate. The February 2016 comScore Report shows 199 million people in the United States owned smartphones, which accounted for 79.3 percent of the mobile phone market.[34] The size of the mobile e-commerce, or **m-commerce**, market is expected to exceed $149B by 2019.[35]

Additionally, mobile use is favored by the young. According to Nielsen's measures of mobile device use, the younger the age group, the greater the percentage of people with mobile devices. Further, younger people have more devices per capita than older groups.[36] These young cohorts will further increase mobile systems use in the years to come.

Because of this vast and growing market, mobile systems are having a major impact on business and society today—impact that is forcing industry change while creating new career opportunities for mobile-IS-savvy professionals, as well as large numbers of new, interesting mobile- IS-related jobs.

Figure 4-23 summarizes the mobile-system impact for each of the five components of an information system. We will discuss each of the components in this figure, starting with hardware.

Hardware

Clearly, increasing demand for mobile systems means the sales of many more mobile devices, often at the expense of PC sales. Hewlett-Packard, a large PC manufacturer, learned this fact when it didn't respond quickly enough to the onslaught of mobile devices and was forced to eliminate 27,000 jobs in 2012. In the future, there will be high demand for innovative mobile devices as well as cheap copycats.

If you're reading this book, you're unlikely to be a hardware engineer, and if you're not living in Asia, you're also unlikely to be involved in hardware manufacturing. However, any market having 3.9 billion prospects is ripe with opportunities in marketing, sales, logistics, customer support, and related activities.

	Hardware	Software	Data	Procedures	People
Impact of mobile systems growth	Many, many more mobile devices will be sold.	Compact interfaces; new technology for active users; application scaling.	More data, but more information? Less device real estate means fewer ads possible.	Always on, always at work. Employee lifestyle becomes hybrid of personal and professional.	Ability to thrive in a dynamic environment more important.
Industry changes	PCs less important; high demand (and requirement) for innovative devices as well as cheap copycats.	html5, css3, and JavaScript increase capability of thin-clients.	Loss of control. Ad model in danger?	Personal mobile devices at work.	More part-time employees and independent contractors.
Career opportunities	Jobs for mobile device sales, marketing, support.	New technology levels the playing field for html5. Business expertise needed for mobile requirements. New companies!	Reporting and data mining even more important. Design of effective mobile reports.	Innovative use of just-in-time data. Need for adjusting business processes gives another premium to non-routine problem solvers.	Independent contractors (and some employees) work where and when they want. What is this new social organism?

FIGURE 4-23
Five Components of Mobile Change and Opportunity

Software

The reduced size of mobile devices requires the invention of new, innovative interfaces. The mobile user is an active user and expects an active screen experience. The premium will be for moving graphics, changing Web pages, and animation. Applications will need to scale from the very smallest to the very largest, while providing a user experience appropriate to the device's size.

Rapid technology change in mobile software continually levels the playing field. Today, for example, expert programmers in Objective-C better not relax. html5 and css3 are gaining popularity, and they will reduce the need for Objective-C expertise. Further, as you learned in Q4–5, while languages like Objective-C are difficult and time-consuming to learn, html5, css3, and JavaScript are less so. With the reduced barrier to entry, hordes of less experienced and less educated new entrants will appear as competitors. You might be one of them.

Additionally, continually evolving software means new and exciting entrepreneurial opportunities. Are you sorry that you missed the early days working at Facebook? Right now, somewhere, there is another Mark Zuckerberg starting... well, what? Because of the continually changing software environment, new opportunities abound and will continue to do so for decades.

Data

Many more mobile systems mean an incredible amount of new data, data that professionals can use to create much more information. But, as you learned in Chapter 1, more data doesn't necessarily mean more information. In fact, many business professionals believe they're drowning in data while starving for information. What can be done with all of this mobile-systems data to enable humans to conceive information of greater value to them? Data mining and better reporting are possibilities for you that are discussed in Chapter 9.

On the other hand, not all the news is good, at least not for many organizations. For one, smaller screens means less room for advertising, a factor that limited the success of the Facebook public offering in May 2012. Also, mobile systems increase the risk of organizations losing control over their data. In the past, employees used only computer equipment provided by the employer and connected only via employer-managed networks. In that situation, it is possible for the

ETHICS GUIDE

FREE APPS FOR DATA

You're sitting in your Introduction to MIS class, and the professor starts talking about how profitable software development can be. He points out that billionaires like Bill Gates (Microsoft), Larry Ellison (Oracle), Larry Page (Google), and Mark Zuckerberg (Facebook) all made their fortunes by developing useful software. But a vocal classmate jumps in and points out that he's never paid any of those people a penny. He uses Google Search, Gmail, and Facebook all for free. Yes, he uses Microsoft Office, but it's the free online version through OneDrive. Even the apps on his smartphone are free.

Then comes the perennial question, which also happens to be a major point of frustration for the tech industry: How do you make money from free apps? The professor says something about capturing market share, potential income, and future innovation. You're not buying it. You're interested in *real* income, not *potential* income.

Nick the Data Broker

The person sitting next to you, Nick, starts smiling broadly and nods his head. He's in your group for your big class project. He leans over and whispers, "If you're not paying for it, *you* are the product. Data is where you make money, not software. Give them the software, take the data, and make the money. It's simple."

You're a little confused at first. But then you think back to last Wednesday when you first met Nick. He said he was coming back to school to get a degree in MIS because he needed the technical knowledge for his new job with his brother's company. He explained that his brother was a data broker (sometimes called an information broker). He buys data about individuals from companies and then sells it to other companies for a profit. It sounded like they were doing really well. Before you could even ask if it was legal or ethical, Nick quipped, "Yes, of course it's legal. Everyone does it." He had obviously gotten this question before.

But was Nick right? He isn't a billionaire like Bill Gates. Nick was only concerned with buying and selling data. He wasn't interested in application development. But he did make a good point, and it got you thinking. What if you started a business that made applications that were designed to collect individual data? You could make dozens of useful apps, collect individual data, and then sell it to Nick.

But what data would Nick pay for? How much of it could you get? He wouldn't care about gaming data. But he would pay for data about user behavior like which Web sites they visit, where they're located, who their friends are, and what they purchase.

Flashlight Apps

At lunch, you do a few searches about how mobile applications can access data on smartphones. It turns out that users just have to grant the application permission(s), and it can access *any* data on the phone. Could that be right? *Any* data? This could be a gold mine. You get excited at the prospect of harvesting thousands of terabytes of data and selling them to Nick. You could retire in a month.

