



# Emerging Computer Technologies

## Learning Objectives

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After reading this chapter, you should be able to complete the following:

- List the impact of mobile phones, smart cards, GPS, and augmented reality.
- Summarize the key developments of e-readers, tablets, and smartphones.
- Describe the significance of artificial intelligence.
- Explain the concept of cloud computing.

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## Introduction

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The final stop in our journey toward computer literacy is the emerging computer technologies of the present and what might be on the horizon in the future. Instead of trying to imagine what computers will be like in 50 years, we are going to look at the near-term future (with the exception of the cloud) and the computer technologies emerging right now. We can get a glimpse of this future by studying some of the trends that are occurring before our eyes. In this chapter, we will explore topics such as mobile computing, artificial intelligence, and something called cloud computing.

Even looking at the near-term future is a difficult task. Bill Gates, the founder of Microsoft®, did this for the computer industry in 1995 when he published *The Road Ahead*. In this book, he pointed out famous historical examples of experts who clearly got the future wrong. There was the professor in 1878 who thought that electric lighting was a gimmick. Then there was the U.S. Patent Commissioner who in 1899 was convinced that every significant invention had already been invented (Gates, 1996). In the middle of the 20th century, many people believed that every family in the 21st century would have a helicopter or at least a personal jet pack. We will try to do a better job with our predictions in this chapter. Let's take a look at the exciting road we are on now, as well as the road ahead.

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## Pre-Test

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1. GPS works through a process called
  - a. triangulation.
  - b. triatomic.
  - c. triangularity.
  - d. triarticulate.
  
2. Who makes the Kindle e-reader?
  - a. Amazon
  - b. Microsoft®
  - c. Apple®
  - d. Barnes & Noble
  
3. IBM®'s Deep Blue was an expert system capable of
  - a. determining the nature of a bacterial infection.
  - b. beating the world's best chess player.
  - c. diagnosing blood diseases.
  - d. emulating language skills.
  
4. Which of the following is NOT an example of a personal cloud individuals can use to store their data?
  - a. Dropbox
  - b. Carbonite®
  - c. SkyDrive®
  - d. UBUNTU

**Answers**

1. a. triangulation. *The answer can be found in Section 9.1.*
2. a. Amazon. *The answer can be found in Section 9.2.*
3. b. beating the world's best chess player. *The answer can be found in Section 9.3.*
4. b. Carbonite. *The answer can be found in Section 9.4.*

## 9.1 Mobile Phones

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Years ago, if you were away from your phone or office you had to look for a pay phone. For a dime, you could make a telephone call that lasted a few minutes. Pay phones were ubiquitous, with several often lined up in a row at heavily populated public places. Sometimes, there was an actual phone booth with a folding glass door that enabled people to make phone calls in relative privacy. The comic book hero Superman made these famous as the place he transformed from Clark Kent to the superhero. But today, the pay phone and the phone booth are little more than a memory. Now, calling from the road is as easy as reaching into your pocket.

### Smartphones

One of the most significant new computing devices in the last few decades is the smartphone. During the 1990s, three major technological developments gained popularity. First, were cell phones and their service plans, which became much less expensive. By the end of the decade, almost everyone had one. Second, a new type of electronic device emerged at the same time called the **PDA** or Personal Digital Assistant. These small, handheld computers, initially sold by Palm and Visor, offered calendars, datebooks, organizational software, and gaming applications. Third, laptops were increasingly able to surf the Internet, provided their owners could locate a Wi-Fi hotspot. As email became more essential, laptops were often carried just to check email. By the end of the 1990s, businessmen and women were often lugging around all three devices to remain as productive as possible. Could all three merge into one?

This dream was realized in 2004, when the BlackBerry® smartphone was introduced for AT&T and T-Mobile cell service. A smartphone combined the features of a PDA with a cell phone and the ability to check email. It also served as a flash drive, media player for music and video, and picture viewer. And it added a QWERTY keyboard, with keys that were smaller but laid out in the same configuration as a standard computer keyboard. Soon, other competitors emerged and BlackBerry® quickly lost market share, most notably to the iPhone®, of which 6 million were sold in 2007, its first year on the market (<http://www.statista.com/statistics/12743/worldwide-Apple-iphone-sales-since-3rd-quarter-2007/>).

### iPhone®

Apple's® eagerly awaited iPhone® capitalized on the huge following it had established with its iPod® handheld music and video players and Macintosh® computers. Duplicating the same elegance and user-friendliness with its iPhone®, Apple® began to dominate the market, as its iPhone® App Store<sup>SM</sup> enabled users to download applications that fit their own unique needs. TIME™ Magazine named it as the invention of the year in 2007. In 2009, the

iPhone® 3.0 included a camera, 3G connection speeds, and voice control. At the same time, Apple® also improved the device's **GPS** functionality. In 2012, the iPhone® 4S came in 16- to 64-GB memory options, with prices between \$199 and \$399. At 4.5 in. tall, and 2.3 in. wide, it weighed just 4.9 ounces and was .37 in. in depth. With Wi-Fi, Bluetooth™ wireless, and **4G** cellular connection speeds, it transferred data quickly. It also introduced human-like interface with Siri®, which attempted to answer voice commands by the user (<http://www.apple.com/iphone/specs.html>).

### A Closer Look: The iPhone®

Do you have an iPhone®? What do you like and dislike about it compared to other smartphones?

To see how Siri® works, visit this site: <http://www.apple.com/iphone/features/siri.html>

In 2013, the iPhone® 5 is the latest in the fast-evolving line of Apple® phones. You can learn about it here: <http://www.apple.com/iphone/>

## Android™

While the iPhone® was making headlines, the executives at Google began planning their own revolutionary announcement. In 2005, Google purchased the developer of a mobile operating system called Android™. In 2007, it began releasing the Android™ code to developers, and with phones manufactured by HTC and with Verizon as its carrier, Google capitalized on its huge Web-based following as a search engine. By 2010, it earned the distinction of having the world's most used smartphone platform (Tecca, 2012). Today, it is the operating system for millions of phones (popular ones include HTC and Samsung Galaxy® series), tablets, and related computing devices (<http://www.Android.com/about/>).

## Windows®

Microsoft® also is a major player in the smartphone competition. With a Windows® operating system, a variety of manufacturers offer Windows® smartphones, including: Samsung Focus 2, Nokia Lumia 900, HTC Titan II, and LG Quantum.

It boasts a simplified design with the use of Live Tiles (this is similar to the Windows® 8 operating system for tablet and desktop computers). Live Tiles allows the user to personalize the start screen by placing any applications, photos, games, songs, websites, or documents they want. These items will update automatically in real time, allowing the user to get the latest information on the items they are following (<http://www.windowsphone.com/en-us/features>).

## Smart Cards

Phones are not the only “smart” devices out there. There is also an emerging technology called the **smart card**, which looks like a credit card, but has an embedded processor that replaced the magnetic strip used for identification purposes in traditional credit cards. The processor also has a memory so that data about the owner can be stored. A smart card can

be swiped in a smart card reader in much the same way as a credit card, but it can also communicate through a radio frequency interface. Smart cards are currently more popular in Europe than the United States; for example, every German citizen carries a smart card containing information for medical purposes. The smart card can do many things that a credit card cannot. The Smart Card Alliance (<http://www.smartcardalliance.org/>) is a nonprofit group working to promote the use of this technology in areas such as electronic monitoring, finance, government, health care, identity, telecommunications, and transportation.

The smart card is very different from the magnetic stripe card, which is in wide usage today. These do not have an embedded computer processor, but they are “smart” because they contain data encoded with iron particles on the back of the card. These are used in hotels for access to rooms, ATM cards, credit cards, driver’s licenses, and many other areas.

