

Supplement for

Emerge with Computers &

Emerge with Computer Concepts

Version 5.0

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## Welcome!

These pages supplement *Emerge with Computers* and *Emerge with Computer Concepts* Version 5.0. The Table of Contents below lists the topics alphabetically.

The topics and modules in this supplement are assembled in the order of the *Emerge* MindTap Reader, but you can use this supplement even if you're not using the MindTap Reader – the order of topics will be different, *but the content is all here*.

*Emerge* takes learning online to a whole new level, allowing you to experience the power of technology and harness that power to improve your life and help build a better world.

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## Digital Technology

**Digital technology** and digital electronics allow us to manipulate all types of information as digits (1s and 0s) in order to store and manage the information more efficiently and effectively.

### Why This Matters

Digital technology, including all forms of computers, has extended human capabilities by allowing us to manipulate and explore information in ever-faster and more creative ways. The information can be expressed through words, numbers, sounds, and images. By better understanding digital technology, we improve our control over such information.

### Consider This

Consider the impact of digital technologies on your daily life. If you are like many people, your day might start with your mobile phone's alarm app waking you. The smart phone is one of many digital devices that have dramatically changed people's lives, level of connectivity, and productivity. Throughout the day, you probably use your phone to communicate with friends and perhaps business associates, look up information on the Web, check your friends' Facebook statuses, snap photos and post them online, send e-mail, plan your evening, play games, watch movies, and listen to music. All of these activities are possible because information and media are digital and easy to manipulate with the tiny but powerful processor in your phone.

While digital devices like smart phones, notebooks, tablets, and hi-def TVs impact our daily lives, they also make businesses more productive and successful. Digital information systems provide critical information to decision makers at just the right time to optimize a business strategy. Digital technologies also make it possible to crunch large quantities of scientific data to make amazing discoveries and life-saving products. From the human genome to the possibility of life in distant galaxies, digital technologies make it possible to collect and process huge amounts of information—information that could never be properly analyzed by unassisted humans.

As you read this chapter, consider all the ways that you interact with digital information and media each day, and the devices that you use to access it. How does digital technology assist professionals in areas that interest you? What is the greatest discovery or most important research conducted that would not have been possible without digital technologies?

### Essential Information

Digital technologies are a major influence on everyone's lives. Representing all types of information digitally allows that information to be stored, transported, shared, and manipulated in ways previously not possible. Digital technologies have become

important tools in all professions and in managing our digital lives. Students studying business, engineering, law, nursing, music, art, political science, physics, chemistry, and all other disciplines, spend a considerable amount of time learning the digital technologies that will assist them in their future professions.

Many of the valuable tools that we interact with every day use digital technology to increase our productivity, increase our capabilities, entertain us, and expand our experiences. Some digital technologies have become essential to modern life.

Before delving into hardware, software, networks, business systems, and other high-level topics, it is important to grasp basic principles of digital technology. This section introduces the basics and establishes a vocabulary for discussing higher-level concepts.

### **Ethical Dilemmas**

Some fear that digital technologies are making life less personal and more stressful. Since the advent of digital technologies, software has made it possible for people to become many times more productive than they used to be. However, the pressure to be more productive can take its toll. Most of us lead a digital lifestyle, which involves looking at computer displays as much, if not more than, looking at the world around us. Such a lifestyle is not “natural,” argue some, while others counter that this is just another step in human evolution. Some see technology and the digitization of the world as the end of life as we know it, while others view it as a vast and exciting new frontier. Some think technology is turning us all into robots, while others see it unlocking our true human potential.

Whichever side you may agree with, or if you are somewhere in the middle, certain facts remain. Some people do indeed have issues with various forms of computer addiction. Deadly accidents have increased dramatically due to distracted driving and individuals using mobile phones when they should be watching the road. Social etiquette is changing with each new use of technology as a tool for interacting with others. Many of us communicate less face-to-face, than we do online. The digitization of media and information has caused serious concerns over intellectual property rights, privacy, and information security. In fact, dozens of ethical and societal issues have arisen or become exacerbated because of our use of digital technologies. What do you think? Do the problems raised by digital technologies outweigh the benefits? Consider this as you read about the basics of digital technologies.

### **Digital Technology Topics**

- Digital Literacy
- Computing Platforms

## Digital Literacy

**Digital literacy** refers to an understanding of how computers represent different types of data with digits and how the usefulness of that representation assists people in leading productive lives.

### Why This Matters

Digital literacy has become a requirement for most careers, and a valuable asset for leading a productive, fulfilling life. Most colleges and many high schools now require students to prove that they are competent with computers and digital technology in order to graduate. Digital literacy is a fundamental difference between the economies of successful, developed countries and struggling countries. Today, digital literacy is closely aligned with financial opportunity and independence.

### Essential Information

This section on digital literacy—or the basic concepts underlying computers and digital technology—describes the most elementary building blocks of computers and other digital electronics. These topics provide a foundation for understanding all things digital.

For example, by understanding how movies are digitized and stored, you can understand why movies require much more storage capacity than music. This information could assist you in purchasing a computer or a cellular plan that best meets your movie consumption needs. Similarly, by understanding how computers represent all sorts of data as bits, you can get a sense of how today's most popular mobile phones are able to provide so many functions.

Understanding digital technologies empowered a college student named Mark Zuckerberg to establish the billion-dollar social networking business, Facebook. It empowered citizens in Egypt and elsewhere to reclaim their governments. Digital technologies have changed lives in both subtle and dramatic ways.