But then a sinking feeling comes over you. What if you're not the first person to think of this idea? What if someone else is already giving away apps and harvesting users' data. You decide to check the permissions for one of the most useful free applications you have on your phone—your flashlight app. You search for "flashlight app permissions" and you see dozens of news articles referencing a threat report by SnoopWall.[37]

The SnoopWall report looked at the permissions required by the top 10 flashlight apps for Android smartphones. The results were shocking. All of these apps did more than just turn a light on and off. They required permission to access data about your location, network connectivity, and USB storage. They also required permissions to install shortcuts, receive data to/from the Internet, modify your system settings, and disable your screen lock.

The app you use was third on the list. Not good. You decide to check to see whether the report was accurate. Were these apps harvesting all this data? You look at the first six flashlight apps that show up in Google Play. The results are shown in the table below. The bottom three rows show the changes in the number of permissions from 2013, 2014, and 2016.

Seeing all of the permissions required by these simple flashlight apps is distressing. Why would your flashlight need your GPS coordinates? Who was getting this data? What were they using it for? It looks like someone had already thought of your data-harvesting idea. It may be too late to make any money off the free-app-for-individual-data scheme. All of a sudden, these free apps don't look as attractive to you—as a consumer.

Permissions	Super-Bright LED Flashlight	Brightest Flashlight Free	Brightest LED Flashlight	Flashlight	High-Powered Flashlight	Tiny Flashlight + LED
Take pictures and videos	X	X	X	X	X	X
Receive data from Internet	X		X		X	
Control flashlight	X	X	X	X**	X	X
Change system display settings	X*		X*		X*	
Modify system settings	X*		X*		X*	
Prevent device from sleeping	X	X	X	X	X	X
View network connections	X	X	X	X	X	X
Full network access	X	X	X	X	X	X
Run at startup						X
Control vibration						X
Retrieve running apps			X*		X*	
Modify or delete the contents of your storage		X	X*		X*	
Read the contents of your storage		X	X*		X*	
View Wi-Fi connections		X	X*		X*	
Read phone status and identity		X	X		X*	
Read Home settings and shortcuts		X		X*		
Write Home settings and shortcuts				X*		
Disable your screen lock				X*		
Install shortcuts		X		X*		
Uninstall shortcuts		X		X*		
Approximate location		X			X*	
Precise location		X			X*	
Disable or modify status bar		X*				
Draw over other apps			X**			
Count 2013	20	15	13	9	15	6
Count 2014	8	15	13	9	15	7
Count 2016	6	14	8	5	6	7
* Dropped for 2016 ** Added for 2016						

DISCUSSION QUESTIONS

1. Consider the decision to create a free application designed to harvest individual data.
   a. Is this decision ethical according to the categorical imperative (pages 23–24)?
   b. Is this decision ethical according to the utilitarian perspective (pages 60–61)?
   c. How would users react if they knew their data was being harvested in exchange for a free app?
2. Suppose Google becomes aware that apps in the Google Play store are harvesting user data unrelated to the function of the application.
   a. Does it have a *legal* obligation to find out which apps are harvesting data inappropriately?
   b. Does it have an *ethical* obligation to find out which apps are harvesting data inappropriately?
   c. Does Google provide free apps in exchange for individual data? Why?
3. How hard should Google work at curating apps in Google Play to ensure that appropriate permissions are set?
4. In 2014, Symantec found that 17 percent of all Android apps were malware in disguise.[38] But a report by Google found that less than 1 percent of all Android devices had a potentially harmful application installed.[39]
   a. Is it ethical for Google to remove applications it considers inappropriate? Consider both the categorical imperative and utilitarian perspectives.
   b. Is it ethical for Google to limit permissions for certain applications? Consider both the categorical imperative and utilitarian perspectives.

organization to control who does what with which data and where. No longer. Employees come to work with their own mobile devices. Data leakage is inevitable.

With more people switching to mobile devices and with less room for ads, online advertising revenue may be sharply reduced, possibly endangering the revenue model that supports most of the Web's free content. If this happens, dramatic change is just around the corner!

Procedures

Mobile systems are always on. They have no business hours. And people who use mobile systems are equally always on. In the mobile world, we're always open for business. It is impossible to be out of the office. One consequence of always-on is the blending of our personal and professional lives. Such blending means, in part, that business will intrude on your personal life, and your personal life will intrude on your business. This intrusion can be distracting and stressful; on the other hand, it can lead to richer, more complex relationships.

Employees will expect to use their mobile devices at work, but should they? In truth, who can keep them from it? If the organization blocks them from connecting to the work-related networks, they can connect over the wireless networks that they pay for themselves. In this case, the organization is entirely out of the loop. Could employees send confidential corporate information through their personal mobile devices? We will discuss these issues in more detail in Q4-7.

Mobile systems offer the potential of **just-in-time data**, which is data delivered to the user at the precise time it is needed. A pharmaceutical salesperson uses just-in-time data when she accesses a mobile system to obtain the latest literature on a new drug while waiting for the doctor to whom she will pitch it. She needn't remember the drug's characteristics any longer than it takes her to walk down the hallway and make the sale.

Furthermore, some organizations will passively wait for change to happen, while others will proactively reengineer their processes to incorporate mobile systems for higher process quality. Either way, the need for business process change creates opportunity for creative, nonroutine business problem solvers.

People

Mobile systems change the value of our thinking. For example, just-in-time data removes the premium on the ability to memorize vast quantities of product data, but creates a premium for the ability to access, query, and present that data. Mobile systems increase the speed of business, giving an advantage to those who can nimbly respond to changing conditions and succeed with the unexpected.

With the ability to be connected and always on, organizations may find they can be just as effective with part-time employees and independent contractors. The increasing regulatory complexity and cost of full-time employees will create an incentive for organizations to do just that.

As that occurs, professionals who can thrive in a dynamic environment with little need for direct supervision will find that they can work both where and when they want, at least a good part of the time. Once you're always on and remote, it doesn't matter if you're always on in New Jersey or at a ski area in Vermont. New lifestyle choices become possible for such workers.

These mobile workers can work where they want and for whom they want. There won't be a boss looking over their shoulder. They can work multiple jobs with different companies at the same time! Companies may have to change the way they pay workers. Instead of paying employees by the hour, they would need to focus more on paying for productivity. This shift toward focusing on performance will empower great employees and make it harder for slackers to hide out in an organization. Companies will benefit from mobile workers too. They won't need as much expensive commercial office space. What an incredible time to be starting a business career!

Q4-7 What Are the Challenges of Personal Mobile Devices at Work?

So far, we've focused on mobile applications that organizations create for their customers and others to use. In this question we will address the use of mobile systems *within* organizations.

In truth, organizations today have a love/hate relationship with their employees' use of their own mobile devices at work. They love the cost-saving possibility of having employees buy their own hardware, but they hate the increased vulnerability and loss of control. The result, at least today, is a wide array of organizational attitudes.