## GPS

One of the powerful tools that many mobile devices have is GPS. GPS is an acronym for Global Positioning System, a network of satellites (24 of them), computers, and receivers that can work together to calculate your exact position on earth (latitude, longitude, and altitude). This is achieved by **triangulation**, or comparing the time it takes for a signal to reach three different satellites. The Department of Defense built this revolutionary technology at a cost of \$12 billion and it was originally intended primarily for military use. However, GPS in nonmilitary applications first appeared as turn-by-turn navigational aids in automobiles in 1990. Apple® made GPS a central feature of the 3.0 version of its iPhone®. This meant that you could hold the phone in your hand and look at exactly where you were walking on either a drawn map or from a satellite view. GPS is now showing up on tablet computers. Who knows, in the future, being “lost” might become an old-fashioned idea! If you are walking around with a smartphone that’s guiding you with its GPS, would it be possible to “augment” your experience with real-time data? Yes indeed.

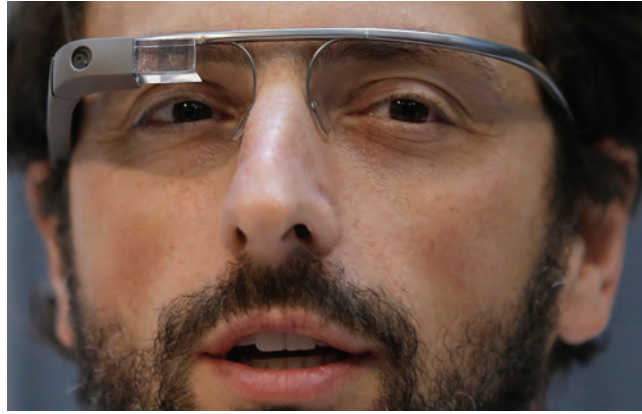
## Augmented Reality

To augment means to increase or improve. How could a smartphone improve your own reality? **Augmented reality** is a term used to define a new smartphone experience in which GPS data is combined with a vast database of information about your current location. Imagine this scenario. You are walking around Times Square in Manhattan for the first time, and you are a little lost. You take out your smartphone and enter the augmented reality mode, which begins to ease your fears. First, when you aim your smartphone at various buildings, it tells you about each of them.

Once you are comfortable with your bearings, you realize you are hungry. You speak a command into the phone, such as “nearest pizza.” In the blink of an eye, directions to the closest pizza shops appear on your screen, along with user reviews and recommendations. You follow your smartphone to the front door of a nearby restaurant. You sit down at a booth and enjoy a slice of authentic New York pizza while observing the view of the busy street outside. You smile, take a picture of yourself, and upload your photo and GPS coordinates to Facebook. Your friends, who are also lost several blocks away, now can easily track you down. While you wait and enjoy your pizza, you use your smartphone to purchase theater tickets, reserve a room for the night, and email your parents that you are

having a fabulous time. You have just augmented your reality. The future is near at hand, and so is your trusty smartphone.

Google Glass™ is one example of this technology that can augment your reality. This is a standard pair of glasses with a camera at the top with a transparent cube. The idea is that it can display maps and information as you are walking around town. Interaction occurs via your own voice, and when you are talking on the phone, you can share what you are seeing at that moment. Google calls this Project Glass (<http://g.co/projectglass>).



Here, Google cofounder Sergey Brin wears Google Glass™ glasses. Would you use Google Glass™ glasses? Why or why not?

*AP Photo/Jeff Chiu*

### Questions to Consider

1. What is the “new PC”?
2. Why is mobile computing important?
3. What is an Apple® laptop called?
4. What is the difference between a laptop and a tablet?
5. List two brands of smartphones. What types of features do they provide?
6. What does the acronym GPS stand for? What three pieces of information does GPS tell you?
7. What is augmented reality?

## 9.2 Tablets and Touch Screens

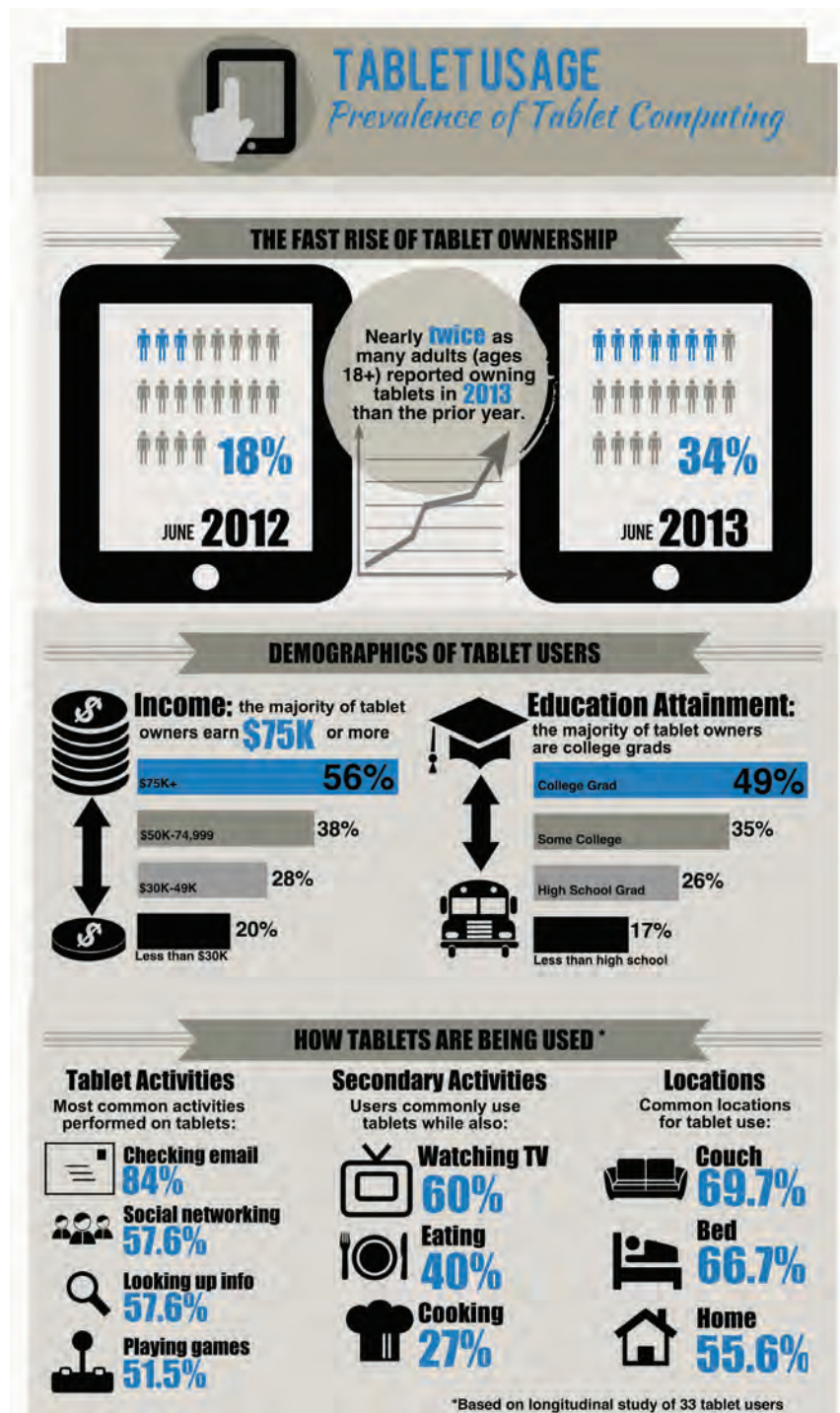
If you have ever gone shopping to purchase a car, you have certainly noticed that all automobiles are not made alike. As you walked around the dealership, it was clear that there were significant differences in price, color, size, speed, and fuel efficiency. Ultimately, though, the cars all had four tires and were designed to get you and your cargo from point A to point B. Computers are similar in the sense that while all of them have common functions (communication and processing data), they come in different shapes and styles. We have already talked about desktop, laptop, notebook, and netbook computers. Now, we are ready to explore a final type—the **tablet**.