Consider a recent report by Tech Pro Research that estimates 74 percent of companies have adopted BYOD or are planing to do so.[40] If you aren't already bringing your own device to work, you'll soon have to. Yet only 43 percent of all organizations have created an official mobile-use policy.[41]

Advantages and Disadvantages of Employee Use of Mobile Systems at Work

Figure 4-24 summarizes the advantages and disadvantages of employee use of mobile systems at work. Advantages include the cost savings just mentioned as well as greater employee satisfaction of using devices that they chose according to their own preferences rather than organization-supplied PCs. Because employees are already using these devices for their own purposes, they need less training and can be more productive. All of this means reduced support costs.

On the other hand, employee use of mobile devices has significant disadvantages. First, there is the real danger of lost or damaged data. When data is brought into employee-owned computing devices, the organization loses control over where it goes or what happens to it. IBM, for example, disallowed the use of Apple's voice searching application, Siri, on employees' mobile devices for just that reason.[42] Also, if an employee loses his or her device, the data goes with it, and when employees leave the organization, the data on their personal devices needs to be deleted somehow.

Organizations also lose control over the updating of software and the applications that users employ. This control loss leads to compatibility problems; users can process data, for example edit documents, with software that is incompatible with the organization's standard software. The result to the organization is a mess of inconsistent documents.

Possibly the greatest disadvantage of employee use of their own devices is the risk of infection. The organization cannot know where the users have been with their devices or what they've done when they've been there. The possibility of severe viruses infecting the organization's networks is real. Finally, all of these disadvantages can also lead, ironically, to greater support costs.

Given all that, organizations cannot avoid the issue. Whatever the costs and risks, employees are bringing their own devices to work. Ignoring the issue will simply make matters worse.

Advantages	Disadvantages
Cost savings	Data loss or damage
Greater employee satisfaction	Loss of control
Reduced need for training	Compatibility problems
Higher productivity	Risk of infection
Reduced support costs	Greater support costs

FIGURE 4-24
Advantages and Disadvantages of Employee Use of Mobile Systems at Work

Survey of Organizational BYOD Policy

A **bring your own device (BYOD) policy** is a statement concerning employees' permissions and responsibilities when they use their own device for organizational business. Figure 4-25 arranges BYOD policies according to functionality and control. Starting in the lower left-hand corner, the most primitive policy is to ignore mobile use. That posture, which provides neither functionality to the employee nor control to the organization, has no advantages and, as just stated, cannot last.

The next step up in functionality is for the organization to offer its wireless network to mobile devices, as if it were a coffee shop. The advantage to the organization of this policy is that the organization can sniff employees' mobile traffic, thus learning how employees are using their devices (and time) during work.

The next policy provides more functionality and somewhat more control. Here the organization creates secure application services using https (explained in Chapter 10) that require employee sign-on and can be accessed from any device, mobile or not. Such applications can be used when employees are at work or elsewhere. These services provide controlled access to some organizations' assets.

A fourth policy is more of a strategic maneuver than a policy. The organization tells employees that they can sign on to the organization's network with their mobile devices, but the employee is financially responsible for any damage he or she does. The hope is that few employees know what their exposure is and hence decide not to do so.

A more enlightened policy is to manage the users' devices as if they were owned by the organization. With this policy, employees turn over their mobile devices to the IS department, which cleanses and reloads software and installs programs that enable the IS department to manage the device remotely. Numerous vendors license products called **mobile device management (MDM) software** that assist this process. These products install and update software, back up and restore mobile devices, wipe employer software and data from devices in the event the device is lost or the employee leaves the company, report usage, and provide other mobile device management data.

This policy benefits the organization, but some employees resist turning over the management of their own hardware to the organization. This resistance can be softened if the organization pays at least a portion of the hardware expense.

The most controlling policy is for the organization to declare that it owns any mobile device that employees connect to its network. To be enforceable, this policy must be part of the employee's contract. It is taken by organizations that manage very secure operations and environments.

Control

Functionality	Low ←				→ High
High			You're responsible for damage	We'll check it out, reload software and data, and manage it remotely	If you connect it, we own it
		We'll offer limited systems you can access from any device			
	We'll be a coffee shop				
Low	They don't exist				

Full VPN Access to Organizational Systems

Organizational Services on Public Internet

Access to Internet

None

FIGURE 4-25
Six Common BYOD Policies

BYOD Policy	Description	Advantage to Organization
They don't exist	Organization looks the other way when employees bring mobile devices to work.	None
We'll be a coffee shop	You'll be able to sign in to our wireless network using your mobile device.	Packet sniffing of employee mobile device use at work.
We'll offer limited systems you can access from any device	Organization creates https applications with sign-in and offers access to noncritical business systems.	Employees gain public access from any device, not just mobile devices, without having to use VPN accounts.
You're responsible for damage	Threatening posture to discourage employee use of mobile devices at work.	Appear to be permissive without actually being so.
We'll check it out, reload software, then manage remotely	Employees can use their mobile devices just as if they were computers provided by the corporate IS department.	Employee buys the hardware (perhaps with an employer's contribution).
If you connect it, we own it	Employees are not to use mobile devices at work. If they do, they lose them. Part of employment agreement.	Ultimate in control for highly secure work situations (intelligence, military).

FIGURE 4-26
Advantages of Example BYOD Policies

In some military/intelligence organizations, the policy is that any smart device that ever enters the workplace may never leave it. The advantages of these six policies are summarized in Figure 4-26.

BYOD policies are rapidly evolving, and many organizations have not yet determined what is best for them. If your employer has a committee to develop such policies, join it if you can. Doing so will provide a great way to gain exposure to the leading technology thinkers at your organization.

Q4-8 2027?

There's a really old movie called *You've Got Mail* (1998) starring Tom Hanks and Meg Ryan. In it, the characters get really excited when they get "mail." The term *email* was so new at the time that it hadn't even caught on yet. You can see people in the movie reading newspapers and paper books. Oh, how times have changed.

Fast-forward to today. Email now comes in seconds after it's sent. You check your email during commercial breaks while you're watching TV, while you're driving in traffic, and while you're sitting on the toilet. Instead of checking your email with bated breath, you're dreading seeing more work pile up in your inbox. Or worse—bills, spam, and viruses.

New hardware and software have changed everyday life. People are always on, always connected, always communicating, always working and playing. This trend will continue. The Internet of Things will allow us to be continually connected to more and more devices. You'll be able to control your home, and everything in it, from your smartphone. Your home will be so smart that it will analyze you. It will see what, how, and when you do things and then anticipate your needs.