Today, the device that garners the most attention is the tablet computer. This is a thin, flat device in which the user communicates through touching a flat surface. This includes typing on a QWERTY keyboard (digitally represented on the screen) and swiping for such interactions as moving items or turning a page of a book. Pinching the screen with two fingers lets you easily zoom in and out. Tablets are powerful computers that combine portability with ease of use and operation. Major players in this market include the pioneering efforts of Apple® with its iPad®, followed by Amazon's Kindle Fire, Barnes & Noble's Nook® Tablet, Google's Nexus 7™, and Microsoft's Surface. Asus®, Sony®, and Samsung's Galaxy® are currently manufacturers of significant Android™ tablet computers.

### What Is a Tablet Computer?

The best way to define a tablet computer is to compare it to other devices. A tablet computer, or a slate, is a portable computer that combines the mobility of a laptop with the touch screen of a smartphone. It is larger than a cell phone and therefore, has a bigger screen, greater memory, and a faster processor. It does not have the physical keyboard found in the laptop, but instead when data entry is required, a virtual keyboard appears on the screen. Since the screen is touch-sensitive, each letter is registered when you lightly touch it. This takes some getting used to, since there is no physical sensation of a key actually being depressed (Parsons & Oja, 2010, p. 59). Although tablet computers have dominated the news of late, they have actually been around for a long time. Tablet computers have many uses—and users. For example, delivery drivers (most notably UPS) and service technicians use them to record the results of their work, such as dropping off a package or making a repair. These computers have replaced the old paper, pencil, and clipboard. The tablet computer is connected to the Internet so that information is immediately processed and made available. Figure 9.1 shows more information on who uses tablets and what for.

Figure 9.1: Tablet Users



Tablet use is on the rise, and the majority of tablet users are college graduates who earn \$75,000 or more a year. Tablets are often used for social networking and to check email.

Source: "Tablet Ownership 2013." Pew Research Center's Internet & American Life Project. 24 June 2013. Retrieved from: <http://pewinternet.org/Reports/2013/Tablet-Ownership-2013.aspx>

"Understanding Tablet Use: A Multi-Method Exploration." Google, Inc. October 2012. Retrieved from: [http://static.googleusercontent.com/external\\_content/untrusted\\_dlcp/research.google.com/en/us/pubs/archive/38135.pdf](http://static.googleusercontent.com/external_content/untrusted_dlcp/research.google.com/en/us/pubs/archive/38135.pdf)



## History of the Tablet Computer

The idea of a flat, tablet computer dates back to the 1980s. Originally, engineers sought to develop a way for people to write on portable screens with a special stylus. The tablet would translate handwriting into computer text. One of the first tablets was the Apple® Newton. It was announced with great hype and fanfare in the late 1980s, but it was a market failure because it was too expensive and did not provide the functionality it promised. But the tablet idea did not die. In the early 1990s, many people thought the electronic pen would come to rival the importance of the mouse as an input device. Microsoft® created Windows® for Pen Computing, and IBM® introduced its ThinkPad, which was originally a pen-based system. Bill Gates continued to be a strong proponent of this device and introduced a Tablet PC in 2000 (Cowart & Knittel, 2008, p. 1357). Despite the push from companies like Apple® and Microsoft®, these early tablet computers were not as successful as hoped. They were not necessarily failures, either, if you see them as an evolutionary step in moving computing away from the desktop and toward the handheld world that we have today (Bennis & Gibson, 1998, p. 85). When you think of it this way, the Newton was the precursor to the e-reader.

## e-Reader

The next, and far more successful stage in tablet-like computing devices, was the e-reader. These devices mimic a book in that they allow the user to read downloadable content such as books and magazines. Currently, the Amazon Kindle (<http://www.kindle.com>) has captured a significant share of this market. It is as thin as a magazine at 1/3 of an inch thick, and lighter than a paperback at 10.2 ounces. The initial versions did not use Wi-Fi at all, but instead used **3G wireless** (cell phone service that enables connectivity to the Internet) to download content. Amazon called this Whispernet, and it used the Sprint EVDO cell system in the United States. Although you had to pay for the content (such as books, magazines, and newspapers), the wireless connection was free and much more accessible than Wi-Fi hot spots. Anywhere you used your cell phone, the Kindle could download a book in about 60 seconds.

Now, all of the Kindle versions also include Wi-Fi. For example, the Kindle Paperwhite 3G has Wi-Fi and the free cell tower connectivity. It has a backlit display and an 8-week battery life. The 6-inch display (larger models are available) is amazingly similar to the look of real paper (using its E Ink technology), and is not affected by glare like a laptop. An e-reader can hold about 1,500 books in its internal memory. All of the books are also stored in your own personal library in Amazon's computers, so even if your Kindle is lost or broken, your books are forever safe. Another unique feature of the Kindle is its experimental Web browser that lets you check your email for free.

The Kindle can read PDF and Word files, and is now being integrated into online education courses so you can take your electronic books with you (as you may be doing with this book on digital literacy). In May 2009, Kindle announced that it would offer textbooks from major publishers, and began running pilot programs at Arizona State, Case Western Reserve University, Pace University, and Princeton. Using the Kindle reduces textbook costs and also is more environmentally conscious because e-books require no paper (U.S. News and World Report, 2009).

There was an important legal case regarding price fixing and e-books. The problem was that some publishers agreed to fix e-book prices. As of May 2012, Simon & Schuster,

Hachette, and HarperCollins have reached agreements with the states suing them (Mello, 2012).

Just as smartphones did for the cell phone industry, the iPad® changed the game for the future of tablet devices.

## iPad®

In early 2010, Steve Jobs of Apple® announced the arrival of a “magical and revolutionary product” called the iPad® (Sutter & Gross, 2010). It was the next generation of the tablet computer, which Jobs promised would do for the tablet computer industry what the iPhone® had done for the cell phone industry. There were cell phones before the iPhone® and there were tablets before the iPad®, but the Apple® ingenuity and aesthetics promised to redefine the playing field.

Continuing the “i” naming strategy (from the iPod® music player and iPhone® before it), the iPad® has several important features, including a 9.7-inch Retina display, which boasts 3 million pixels. A nice aspect of its touchpad is that it can register multiple touches at the same time. This means you can enter key combinations (such as CTRL–C for copy, or shift A for a capital letter). The iPad® is less than half an inch thick (.37 inches) and weighs only

1.44 pounds—an ideal screen size for browsing the Web, reading e-books and newspapers, watching movies, and responding to email. It is 9.5 in. tall and 7.31 in. wide. It connects to the Internet with Wi-Fi and wireless connectivity through a cell phone plan. But it is also suited for productivity applications such as Word and Excel®. With a 10-hour battery life, it is a good companion for road trips or airplane rides (<http://www.apple.com/iPad/design/>).



Here, a full size Apple® iPad® 4th generation is compared to a new Apple® iPad® mini. Do you have an iPad®? How do you use it?

*AP Photo/M. Spencer Green*

A newer and smaller version is called the iPad® mini. It boasts most all of the same features as the larger version, but is more compact with a 7.9-inch screen (<http://www.apple.com/iPad-mini/overview/>).

## iPad® Significance

The iPad® is not just a tablet computer; its introduction affects other industries as well. As the paper-based newspaper business continues to struggle in many cities, existing papers are looking for new revenue streams in the world of computing. One source has been advertisements in electronic versions available on the Web. But one of the important ways that people have read newspapers is on the go, and the iPad® seems to be a perfect device for a marriage of the newspaper with the electronic world. The large screen allows images

and text to be displayed, and in theory, people will be willing to pay for the daily electronic delivery of the local and national news in this format.