SECURITY GUIDE

POISONED APP-LES

Have you ever stopped to look up at the stars on a clear night and seen a faint white light tracking slowly across the sky? If so, you've seen a satellite orbiting the earth at speeds exceeding thousands of miles per hour. What may surprise you is that early spacecraft launched by NASA had less computing power than your smartphone. That's right—the small handheld device you use for checking social media and email and for playing games is more powerful than the first spacecraft. But why do you need all of that computing power? Phone calls and text messages don't seem to require massive processing power. Welcome to the era of the "app"!

Apps are the drivers of faster and more powerful smartphones. Apple and other smartphone manufacturers release new versions of their phones on an annual basis. Keeping up with the flashiest and most powerful apps drives the demand for faster processing chips and more memory. Advancements in both of these areas often happen without increasing the form factor of the phone or reducing battery life.

Smartphone users have a seemingly insatiable appetite for apps. In 2014, the Apple App Store contained more than 1.2 million apps, reported 75 billion app downloads, and listed 9 million registered app developers.[43] These apps allow you to do everything from making stock trades on the go to checking the latest weather conditions anywhere in the world. While most apps cost only a few dollars, many of them are free. You may be wondering, "How is this possible?" and "Are there any hidden costs?" You may be surprised to learn that free apps may not be such a great deal after all.

XcodeGhost Haunts iOS

The App Store is generally a well-regulated marketplace. Apps are screened for security vulnerabilities and vulgar content in order to create a safe experience for users. However, with more than a million applications available to consumers, it is inevitable that some malicious apps clear the screening process.

Apple recently reported that dozens of apps available on the App Store contained a malware application named XcodeGhost. Apps containing this malware reportedly accessed user credentials, hijacked URLs, were able to read and write data on devices, and compromised other iOS apps. WeChat, an app used extensively in China, was affected by XcodeGhost and contributed heavily to the tally of more than 500 million iOS users who could have been exposed to this dangerous malware.[44]

The malware was embedded in apps available on the App Store because developers chose to install a compromised version of the Xcode developers kit despite warnings that the software had been altered. Developers were downloading the compromised software because it had been posted on a server offering faster-than-standard download speeds.

Once this vulnerability had been identified, Apple notified users that the dangerous apps had been removed from the App Store and that they were collaborating with developers to ensure that this type of incident does not happen again. However, even with these apps identified and removed,

Source: © CarmenMurillo/iStock/Getty Images Plus

this security breach begs the question "What other vulnerabilities are lurking in the App Store, and have you already downloaded any of these potential threats?"

Installation App-rehension

Have you ever been using your phone and seen an alert message indicating that one of the apps on your phone was accessing your location information in the background? If so, were you worried? Did you allow the app to continue monitoring your location, or did you shut it off? A key point to consider is that an app does not have to be considered malware to be dangerous or invasive. In fact, many of the apps on your phone are likely accessing data that are unrelated to the app's specific purpose. For example, a survey of apps with built-in networking tools revealed that 13 out of 15 of these apps uploaded all user contacts on the phone to remote servers managed by the app developers.[45] Contact information can then be sold to advertisers and other third parties for a profit.

This type of indirect information gathering is why many of the apps downloaded from the App Store are free. End users end up paying for them with their privacy. But why do users tolerate an invasion of their privacy? Users often fail to review the usage agreement for each app.[46] Even more striking is that developers can change the terms of privacy agreements after a user has agreed to a prior version of the terms.

Despite the tremendous convenience, productivity, and entertainment afforded by our phones and apps, there are hidden costs. These hidden costs may include the risk of downloading dangerous software or inadvertently allowing apps access to private data. A little app-rehension may help users prevent a serious privacy invasion or data theft.

DISCUSSION QUESTIONS

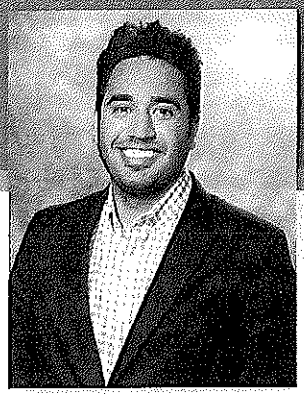
1. Think about your use of various phone and computer apps and your interactions on social media. Have you ever experienced a breach of your privacy or personal data? What was the impact of this breach? Were you able to resolve it, or were you forced to live with the consequences?
2. Try to identify three different strategies that any smartphone user could follow in an attempt to minimize the risk of installing and using dangerous/risky apps.
3. Reflect on the trade-off between free apps and the potential privacy risks that these apps may introduce. Has this article changed your perception of free apps? If so, how?
4. Conduct an Internet search to identify if there have been any recent security vulnerabilities introduced through an app store (e.g., the App Store, Google Play, or Windows Phone Store). If so, conduct a brief investigation to see which apps are involved, how many people have been affected, and whether the vulnerability has been resolved.

Imagine your TV turning on every morning at just the right time so you can watch the markets open (see Figure 4-27). You smell fresh-baked bread, your shower turns on by itself, and your car knows exactly when to self-start so it's warm when you get in. Your self-driving car will let you work on your way to work. You'll see these anticipatory systems at your job too.

How will advances in hardware and software affect the types of jobs you'll go to? Ten years from now, the best-paying jobs will be ones that don't currently exist. The following are hot jobs today: IoT architect, marketing technologist, BigData architect, and DevOps manager. These job titles didn't exist 10 years ago. Ten years from now, there will be an entirely new set of jobs that you haven't heard of before.

How do you prepare for future jobs? What types of jobs will pay well? Regardless of your current college major, your future job will probably require a high level of tech skill. The best way to prepare for these types of jobs is to cultivate creativity, novel problem solving, and good judgment and have a sincere desire to learn new things.

CAREER GUIDE



Name: Alfredo Zorrilla
Company: Microsoft Corp.
Job Title: Technical Account Manager
Education: University of Utah

Source: Alfredo Zorrilla

1 How did you get this type of job?

When I interviewed for the role, I presented myself as a well-rounded candidate by highlighting a combination of soft and technical skills acquired as part of professional and academic experiences. The soft skills came as a result of several years serving in various customer service and relationship management roles at a major financial institution. Those skills include the ability to establish excellent interpersonal relationships, lead and work well with teams, and communicate in an effective and concise manner. The technical skills were acquired academically and include a broad understanding of a variety of IS topics like programming, networking, statistics, and system and database architecture and modeling.

2 What attracted you to this field?

Working as a technical account manager is a great way to combine relationship management with technical planning and troubleshooting. I realize that there's a certain romanticism around the stereotypical geek who can bang out 10,000 lines of code a day while chugging their favorite citrus-flavored soda and indulging in their preferred brand of crunchy cheesy-puffs, but I didn't want to just sit at a desk all day and "crush code." I also wanted to be involved in high-level strategy discussions with BDMs (business decision makers) and TDMs (technical decision makers). This field allows me to do a little of both.