Ultimately, you, the consumer, will determine the future success of the tablet computer by placing votes with your purchasing dollars. Those purchasing dollars for tablets are now divided between Apple® and its competitors.

## Android™ Tablet

Among the Apple® tablets, there are now a variety of others on the market, which run on the Android™ operating system. The main difference is that while Apple®'s iOS is a closed system, Google's Android™ is open source. This means that it opens the doors to many hardware companies that want to venture into the tablet market.

As of June 2013, CNet provided the following list of the best Android™ tablets (Franklin, 2013):

1. Google Nexus 7™
2. Google Nexus 10
3. Samsung Galaxy® Note 8
4. Asus® Transformer Pad TF700
5. Asus® Transformer Pad TF300
6. Sony® Xperia Tablet Z
7. Samsung Galaxy® Note 10.1

## Fire and Nook®

This is a highly competitive market and there are two examples of a blending of tablets and e-readers.

Two examples of Android™ tablets are the Kindle Fire and the Barnes & Noble Nook®. The Kindle Fire, initially released at the end of 2011, has a 7-inch color touch screen that can display 16 million colors in high resolution. With built-in **Wi-Fi**, it can access the Internet and search the Web quickly with the Amazon Silk browser. It has an app store and access to the millions of books sold by Amazon. Owners can purchase Amazon Prime, which gives them access to over 100,000 movie and TV programs. Finally, Amazon has developed a "lending library" in which users can borrow one book a month for free from a selection of over 145,000 (<http://www.amazon.com/Kindle-Fire-Amazon-Tablet/dp/B0051VVOB2>). In late 2012, Kindle released a new Kindle Fire HD with an 8.9-inch display. This device is more of a direct competitor against the iPad®.

The Barnes & Noble Nook® is the primary competitor for the Fire because they are similarly sized and priced. In 2009, the bookstore chain announced the development of the Nook® e-reader (<http://www.barnesandnoble.com/u/nook/379003208>). Two years later, it released the Nook® Color, and in April 2012, partnered with Microsoft®. The Nook® Color is similar to the Kindle Fire with books, apps, Web browsing, and videos also viewable with its brilliant 7-inch color display. It can be difficult for a customer to select between the two.

The Nook® also comes in a larger HD version now, which is similar in size to the Kindle Fire HD (<http://www.barnesandnoble.com/p/nook-hd-plus-barnes-noble/1110060512>).

Which is better, the Fire, Nook®, or iPad® mini? Ultimately, the choice is yours based on the plans you have for the use of the device.

### Questions to Consider

1. Why would you want to touch a computer screen?
2. What are the main features of the tablet computer?
3. What were some 20th-century examples of tablet computing?
4. Who announced the availability of the iPad®?
5. What are some features of the iPad®?
6. How did Amazon.com decide to compete with Apple®?
7. What device did the bookstore Barnes & Noble release to compete with Apple®?
8. What is the main difference between the Apple® and Android™ operating systems?

## 9.3 Artificial Intelligence

If you have a smartphone, have you ever wondered if it was really “smart”? Does it have intelligence? Is it thinking while you are using it? The goal of many computer scientists since the mid-20th century has been to create a computer that could perform logical operations so well that it could actually learn and become sentient or conscious. The effort to achieve this is called **artificial intelligence**, or AI. In this section, we will explore some of the historical attempts to realize this dream, analyze the current state of the field, and (in keeping with the theme of this chapter) ponder what the future holds for AI.

### What Is Intelligence?

Intelligence is a complicated notion that can be difficult to define. A typical dictionary definition might suggest that it is the “capacity for learning, reasoning, understanding, and similar forms of mental activity,” but the more you think about the concept, the more difficult it is to define. The 17th-century philosopher Descartes famously said, “Cogito ergo sum,” which is Latin for “I think, therefore I am.” In other words, thinking, intelligence, and self-awareness were the measure of what it meant to have existence.

This makes sense, but logic and intelligence can become more difficult to define when we are talking about a machine. Consider this classic question: which is more accurate, an analog clock (one with moving hands) that is broken, or a digital clock (one with numbers) that eternally loses one second every day? An intelligent human might say that certainly the digital clock is best because he or she could easily approximate the correct time. However, an “intelligent” computer might approach this question with an entirely different logic. The computer might select the broken analog clock. Why? It would say that the analog clock is EXACTLY correct twice each day, and that the digital clock will be correct only once every 236 years. Therefore, the broken clock is more “accurate” from this perspective. The intuitive answer is the digital clock because it provides an approximation of truth. In a literal, logical sense, the analog clock is more correct. This question

demonstrates how difficult it can be to define what is intelligent and what is not. Who is exhibiting more intelligence, the computer or the human?

## The Turing Test

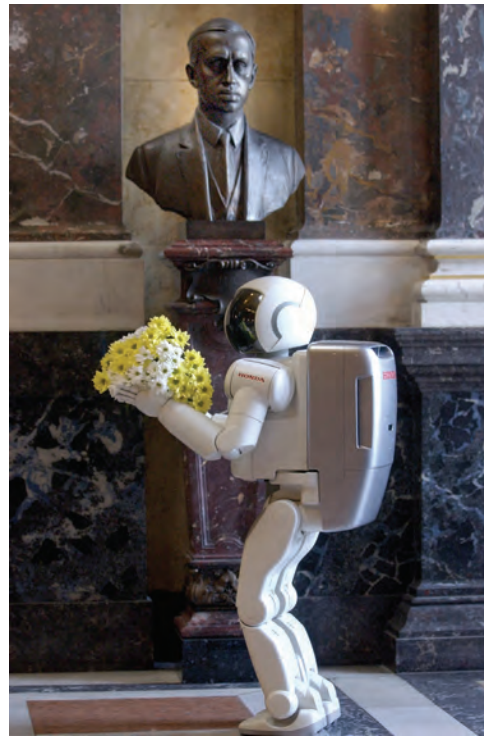
Along with the birth of the modern computer in the 20th century came the idea, hope, and dream that one day these machines might become intelligent. One of the first people to consider the philosophical implications of intelligent machines was mathematician Alan Turing. In 1937, he developed a thought experiment that he called a Turing Machine. With it, in 1950, he proposed his **Turing Test**, which he believed could prove whether or not a computer was intelligent. The experiment went like this: a judge begins communicating with a person hidden behind one curtain and a computer hidden behind another. If the judge cannot tell the difference between the real person and the computer, then the computer is considered to be intelligent. The Turing Test became a founding concept in the philosophy of artificial intelligence (Leavitt, 2006).

## I, Robot

The same year that Turing proposed his famous test, science fiction author Isaac Asimov popularized his “Three Rules of Robotics.” The term **robot** dates back to 1923, when Karel Capek first coined it in his play called *R. U. R.* (Rossum’s Universal Robots). From that point on, the word robot meant a computer that looked and acted like a human. By 1950, with advances in computers and Turing’s work in artificial intelligence, Asimov began considering the implications of smart machines in his book *I, Robot*. His Three Laws are as follows (White, 2005, p. 55):

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Although Asimov initially proposed these laws in a short story titled “Runaround” in the 1940s, it was a decade later in his *Foundation Trilogy* that they became another cornerstone of artificial intelligence. Intelligent computers would not become monsters that ravaged society like Dr. Frankenstein’s creation did. There would be nothing to



**A robot brings flowers to the bust of Karel Capek, the Czech playwright who first coined the term “robot.” How can you tell whether or not a robot or other machine has artificial intelligence?**

AP Photo/CTK/Michal Dolezal

fear if these laws were embedded within each machine. It was an optimistic decade, in part because of the success that programmers were having with expert systems.

## Expert Systems

Actually, in the early 1950s, the term artificial intelligence had not been coined yet. This would not happen until 1956, when John McCarthy first proposed it. Herbert Simon and others demonstrated the first working AI software program, known as Logic Theorist (McCorduck, 2004, p. xxvii). Soon, programmers were developing software that could perform limited reasoning tasks brilliantly, such as playing the game of chess. Many predicted that real human intelligence would soon be achieved on the computer, but this did not happen. Broad language skills and natural intelligence proved more difficult to emulate than was originally thought.

Instead of trying to duplicate human intelligence, programmers limited themselves to **expert systems**, or computers and programs that contained extensive amounts of information in a specialized field. One of the first was a computer that could perform a medical diagnosis. If a doctor entered symptoms into a computer, it would pose other questions to ask and eventually make a diagnosis of the patient's condition. Examples included expert systems known as MYCIN and Internist. MYCIN could diagnose bacterial infections, while Internist helped physicians identify infectious blood diseases (Nikolopoulos, 1997, p. 3). One of the most advanced expert systems was IBM's Deep Blue, which in 1997, was able to beat Garry Kasparov, the world's highest ranking chess player, in a series of six matches.

## Watson on Jeopardy

Another example of an expert system was an IBM® computer named Watson who competed against real people on television episodes of Jeopardy. Watson is a question and answer machine, which reads human language and presents answers to questions from its database. Remarkably, the computer was victorious. Ken Jennings, one of the Watson competitors (and who was famous himself for a 74-game Jeopardy winning streak) proclaimed humorously when he lost, "I, for one, welcome our new computer overlords." *The New York Times* claimed that the win was not "trivial," but a significant turning point. The article stated that it was "proof that the company has taken a big step toward a world in which intelligent machines will understand and respond to humans, and perhaps inevitably, replace some of them" (<http://www.nytimes.com/2011/02/17/science/17jeopardy-watson.html>).

However, Watson was not perfect by any means. One question was: "Its largest airport is named for a World War II hero; its second largest for a World War II battle." Watson's answer was Toronto. Keep in mind that the question category was U.S. cities, and Toronto is in Canada. Watson's answer received some laughs from the audience. Nevertheless, the victory was, according to some, vindication that the entire field of artificial intelligence was progressing.

## Human/Technological Convergence

AI and computers are impacting human life in many ways. One is a technological convergence with the human body to augment our physical capabilities. While you might

think this is a futuristic idea, human/technological convergence has been in existence for centuries. In the simplest way, think of very old technologies like eyeglasses or even large horns as hearing aids. Today, these have been replaced by retina implants and implanted hearing devices.

The future has even more remarkable ideas coming. In November 2012, *Wired* magazine reported on the possibility of thought-controlled robotic arms. With volunteers trying out the new appendages in early 2013, it promises a revolution in enabling humans to mimic biology and more seamlessly meld human and technology together. The inventor, Max Ortiz Catalan, said, “Our technology helps amputees to control an artificial limb, in much the same way as their own biological hand or arm, via the person’s own nerves and remaining muscles” (Clark, 2012).

The medical field is certainly one area where you should expect to see more of this convergence. There are Computer Assisted Surgeries (CAS) in which complex imaging helps the surgeon navigate the body. Another example is surgery that takes place with a robot without the direct control of a human. These robots excel in performing very precise repetitive movements better than a human surgeon (“Robotic Surgery,” n.d.).

### **A Look Further:** Robotic Surgery

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Learn more about robotic surgery by visiting:

<http://www.robotic-surgery.med.nyu.edu/for-patients/what-robotic-surgery>

### **Technology Today:** Artificial Intelligence and Robots

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Scientists have made great strides in the field of robotics and artificial intelligence, but they have yet to come close to developing the human-like robots that science fiction fans are accustomed to seeing. That’s because creating machines that can replicate the way humans move and think is much more difficult than it might seem.

Manufacturers have employed robots for decades, but most of them are still little more than large mechanical arms that are programmed to move parts from one place to another. These robots can work faster and for longer periods of time than humans, just as computers outperform humans at rote tasks like solving math problems.

What robots and computers still lack, however, is the ability to reason and make decisions on their own. Scientists specializing in artificial intelligence have succeeded in giving computers what appears to be a certain amount of decision-making ability.

For instance, computer programs are widely used to render decisions in the financial services industry. These programs use what is known as neural network technology to evaluate the information of individuals applying for credit—their age, occupation, income, past credit history—and determine whether they are a good or bad risk. But these programs don’t decide what information is relevant to this analysis, nor do they determine on their own what constitutes a good or bad risk.

### **Expert Systems**

Computer programmers consult with humans who have years of experience in making such decisions and then write programs that allow computers to mimic those experts’ thought processes when evaluating data.

*(continued)*

### Technology Today: Artificial Intelligence and Robots (*continued*)

Such programs, also referred to as expert systems, are used in a number of fields. Some hospitals use them to diagnose certain medical conditions based on a patient's vital signs (heart rate, blood pressure, and so forth). Manufacturing companies use expert systems to cut operating costs by teaching them to recognize when production machines need preventive maintenance.

Scientists continue to study the process by which the human brain acquires and adapts to new information in hopes of eventually creating computers or robots that actually can think and reason on their own.

A team of researchers in Wales created a robot called Adam that conducts its own scientific experiments. "It can think of hypotheses and then do the experiments, and we've checked that it's got the results correct," Ross King, one of the researchers, told Reuters News (RedOrbit.com, 2009). In 2012, the Bioinformatics Group at Aberystwyth University said, "The Robot Scientist is perhaps the first physical implementation of the task of Scientific Discovery in a microbiology laboratory. It represents the merging of increasingly automated and remotely controllable laboratory equipment and knowledge discovery techniques from Artificial Intelligence" ("Artificially Intelligent Robot," n.d.).

#### A Robot Astronaut

Meanwhile, scientists from NASA and General Motors have developed a robot that can be used in both the automotive and aerospace industries. Robonaut 2, nicknamed R2, is the second generation of a robot that NASA started working on with the Defense Advanced Research Project Agency—the same agency that created the Internet.



**Robonaut 2 in International Space Station.**

NASA

The first generation Robonaut, as its name implies, was intended to be a robot astronaut. Robonaut 2 has a distinct humanoid appearance, but it's likely to log more time building cars than exploring outer space. It can lift 20 pounds with each arm, about four times that of other humanoid robots, according to NASA. Its nimble hands, fingers, and opposable thumbs also enable it to use the same tools normally used by humans.

In addition to employing it in the car assembly process, GM officials expect to borrow technology used to create Robonaut 2's controls, sensors, and vision systems to develop advanced safety systems in future vehicles (Lombardi, 2010).

#### Links for More Information

Follow R2 at the official NASA website:

<http://robonaut.jsc.nasa.gov/default.asp>

View images taken by NASA:

<http://www.flickr.com/photos/nasarobonaut/>

## Can Machines Think?

Can machines think? In part, the answer depends on how we define these three simple words (Nilsson, 2002, p. 2). Begin with the word *can*. If by can we mean someday in the



future, then the answer is yes, that is quite possible. But if we mean, “Can machines think right now?” as in having broad enough intellectual powers to pass the Turing Test, then the answer is no. The second word is machines. If by machine we mean the computer on your desk, then no, a machine cannot think. It might appear to, based upon clever programming techniques and massive processing power, but it will not attain self-awareness and one day suddenly suggest to you, “I think, therefore I am.” The final word is think. Again, there are two ways to look at this. If by think we mean a computer with the language skills to pass the Turing Test, then no, machines cannot think. However, if by think we mean a computer with enough expert knowledge to beat any human on the face of the earth in a game of chess, and even in Jeopardy, then yes, machines can think. Ultimately, the answer to this question depends on how you choose to define your terms.