3 What does a typical workday look like for you (duties, decisions, problems)?

There isn't a typical workday for me because there is always a different challenge or opportunity to tackle. I work directly with a very large Microsoft client, so some days I will be interacting with a VP of Infrastructure to learn more about the long-term IT goals of the organization and how they tie to its business priorities, while on others, I will be sitting side by side with a group of engineers trying to resolve a complex technical incident. I also have to work with several groups internally like Sales, Support, and the Product Group to ensure we are all achieving our mission of One Microsoft. The best way to describe what I do is this: work across every level of the client organization and leverage several different groups of my internal organization to ensure the customer is realizing maximum value from their software investments.

4 What do you like most about your job?

The best part about my job is the flexibility. Flexibility doesn't just mean that I can work whenever I want (which is true but does require a high level of self-motivation) but also that I can work toward my goals in whatever way I deem most efficient. We are encouraged to behave as "our own business," so even though there is an established set of best practices we can follow, how or if we implement them is ultimately up to us. Priority number one is for the clients to be happy with their Microsoft investment, and the best way to accomplish this is for their infrastructure to be stable.

5 What skills would someone need to do well at your job?

A successful technical account manager needs to wear many hats. One minute you may be discussing really technical problems with a systems engineer and the Microsoft Support team, and the next you may be presenting a solution to a VP or CIO alongside the Sales team. Therefore, the most important skill is to be able to interface successfully with anyone in the client and internal organizations. This requires the ability to communicate well, demonstrate a sense of empathy and ownership,

solve problems quickly, work well under pressure, speak the languages of business and technology, and, above all, accomplish everything with high a level of integrity and accountability.

6 Are education or certifications important in your field? Why?

Absolutely. Continuing education and certifications are a great way to remain relevant and not become stale. Technology is changing at such a rapid pace that it is essential for organizations to become nimble so they can keep up with others in their industry. This makes it more important than ever to embrace and become acquainted with the latest trends so we can speak knowledgeably when the client expresses interest in pursuing a new direction. If we can't do that, a competitor surely will.

7 What advice would you give to someone who is considering working in your field?

Work toward achieving 300- to 400-level understanding in an area you are passionate about and 100- to 200-level understanding in everything else. The competition in the job market is fierce. If you can demonstrate you are an expert in one or two things but can also speak reasonably well to many others, you become a coveted candidate because many platforms are becoming increasingly interdependent. Also, build up a strong network, become part of a community, and leverage social media to broadcast yourself as a subject matter expert (SME) in a given topic. Blogging or contributing to sites like GitHub or Stack Overflow is a great way to achieve this.

8 What do you think will be hot tech jobs in 10 years?

Anything having to do with cloud, mobile, IoT, and BigData/analytics. The latter, in particular, will probably continue to experience tremendous growth as machine learning becomes more ubiquitous in industry.

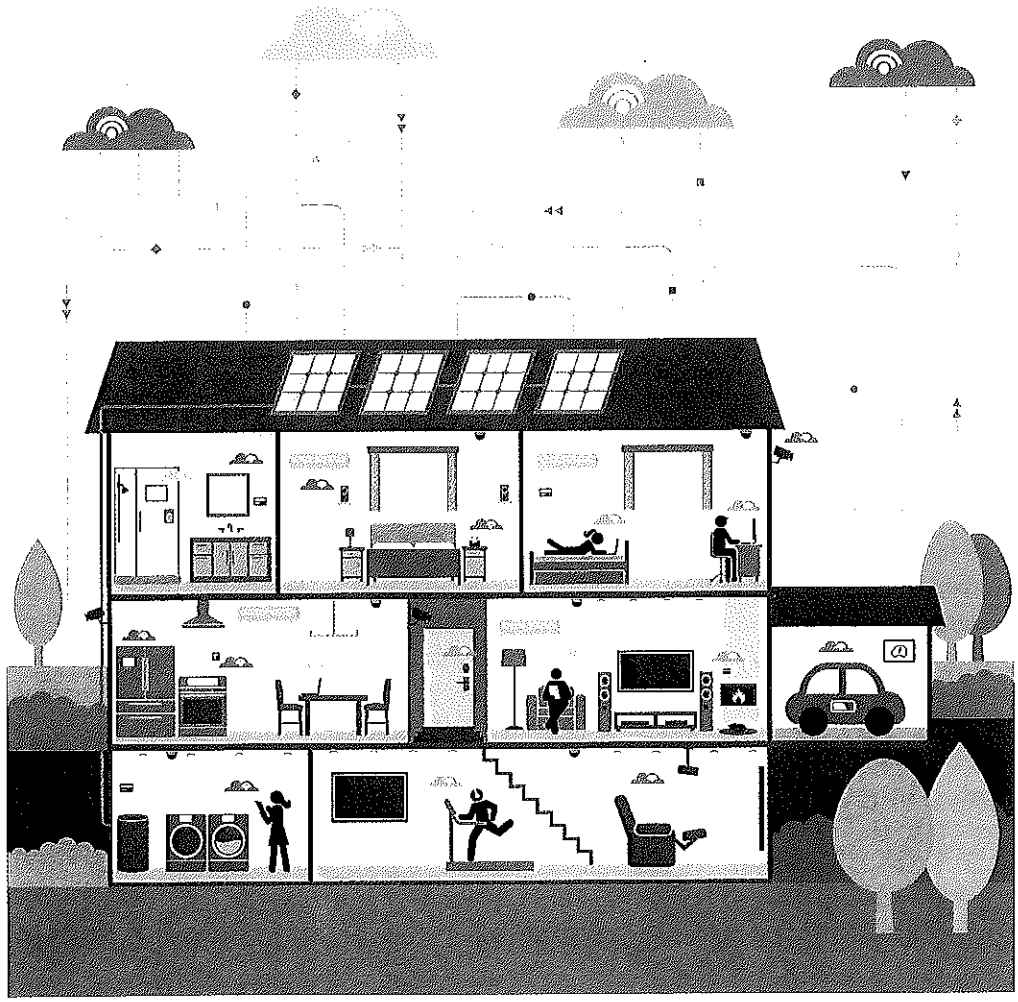


FIGURE 4-27
Smart Home
Source: Si-Gal/iStock Vectors/Getty Images

ACTIVE REVIEW

Use this Active Review to verify that you understand the ideas and concepts that answer the chapter's study questions.

Q4-1 What do business professionals need to know about computer hardware?

List types of hardware and give an example of each. Define *bit* and *byte*. Explain why bits are used to represent computer data. Define the units of bytes used to size memory.

Q4-2 How can new hardware affect competitive strategies?

Define *IoT* and describe a smart device. Explain why smart devices are desirable. Give two examples of how businesses could benefit from smart devices. Describe the difference between AR, MR, and VR. Explain why sense of presence is important in virtual environments. Describe how self-driving cars could be safer and cheaper and make life easier. Explain how 3D printing works and how it could affect new product design, manufacturing, distribution, and consumer purchasing.

Q4-3 What do business professionals need to know about software?

Review Figure 4-12 and explain the meaning of each cell in this table. Describe three kinds of virtualization and explain the use of each. Explain the difference between software ownership and software licenses. Explain the differences among horizontal-market, vertical-market, and one-of-a-kind applications. Describe the three ways that organizations can acquire software.

Q4-4 Is open source software a viable alternative?

Define *GNU* and *GPL*. Name three successful open source projects. Describe four reasons programmers contribute to open source projects. Define *open source, closed source, source code,* and *machine code.* In your own words, explain why open source is a legitimate alternative but may or may not be appropriate for a given application.

Q4-5 What are the differences between native and Web applications?

In your own words, summarize the differences between native applications and Web applications. In high-level terms, explain the difference between object-oriented languages and scripting languages. Explain each cell of Figure 4-19. State which is better: native or Web applications. Justify your answer.

Q4-6 Why are mobile systems increasingly important?

Define *mobile systems*. Name and describe the four elements of a mobile system. Describe the size of the mobile market and explain why there are 3.9 billion mobile prospects. Explain why the mobile market will become stronger in the future. Explain why a problem for one organization is an opportunity for another. Using the five-component model, describe particular opportunities for each component. Define *just-in-time data* and explain how it changes the value of human thinking.

Q4-7 What are the challenges of personal mobile devices at work?

Summarize the advantages and disadvantages of employees' using mobile systems at work. Define *BYOD* and *BYOD policy*. Name six possible policies and compare them in terms of functionality and organizational control. Summarize the advantage of each to employers.

Q4-8 2027?

Explain how email usage has changed over the past 15 years. Describe how an anticipatory system might work. Explain how advances in hardware and software might change the types of jobs you take in the future.

Using Your Knowledge with Falcon Security

Suppose you are part of this Falcon Security team. Briefly summarize how the knowledge in this chapter would help you contribute. Explain why Falcon Security decided not make its own drones using 3D printing. Summarize the challenges it would face if it did decide to make its own drones.

KEY TERMS AND CONCEPTS

Android 129
Application software 131
Augmented reality (AR) 121
Binary digits 117
Bits 117
BlackBerry OS 129
Bring your own device (BYOD) policy 146
Bytes 118
Central processing unit (CPU) 115
Client 116
Closed source 135
Computer hardware 115
Custom-developed software 132
Desktop virtualization 130
Dual processor 116
Exabyte (EB) 118
Firmware 132
Gigabyte (GB) 118
GNU 133
GNU general public license (GPL) agreement 133
HoloLens 154
Horizontal-market application 132
Host operating system 129
Internet of Things (IoT) 119
iOS 129
Just-in-time data 144
Kilobyte (KB) 118
License 131
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Machine code 135
Main memory 116
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Mobile device 139
Mobile device management (MDM) software 146
Mobile systems 139
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Operating system (OS) 126
PC virtualization 130
Personal computers 116
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RAM 116
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Self-driving car 122
Sense of presence 122
Server 116
Server farm 116
Server virtualization 130
Site license 131
Smart device 119
Solid-state storage (SSD) 116
Source code 135
Storage hardware 116
Swift 136
Symbian 129
Tablets 116
Terabyte (TB) 118
Thick-client application 127
Thin-client application 127
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Vertical-market application 132
Virtual 121
Virtualization 129
Virtual machines (vm) 129
Virtual reality 122
Volatile 118
Web application 127
Windows 10 (mobile) 129
Windows Server 129
Zettabyte (ZB) 118

MyMISLab™

To complete the problems with the MyMISLab, go to EOC Discussion Questions in the MyLab.

USING YOUR KNOWLEDGE

4-1. MyMISLab Microsoft offers free licenses of certain software products to students at colleges and universities that participate in its DreamSpark program (formerly known as the Microsoft Developer Network [MSDN] Academic Alliance [AA]). If your college or university participates in this program, you have the opportunity to obtain hundreds of dollars of software for free. Here is a partial list of the software you can obtain:

- Microsoft Access 2016
- Microsoft OneNote 2016
- Microsoft Windows Server 2016
- Microsoft Project 2016
- Microsoft Visual Studio 2015
- Microsoft SQL Server 2016
- Microsoft Visio 2016

a. Search *www.microsoft.com*, *www.google.com*, or *www.bing.com* and determine the function of each of these software products.

b. Which of these software products are operating systems, and which are application programs?

c. Which of these programs are DBMS products (the subject of the next chapter)?
d. Which of these programs should you download and install tonight?
e. Either (1) download and install the programs in your answer to part d or (2) explain why you would choose not to do so.
f. Does DreamSpark provide an unfair advantage to Microsoft? Why or why not?

4-2. MyMISLab Visit the Open Source Initiative's Web site at *www.opensource.org*. Summarize the mission of this foundation. Find the definition of open source on this site, and summarize that definition in your own words. Explain this foundation's role with regard to open source licenses. Summarize the process for having a license approved by the foundation. Describe the advantage of having the foundation's approval.

4-3. MyMISLab Suppose that you are Cam at Falcon Security. List five criteria you would use in helping Falcon Security decide whether it should make its own drones. Justify your criteria.

4-4. Describe how the class enrollment application at your university could benefit from a mobile application that uses the cloud.

4-5. Judging from your personal experience, describe the BYOD policy that appears to be in place at your university. Explain the advantages and disadvantages of the policy to you as a student and to the organization as a whole. How do you think that BYOD policy will change in the next five years? Explain your answer.

4-6. Read Q4-2 if you have not already done so. Critically evaluate the opinions of the author. Do you agree that advances in the IoT and self-driving cars will make life easier? Better? If so, say why. If not, explain what you think will happen when more smart devices and self-driving cars are adopted. Explain how you could prepare for a future high-tech job market.

COLLABORATION EXERCISE 4

Using the collaboration IS you built in Chapter 2 (page 75), collaborate with a group of students to answer the following questions.