## Simulations

One of the final aspects of the future of computing that we will consider is simulation. Though not necessarily a part of artificial intelligence, a **simulation**, at its simplest level, is copying some aspect of real life and portraying that experience on a computer. You might also hear the term **virtual reality** to describe a simulation. Virtual reality is the use of computers to create a simulated environment that has an illusion of reality and immerses you in the experience. Computer simulations and virtual realities are used in a number of different ways. In the gaming world, you can find simulations of sporting activities such as golf and billiards. Advanced motion controls, like those found with the Nintendo Wii™, Xbox®, and other gaming consoles, add to the simulated experience by letting you swing your arm in a game of tennis while you watch the simulated character on the screen imitate your movement.

But simulations are not just for fun and games. Simulation can solve real-world problems, analyze real-world systems, and ask what-if questions about life (Banks, 1998). There are many serious applications, including pilots using simulation for flight training with programs such as Microsoft® Flight Simulator. If you want to learn how to drive a bus, the first step in your training might not be sitting behind the steering wheel but instead sitting in front of a computer monitor. For example, a program released in 2010 simulates various aspects of operating a city bus. You become “Carlos,” a professional bus driver, and are taught the intricacies of the job. The simulation includes driving around town, operating animated wipers under rain conditions, using the wheelchair lift, dealing with computer-generated AI traffic, assisting virtual passengers, and driving through a virtual Times Square. The program attempts to “simulate real driving behavior” to train the next generation of drivers.

With the popularity of programs like this one, we may find that many of our future experiences become simulations. As simulations improve in features, it is possible that the distinction between what is real and what is simulated will begin to become increasingly difficult to make.

## Virtualized Servers

There is a related trend, though not quite as exciting as bus driving simulations, in which computer servers are “virtualized.” These replace physical hardware servers and are becoming a formidable force in the future. One example is VMware (<http://www.vmware.com/>), with the letter VM standing for virtual machine. Other examples are Microsoft®’s

HyperVisor and Citrix Xen. While these have server virtualizations, they can also can virtualize the desktop in which simple computer terminals give the appearance that they are stand-alone PCs. In reality, they are virtualized because the environment (screen icons, programs, data, etc.) are all stored remotely on a server. And where are these remote servers actually located? In the cloud.

### Questions to Consider

1. Are computers intelligent? What is AI?
2. Why was the Turing Test important?
3. Who proposed the Three Laws of Robots?
4. What is an expert system?
5. What are some examples of expert systems, and what they can do?
6. Can machines think?
7. What is a computer simulation? What are some examples?

## 9.4 The Clouds Are Here

As we approach the end of your journey into digital literacy, we must select a destination. This is difficult because computers evolve and change so quickly. But, since our final subject is the future of computing, we will conclude with what most believe is the computing shape of the future. That notion is **cloud computing**, which at its most basic level is the replacement of all personal computers with “dumb” terminals that have no software or complex operating systems on them. Instead, these terminals connect to a World Wide Web in which applications reside alongside your data. But this is the extreme case, and now cloud computing is integrating itself as a way to store and access data from smartphones, tablet computers, laptops, and desktops. And, it is not just data that resides in the cloud, but even applications can exist there. In fact, you might be already using some.

### What Is Cloud Computing?

You already have some experience with cloud computing. In Section 5 of Chapter 7, we discussed Google’s Gmail™. We can use that example here to illustrate some of the key concepts of the cloud. First of all, the cloud is a metaphor for the space on the Internet that can be used to store your data, as well as applications to manipulate it. The Gmail™ application exists online, and to use it, all you need is a connection to the Internet and a browser. Likewise, all of your email is stored in the Google databases as well, rather than on your own personal computer. If you recall, this is a significant departure from the way in which Microsoft® Outlook®’s desktop email program works. With Outlook®, the software application and your email reside on your computer and nowhere else. Therefore, Outlook® operates on your computer (as a reminder this is not to be confused with outlook.com, which is Microsoft®’s cloud-based email system, along with hotmail.com), while Gmail™ operates in a cloud because that is where all of your email exists, as well as the application to view, send, and receive it.



**In cloud computing, applications and data are housed online, rather than on your computer. What cloud applications do you currently use? How do they compare to your computer-based programs?**

*iStockphoto/Thinkstock*

## The Advantages of the Cloud

Google and other software companies are building operating systems that exist online rather than on your computer. This would make your computer very quick to turn on because there would be no complex operating system to boot up. When you pressed the power button, the only thing the computer would need to do would be to connect to the Internet. So, startup time would be measured in seconds rather than minutes.

Another advantage of cloud computing is that it would make computer viruses and malware almost nonexistent. The virus protection would take place at the cloud level, and would not be the responsibility of the individual user. As long as the cloud was protected—and the cloud engineers could have teams devoted just to this function—all of the data residing within it would be immune to attack.

A third advantage is that your programs and data would be available no matter where you were, and on any computer in front of you (as long as there was an Internet connection). If you went to your work computer, all of your data would be accessible there. It would also be at your computer at home, at the computer terminals at the library, or at any hotel that you visited while on vacation. This would also give you a measure of protection, because if your computer at home died while you were writing a paper for school, your work would not be lost. It would still be safely resting in a cloud. You could just go over to your neighbor's house and finish your work there.

Fourth, you would never have to install or update software again. You would simply pay for it once and access it online. Whoever wrote the application would be responsible for updating it, and the next time you logged on, it would be there for you to use. Finally, one of the most important advantages of cloud computing is collaboration and sharing. If you shared your access code with people whom you allowed to have access to your data (such as other students working on a project, family members planning a reunion, or coworkers on a project), then all of you could access, share, and edit the documents in the cloud.

## The Disadvantages of a Cloud

Some suggest that while the cloud is good for limited applications such as email, it could never alone represent the future of personal computing for several reasons. First, many programs are simply too complex and powerful to be operated effectively online. For example, graphics programs or games with computation-heavy, 3-D rendered worlds

need to be run on a personal computer in order for them to be effective. The second disadvantage is privacy. With all of your data on someone else's computers, how certain can you be that no one else is spying on what you are doing? The third disadvantage is that if you do not have Internet access, your computer is worthless, and you are unable to access your data. Although the Web follows us almost everywhere we go these days, it is not everywhere that we want it to be, and sometimes access is a problem. It would be very inconvenient if we could not use our computers in such cases.

Finally, Internet outages would bring productivity in a cloud to a standstill (Velte, Velte, & Elsenpeter, 2010). There have been some notable cloud outages in the past and InfoWorld discussed the "10 worst cloud outages." Number one on the list was when "Amazon Web Services goes poof." This occurred in April 2011 when a routine configuration change caused a problem at Amazon's Northern Virginia data center. The result, according to InfoWorld, was that the system went "totally nutso." A series of problems had spiraled out of control, eventually shutting down most of Amazon's data centers in the eastern United States. The outage lasted for four days, and while no data was lost, access was suspended (Raphael, 2011).

On Christmas Eve 2012, Amazon Web Services (AWS) had a huge outage that significantly affected Netflix. As a *Wall Street Journal* reporter later claimed, the lesson from this was that "Any company can fail" (Schectman, 2012).

Despite these problems, enthusiasm for clouds is still on the rise. As you might guess, Amazon is not alone in the clouds.

### Google's Cloud Storage™ Service

Google is a significant player in the realm of clouds. The company not only uses its cloud for its Gmail™, but also its Web-based applications ranging from Internet searching to Google Books™. As we discussed in the last chapter, Google's Drive™ is an important location for storing your files of data and this is a cloud-based storage system. It is hard to know how large the Google cloud (<http://cloud.google.com/>) really is, but by some estimates, it consists of hundreds of thousands of inexpensive servers (some suggest this number is a million) that store all of Google's data (and yours, too). Google estimates that over 1 million applications run on a Google Cloud Platform. Also, it has entire copies of the Web. Unlike the large mainframe computers of the past, the cloud has an impressive feature because it never grows old. A team of engineers and technicians monitor it, and when one of the servers dies (every few years), it is simply removed and replaced by a new one. The entire cloud seems to grow and regenerate more like a living being than an aging machine. Although Google and others have used this type of data system since the 1990s, it was not until 2008 that the term *cloud computing* was used to define it. Soon, people began to realize that this might be the wave (or the cloud) of the future that would define how a majority of computers operate (Malone, 2009, p. 112).

Google suggests that the following are the main reasons to use its cloud (<https://cloud.google.com/>).

1. Archive and back up data.
2. Store application data.
3. Compute at Google Scale.

4. Share data with friends and business partners.
5. Analyze large amounts of data with Google BigQuery Service.
6. Build apps and websites.

Google has a number of other cloud applications you can use in addition to Gmail™ and Google Drive™. Its Google Docs™ and Spreadsheets applications emulate Word and Excel®, although the application itself is nowhere to be found on your computer. The software is located on Google’s servers, so whenever there is an update, the users do not have to reinstall or upgrade their software. The other benefit of Google Docs™ and Spreadsheets is that they are collaborative tools that can be shared with anyone who has an Internet connection, and the creator can access them from any computer. This also has a nice backup safety feature in that your data are not tied to one hard drive that might fail.

### Apple®’s Cloud

Apple® has recently made a significant push into the cloud, called the iCloud®. It stores and provides the user access to a number files such as documents, contact information, images, and music. The iCloud® is also now built into Apple® devices such as the iPhone®, iPad®, and the Mac® (<http://www.apple.com/iCloud/>). What this means for the Apple® user is that the iCloud® is now integrated into all Apple® apps and allows users to sync music, apps, and pictures over multiple devices, including Apple® TV, iPad®, iPhones®, and Mac® computing systems. This includes the following:

- iTunes®
- Documents
- Apps
- Calendar, Contacts, and Mail:  
<http://www.apple.com/icloud/>
- iBooks®
- Photo Stream
- Backup data
- Find my iPhone®
- Passbook®



**Apple®’s iCloud® service, which is built into every Apple® device. How might the cloud change the way we use smartphones, music players, and tablets?**

*Iain Masterton/age fotostock/SuperStock*

#### **A Look Further:** The iCloud®

You can watch this video to learn more about it:

<http://www.apple.com/icloud/#video>

### Microsoft®’s Cloud

With the latest release of the Windows® 8 operating system, Microsoft® is also establishing a presence in the cloud. One important way it is doing this is with SkyDrive®. In August 2012, the company announced that its SkyDrive® passed the preview stage to

become operational. Located at [skydrive.live.com](http://skydrive.live.com), it organizes all users' documents and enables access with all associated Windows® 8 operating systems and Windows® phones. Also working with Windows® 7, it provides all users with an immediate 7 GB of data (McDougall, 2012).

*PC World* recently published an article stating that there were five main reasons why SkyDrive® was better than Google Drive™. First, was that it has more free storage (7 GB to Google's 2 GB). Second, it has deeper support of Microsoft® document formats. Third, it has better mobile support (for the moment). Fourth, it has better pricing (such as \$30 per year for an extra 25 GB). Finally, SkyDrive® also works seamlessly with Mac® iOS operating systems (Paul, 2012).

For an opposing view, *PC World* also published the reasons why Google Drive™ was better than the SkyDrive®. These included better search capabilities, video previews, and more paid storage options (Oswald, 2012).

Ultimately, the choice of clouds is yours to make. And they are not the only ones to consider.

### Dropbox, Amazon, and Other Examples of the Cloud

SkyDrive® is not the only cloud backup system. Carbonite.com is another way to back up all of the current data on your computer in real time to the cloud. Once you sign up and pay a yearly subscription fee for this service, it operates in the background, saving a copy of each of your files to its own cloud. When a file is backed up, a small green dot appears in the bottom left-hand corner of the icon that represents the file to indicate it is safe. This is an excellent way to protect against computer crashes. Hewlett Packard has announced that it will be using Canonical's UBUNTU Linux® as a way to enter the cloud. Another hardware manufacturer, Asus®, is a cloud as an extension to its computers. Likewise, Dell™ computers have a Data Safe, which is information that can be backed up into the cloud.

Launched in September 2008, Dropbox is also a major player in the cloud (<https://www.dropbox.com/>). As of July 2012, 50 million people used Dropbox and were adding 1 billion new files every 48 hours. Many new computers are even preloaded with Dropbox software. And today, about 250 million devices have Dropbox on it. What is it? Dropbox can be used to save any file (such as photos, videos, or documents) and the file will be saved on the Dropbox site as well as other devices (like your computer, tablet, and phone). This lets people access and share files easily, plus it's free to use (<https://www.dropbox.com/news/company-info>).

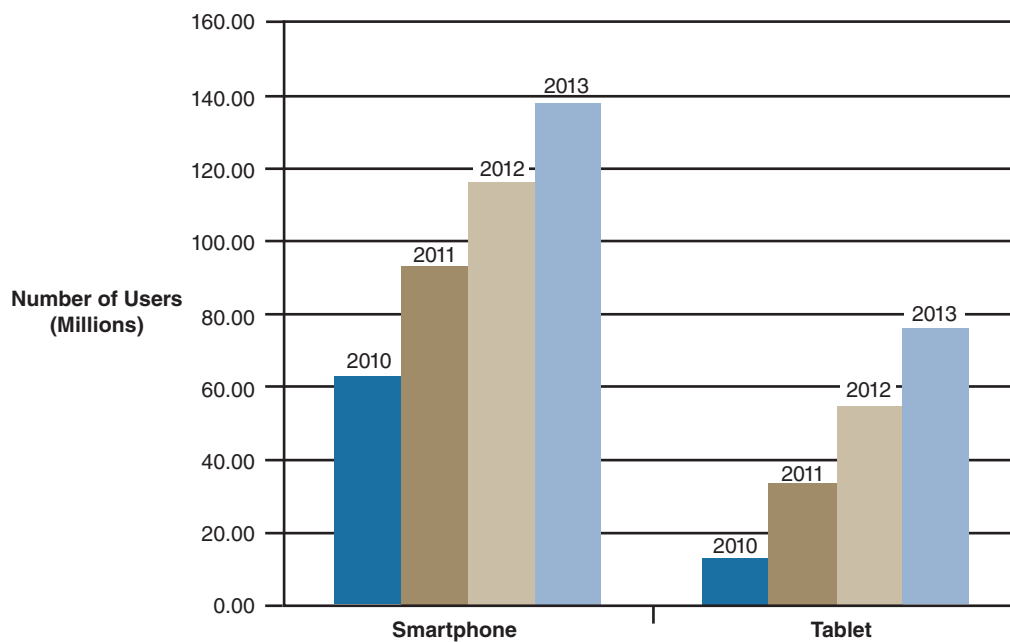
One final example is Amazon Web Services (<http://aws.amazon.com>). Founded in 2006, it provides a service for all companies that require computing power, services, and storage. The benefit is that it is infinitely scalable. If a company grows from 2 people to 100 people overnight, all you need to do is write a check to Amazon and you will instantly have 50 times more storage or computing power than you had the day before. What are some examples of how this service could be used? If you were a media company that wanted customers to see videos, you could rent storage space in the Amazon cloud. Or, if you were a pharmaceutical company, you could rent Amazon's processing power to perform an intensive simulation experiment. The examples are numerous, demonstrating that the cloud is not just for individuals but for businesses as well. In fact, there are four different types of clouds that you might see.

## Four Information Clouds

Now that we have explored some specific uses of the cloud, let's consider some general information about them. Thomas Vander Wal suggested that there will be a hierarchy of four types of clouds. The first will be the Global Information Cloud, which is essentially the Internet. It will remain accessible to everyone who has a computing device with connectivity features. The second cloud in the hierarchy is the External Information Cloud. This is represented by the closed and private data of an organization. Examples are an extranet that you might have at work. The third cloud is the Local Information Cloud. The owner maintains control here, and those who have access must have membership privileges. An example would be a LAN set up at a friend's home where everyone brought their own computers to play a shared game. The final cloud is the Personal Information Cloud. This represents all the digital data that you have created yourself. It could be as simple as a phone number or as extensive as every photo you have ever taken with a digital camera. Each of us would maintain complete access and control over our personal cloud (Malone, 2009, p. 115).