In March 2016, Microsoft released the development edition of its new mixed-reality head-mounted device named Microsoft **HoloLens**. HoloLens differs from digital reality devices like Meta 2 or Oculus Rift because it is a stand-alone, untethered computing device. In other words, it doesn't have to be plugged into a computer. It's a complete Windows 10 computer.[47]

HoloLens has a custom-built holographic CPU, an Intel 32-bit processor, 2 GB of RAM, and 64 GB of storage. It can be used for 2 to 3 hours without being recharged, and it comes with Bluetooth/Wi-Fi connectivity. It also comes with a 2-megapixel HD video camera, four microphones, motion sensors, light sensors, environmental cameras, and a depth-sensing camera.

As a result, HoloLens can do some pretty amazing things. It accepts voice commands and gesture commands (e.g., air tapping), it maps spaces in a room, and, most importantly, it creates holograms (virtual objects) in thin air. You can watch videos of how HoloLens works on its YouTube channel.

In a recent demonstration, Microsoft showed how HoloLens could be used collaboratively by having two people in different locations fix a plumbing problem together. A person with a broken pipe was wearing HoloLens, and a person who knew how to fix the pipe was in separate location. The person wearing the HoloLens could see 3D holographic arrows appear on the pipes indicating what needed to be done to fix the problem. The arrows were being hand-drawn on a tablet showing a live video feed from the HoloLens.

In another example, designers and engineers at Autodesk use HoloLens to collaboratively create new products.[48] Mechanical engineers, industrial designers, and marketing managers can all see the product as it's being designed. They don't have to iterate through numerous physical prototypes. They can make immediate changes to a virtual prototype before it's even built.

Volvo is using HoloLens in a similar way. The company has been able to reduce design times and potentially improve its manufacturing processes with the device. HoloLens also helps with sales. Using the device, customers can change the color of the car they're looking at with one click. Salespeople can also show customers interactive demonstrations of a car's built-in safety features (like automatic breaking sensors) in 3D holographic environments.

The potential uses for HoloLens are staggering. Gamers won't be stuck on the couch playing video games anymore; they will be able to play multiplayer holographic games anywhere with anyone—for 2 hours. HoloLens will also change the way people communicate. Microsoft engineers recently gave a demonstration of "holoportation" in which a real-time interactive 3D hologram of a person was holoported into another room. Users wearing HoloLens could interact with the person as if they were in the same room.

Many other applications in education, entertainment, tourism, design, engineering, and movies are being developed. And, because HoloLens is one of the first mixed-reality devices to become commercially available, it's likely that the best applications for this technology are still unknown. We simply don't know what people will use it for. What is clear, however, is that

big names like Google, Microsoft, and Apple are making large investments into mixed-reality devices like HoloLens. They see the potential and are voting with their wallets.

Recall the RAND study cited in Chapter 1 that stated there will be increased worldwide demand for workers who can apply new technology and products to solve business problems in innovative ways. Microsoft HoloLens is an excellent example of a new technology that will be applied innovatively.

4-7. Consider uses for HoloLens at your university. How might HoloLens be used in architecture, chemistry, law, medicine, business, geography, political science, art, music, or any other discipline in which your team has interest? Describe one potential application for HoloLens for five different disciplines.

4-8. List specific features and benefits for each of the five applications you selected in question 4-7.

4-9. Describe, in general terms, the work that needs to be accomplished to create the applications you identified in question 4-7.

4-10. Some people buy gaming consoles like Sony PlayStation and Microsoft Xbox because of exclusive games. Not all video games are available on all consoles. How important might applications be in the success of digital reality devices like HoloLens, Meta 2, and Oculus Rift?

4-11. You will sometimes hear the expression "Emerging technology is constantly leveling the playing field." In other words, technology eliminates competitive advantages of existing companies and enables opportunities for new companies. How does this statement pertain to HoloLens, iPad, Windows 10, Apple, and Google?

CASE STUDY 4

The Apple of Your i

A quick glance at Apple's stock history in Figure 4-28 will tell you that Apple is an incredibly successful and dramatic company, having peaks around the turn of the century, in 2007–2008, 2012 and again in 2015. At its high, it had the highest market value of any public company worldwide. Apple has been so successful that the NASDAQ stock exchange concluded Apple's price was skewing the price of the NASDAQ 100 Index and reduced Apple's weight in that index from 20 percent to 12 percent. As of this writing, Apple stock is trading at $95 after hitting a recent low of $56 in 2013.

But since Steve Jobs's death (October 5, 2011), there haven't been any groundbreaking products like the iPod, iPhone, and iPad. iWatch was released in 2015, but many initial reviews were tepid at best.[49] There were already several smartwatches

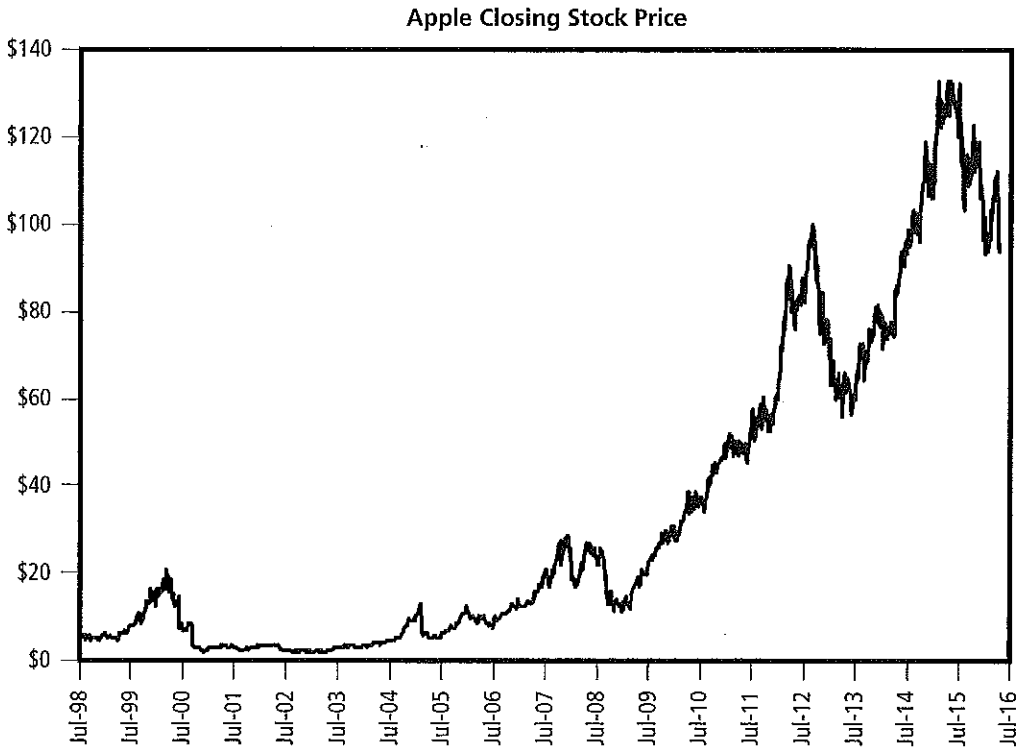

FIGURE 4-28
Growth in Apple Stock Price
Source: Financial data from *finance.yahoo.com*

on the market that had similar functionality, and it had performance issues. Most importantly, it wasn't clear if the iWatch provided enough value over the iPhone that was already in users' pockets. In short, it wasn't an immediate hit. So, what does the future look like for Apple and its shareholders? Uncertain, especially if you consider its past history without Jobs.