And with more and more people owning smartphones, tablets, and other mobile devices, the cloud will continue to grow, as shown in Figure 9.2.

**Figure 9.2: Number of smartphone and tablet users in the U.S.**



**The number of people using smartphones and tablets has increased each year since 2010.**

*Based on data from eMarketer.com. (2011). One in three online consumers to use a tablet by 2014. Retrieved from <http://www.emarketer.com/Article/One-Three-Online-Consumers-Use-Tablet-by-2014/1008701>; Statista. Forecast: number of smartphone users in the U.S. 2010-2016. Retrieved from: <http://www.statista.com/statistics/201182/forecast-of-smartphone-users-in-the-us/>; Statista. Forecast: U.S. tablet PC users 2010-2015. Retrieved from: <http://www.statista.com/statistics/199761/forecast-of-tablet-pc-users-in-the-united-states-from-2010-to-2015/>.*

### Questions to Consider

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1. What is the future of computing?
2. What is cloud computing?
3. How would you describe the cloud? What is in it?
4. What are some advantages and disadvantages of cloud computing?
5. What are some current examples of cloud computing?
6. What are four types of information clouds, and what is their hierarchy?

### Summary

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In this final chapter, our goal was to focus on the present and future of computing. One of the most important emerging trends today is how mobile our computers are. From smartphones to tablets, we can take the power of computing with us on the go, and not sacrifice our connection to or work, play, or the world at large. Another key trend is that our computing devices are increasingly anticipating our needs as artificial intelligence gradually becomes more sophisticated. Another likely development is that more of our life will be experienced as online simulations, such as flight simulation that assists in real-world training of airline pilots. Finally, we looked at one of the most important visions of the future of computing—the cloud. More and more, we will find that our data and our applications are not residing on our own computers but instead somewhere in cyberspace. This is a powerful trend because while we will need an Internet connection to access it, our data will be available to us wherever we might go.

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### Post-Test

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1. GPS works through a process called
  - a. triangulation.
  - b. triatomic.
  - c. triangularity.
  - d. triarticulate.
2. Who makes the Kindle e-reader?
  - a. Amazon
  - b. Microsoft®
  - c. Apple®
  - d. Barnes & Noble
3. IBM®'s Deep Blue was an expert system capable of
  - a. determining the nature of a bacterial infection.
  - b. beating the world's best chess player.
  - c. diagnosing blood diseases.
  - d. emulating language skills.



4. Which of the following is NOT an example of a personal cloud individuals can use to store their data?
  - a. Dropbox
  - b. Carbonite
  - c. SkyDrive®
  - d. UBUNTU
  
5. Which of the following is NOT considered as a smartphone manufacturer?
  - a. BlackBerry®
  - b. Apple®
  - c. Android™
  - d. Microsoft®
  
6. Of the following tablet computers, which does NOT run the Android™ operating system?
  - a. Fire
  - b. Nook®
  - c. iPad®
  - d. Nexus
  
7. A robot is BEST described as a computer that
  - a. looks and acts like a human.
  - b. does what humans ask of it.
  - c. can move.
  - d. can think for itself.
  
8. Which of the following is NOT an example of cloud computing?
  - a. Microsoft® Outlook®
  - b. Carbonite
  - c. Google Docs™
  - d. Amazon Web Services

**Answers**

1. **a.** triangulation. *The answer can be found in Section 9.1.*
2. **a.** Amazon. *The answer can be found in Section 9.2.*
3. **b.** beating the world's best chess player. *The answer can be found in Section 9.3.*
4. **b.** Carbonite. *The answer can be found in Section 9.4.*
5. **c.** Android™. *The answer can be found in Section 9.1.*
6. **c.** iPad®. *The answer can be found in Section 9.2.*
7. **a.** looks and acts like a human. *The answer can be found in Section 9.3.*
8. **a.** Microsoft® Outlook®. *The answer can be found in Section 9.4.*

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## Key Ideas

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- Two of the most significant new computing devices in the last few decades are the smartphone and tablet.
- Smartphones, like the iPhone® and Android™ devices, represent the convergence of phone, GPS, texting, and computer in a size that comfortably fits into a pocket. This enables people to be in constant contact with friends and family. It also has the potential to literally augment our reality with computer-mediated, real-time information about where we are located at any given moment.
- Tablet computing has introduced another dimension of computer interactivity with the prevalence of touch screens, powerful processing capability, and easy mobility.
- The goal of many computer scientists since the mid-20th century has been to create a computer that could perform logical operations so well that it could actually learn and become sentient or conscious. The effort to achieve this is called artificial intelligence, or AI.
- Cloud computing is an idea that has moved past an emerging idea to become what most believe is the computing shape of the future.

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## Critical Thinking Questions

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1. If you could only own one new computer technology that we have covered in this chapter, which would it be and why?
2. Compare and contrast the different ways to interact with a computer that we have discussed in this book. The main ones are physical keyboard, a mouse, voice commands, and touch screens. What are the benefits and drawbacks of each? Will one become more predominant in the future?
3. With the advancements and portability of smartphones and tablet computers, what do you think the future holds for the desktop computer?
4. Do you think computers are intelligent, or it is an illusion of intelligence created by sophisticated programming techniques?
5. What ways are you using cloud computing in your life? If you are not using it, where might be some areas that you would like to give it a try? What benefits do you see with cloud computing?

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## Key Terms

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**3G wireless** Cell phone service that enables connectivity to the Internet.

**4G wireless** The latest and fastest cell phone connection speed. The name refers to it being the fourth generation of standards.

**artificial intelligence (AI)** A computer that simulates or achieves true intelligence.

**augmented reality** A term used to define a new smartphone experience in which GPS data is combined with a vast database of information about your current location.

**cloud computing** The replacement of all personal computers with “dumb” terminals that have no software or complex operating systems on them, but instead connect to the World Wide Web where applications and data reside.

**expert systems** Computers and programs that contained extensive amounts of information in a specialized field.

**GPS (Global Positioning System)** A network of satellites (24 of them), computers, and receivers that can work together to calculate your exact position on earth (latitude, longitude, and altitude).

**PDA (Personal Digital Assistant)** A small, handheld computer, initially sold by Palm and Visor, that offered calendars, date-books, organizational software, and gaming applications.

**robot** A computer that looks and acts like a human.

**simulation** Copying some aspect of real life and portraying that experience on a computer.

**smart card** A card that is small like a credit card, made of plastic, and contains an embedded integrated circuit.

**tablet computer** A portable computer that combines the mobility of a laptop with the touch screen of a smartphone.

**triangulation** A method of finding location by measuring the angles and/or distance from three other known points. It is used to find locations for all GPS, or Global Positioning Systems.

**Turing Test** A test proposed by Alan Turing in 1950 to determine whether or not a computer was intelligent.

**virtual reality** The use of computers to create a simulated environment that has an illusion of reality and that immerses you in the experience.

**Wi-Fi** Wireless connection to the Internet.

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## Web Resources

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To learn more about Artificial Intelligence at MIT, go to:  
<http://www.csail.mit.edu/>

To explore Microsoft® Flight Simulator, visit:  
<http://www.microsoft.com/games/flightsimulatorX/>

For more information about the cloud computing yearly conference, visit:  
<http://cloudcomputingexpo.com/>

To learn how the cloud works, see:  
[http://www.youtube.com/watch?v=TTNgV0O\\_oTg](http://www.youtube.com/watch?v=TTNgV0O_oTg)