Early Success and Downfall

At the dawn of the personal computer age, in the early 1980s, Apple pioneered well-engineered home computers and innovative interfaces with its Apple II PC for the home and its Macintosh computer for students and knowledge workers. At one point, Apple owned more than 20 percent of the PC market, competing against many other PC vendors, most of which are no longer relevant (or in business).

However, Apple lost its way. In 1985, Steve Jobs, Apple's chief innovator, lost a fight with the Apple board and was forced out. He founded another PC company, NeXT, which developed and sold a groundbreaking PC product that was too innovative to sell well in that era. Meanwhile, Apple employed a succession of CEOs, starting with John Sculley, who was hired away from Pepsi-Cola where he'd enjoyed considerable success. Sculley's knowledge and experience did not transfer well to the PC business, however, and the company went downhill so fast that CNBC named him the 14th worst American CEO of all time.[50] Two other CEOs followed in Sculley's footsteps.

During this period, Apple made numerous mistakes, among them not rewarding innovative engineering, creating too many products for too many market segments, and losing the respect of the retail computer stores. Apple's PC market share plummeted.

Steve Jobs, Second Verse

In 1996, Apple bought Jobs's NeXT computing and gained technology that became the foundation of macOS Sierra, today's Macintosh operating system. The true asset it acquired, however, was Steve Jobs. Even he, however, couldn't create an overnight miracle. It is exceedingly difficult to regain lost market share and even more difficult to regain the respect of the retail channel that had come to view Apple's products with disdain. Even by 2011, Apple's PC market share was in the range of 10 percent to 12 percent, down from a high of 20 percent in the 1980s.

In response to these problems, Apple broke away from the PC and created new markets with its iPod, iPhone, and iPad. It also countered retailer problems by opening its own stores. In the process, it pioneered the sale of music and applications over the Internet.

iPod, iPhone, and iPad devices are a marvel of creativity and engineering. They exude not only ease of use, but also now/wow/fun coolness. By selling hot music for the iPod, Apple established a connection with a dynamic segment of the market that was willing to spend lots of money on bright, shiny objects. The ability to turn the iPhone on its side to rotate images probably sold more iPhones than anything else. With the iPad, portable devices became readable, and the market responded by awarding Apple a 44 percent share of the mobile market.[51] And Apple's success continues with the iPhone 7, which, as of this writing, is selling well.

All of this success propelled Apple's stores not only beyond vanilla retailers like Best Buy but also beyond the lofty heights of Tiffany & Co. In 2011, Apple stores were grossing more than $4,000 per square foot, compared with $3,000 for Tiffany and a mere $880 for Best Buy. Apple currently operates more than 447 such retail outlets and has welcomed more than a billion customer visits.[52]

Apple encourages customer visits and loyalty with its open and inviting sales floor, its Genius Bar help desk, and its incredibly well-trained and disciplined sales force. Salespeople, who are not commissioned, are taught to be consultants who help customers solve problems. Even some vocabulary is standardized. When an employee cannot solve a customer's problem, the word *unfortunately* is to be avoided; employees are taught to use the phrase *as it turns out* instead.[53] Try that on your next exam!

Apple has sold more than 25 billion songs through its iTunes online store, 130 million books through its iBookstore, and a mere 75 billion applications downloaded through its App Store. Apple is now the number-one PC software channel.[54]

To encourage the development of iPhone and iPad apps, Apple shares its revenue with application developers. That would be more than $25B paid to developers over the years![55] Developers responded by creating 1,000,000 iOS applications, and an army of developers are at work building thousands more while you read this.

By the way, if you want to build an iOS application, what's the first thing you need to do? Buy a Macintosh. Apple closed its development to any other development method. Adobe Flash? No way. Apple claims that Flash has too many bugs, and perhaps so. Thus, Flash developers are excluded. Microsoft Silverlight? Nope. Microsoft developers are out in the cold too. The non-Apple development community was furious, and Apple's response was, in essence, "Fine, we'll pay our $25B to someone else."

The bottom line? Until Jobs's death, every sales success fed every other sales success. Hot music fed the iPod. The iPod fed iTunes and created a growing customer base that was ripe for the iPhone. Sales of the iPhone fed the stores, whose success fed the developer community, which fed more applications, which fed the iPhone and set the stage for the iPad, which fed the App Store, which led to more loyal customers and, of course, to more developers.

Apple Without Steve Jobs

Apple's future is uncertain. It floundered when Jobs was fired in the 1990s, and it could flounder again. Sure, it'll be around for a long time, but the days of its incredible innovative leadership could be, alas, over.

QUESTIONS

4-12. Which of Porter's four competitive strategies does Apple engage in? Explain.

4-13. What do you think are the three most important factors in Apple's past success? Justify your answer.

4-14. Steve Jobs passed away in October 2011. Until his death, he had been the heart and soul of Apple's innovation. Today, 115,000 Apple employees continue onward in his absence. A huge question for many investors is whether the company can be successful without him. What do you think? What role did Jobs play? How can Apple respond to his loss? Would you be willing to invest in Apple without his leadership? Why or why not?

4-15. Microsoft took an early lead in the development of tablet devices (like the iPad), and it had the world's leading operating system and applications for more than 20 years. Provide five reasons why Microsoft has not been able to achieve the same success that Apple has. Most industry analysts would agree that the skills and abilities of Microsoft's 118,584 employees are as good, on average, as Apple's.

4-16. Considering your answers to the four questions above, if you had a spare $5,000 in your portfolio and wanted to buy an equity stock with it, would you buy AAPL (Apple)? Why or why not?

MyMISLab™

Go to the Assignments section of your MyLab to complete these writing exercises.

4-17. Suppose your first job after graduating from college is working at a large insurance company. Your boss asks you to analyze the impact self-driving cars will have on revenues from car insurance policies. List four ways self-driving cars could impact the insurance industry. Justify your answers.

4-18. Visit *www.distrowatch.com*. Click on one of the top five listed Linux distributions (like Mint, Ubuntu, Debian, Fedora, or OpenSUSE). Click on the Screenshots link for that distribution. List some similarities between this operating system and your current operating system. Summarize the advantages and disadvantages of switching from your current operating system to a Linux distribution.

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