Digital literacy begins with understanding what a computer is and the value of computer literacy. Next, you learn how bits and bytes are used to represent words, values, sounds, music, photographs, drawings, movies, and other information that matters to people, in a digital format. You'll also learn how a tiny device like a smart phone can provide all the hardware required for hundreds of thousands of apps.

### Digital Literacy Topics

- Computer
- Computer Literacy
- Bits and Bytes
- Digitization

- Character Encoding
- Binary Number System
- Digital Convergence

## Computer

A **computer** is a digital electronics device that combines hardware and software to accept the input of data and then process and store the data to produce some useful output.

### Why This Matters

Computers have transformed the world. The ability to digitally represent and process information, including text, values, images, and sound, has allowed us to be more productive and to extend our intellect and understanding of life in this universe. The power of computing can improve every aspect of life, both professionally and personally. Along with a wide array of benefits, computers also generate a wide variety of ethical dilemmas, such as the digital divide, intellectual property rights, privacy, freedom of speech, and health-related issues associated with living a digital lifestyle.

### Essential Information

Computers are made up of hardware—the tangible parts of the computer that take up physical space—and software—the electronic instructions that tell the computer what to do. The hardware and software work together to collect input, perform processing based on the input, store data, and produce output (useful results).

Input can be anything that a computer can collect, such as keyboard characters, mouse or touch pad movements, menu selections on a cell phone made with keyboard arrows or voice commands, music streamed from an Internet server to a smart phone, or a heartbeat monitored by medical sensors.

A computer performs processing, using an integrated circuit designed to manipulate bits in a manner that carries out the instructions of the software. Data can be stored in a computer—that is, held temporarily or permanently, either by using electrical charges or magnetic particles on disks or tapes or by burning pits into the surface of a CD, DVD, or Blu-ray disc.

A computer produces output—the results of the processing shown on a display, printed to paper, pumped through speakers or headphones, or used as input into another computing process.

One of the primary purposes of a computer is to process *data*—bytes stored in a computer that may represent numbers, characters, sounds, or colors—into *information*—data organized in such a way that provides value to the user, such as music, images, the result of calculations, or useful information from a database query.

Computers are classified as either general-purpose or special-purpose. A *general-purpose computer* is designed to carry out a wide variety of activities depending on the software being used. General-purpose computers include personal computers (PCs), servers, and supercomputers. A *special-purpose computer* is designed for a specific computing purpose. Game devices, iPods, digital cameras, and a host of industry-specific devices, such as pacemakers, airport security scanners, and bank ATMs, are special-purpose computers.

Computers are used in five primary areas to improve our lives, as detailed in the following table.

**Table: Primary Uses of Computers**

Computer Use	Description
Computation	Computers' computational power—their ability to calculate and analyze—is solving many of life's biggest mysteries, such as cracking the code of the human genome and unraveling the mysteries of protein folding to find cures for numerous diseases.
Automation	Computers automate otherwise human actions and tasks, such as identifying explosive materials and safely disposing of them as well as calculating and filing a person's taxes.
Communication	Computers enhance human interaction through voice, text, and video communications, providing anywhere, anytime contact.
Entertainment	Computers provide entertainment through digital music and media players, interactive games, motion picture special effects, and many other forms of entertainment.
Managing information	Computers manage information, using databases that can filter and query billions of records to deliver the needed information.



## Computer Literacy

**Computer literacy** refers to a functional understanding of the fundamentals of computers and their uses.

### Why This Matters

Today's college graduates are entering the workforce as knowledge workers expected to add value to the information economy. The information or knowledge economy coupled with the innovation economy provides products that are not manufactured on assembly lines but are created in the minds of an innovative workforce. Most products sold by businesses in the U.S. and other developed countries hold no physical space; they are ideas that serve to improve life.

Knowledge workers depend on their computer skills to generate innovative products. It is impossible to participate in the information/knowledge economy and the innovation economy without computer literacy: fundamental computer skills and understanding. That is why computer literacy is a core requirement in most school systems.

### Essential Information

The expression *computer literacy* understates the level of computer skills that hiring businesses expect in today's college graduates. For that reason, some schools are adopting the expression "computer fluency." *Computer fluency* captures the essence of business expectations. Knowledge workers should have more than a functional understanding of computers; they should command expertise in numerous applications and be swift to pick up new computer skills. Knowledge workers should be as comfortable with computers and digital technologies as they are with breathing.

## Bits and Bytes

A **bit**—short for binary digit—is a digit that can be 1 or 0. A bit is the smallest unit of information that a digital electronics device can manipulate. A group of eight bits is called a **byte**.

### Why This Matters

Bits provide a simple manner of representing information digitally. When combined into bytes and groups of bytes, bits can represent a wide variety of information. Understanding bits and how they represent information is key to understanding the workings of computers and other digital electronic devices.

## Essential Information

Information is represented with bits by assigning the information to a particular state of a bit or group of bits. For example, a bit in the 1 state might be assigned black, while a bit in the 0 state could represent white. Using this encoding, you could represent a black and white image like the one shown on this page. Stored on a computer, the representation would look like a long list of 1s and 0s, but when interpreted by a graphics application, the bits represent colors and are displayed across the page as a grid of pixels, resulting in the cat's face (click the image to view the pixels close up).

Combining bits provides power to represent a greater variety of values. The picture of the feline's face could become a high-quality color photograph by increasing the number of bits used to store each pixel. Two bits can represent four colors, three bits can represent eight colors, four bits can represent 16 colors, and so on. With each additional bit, you double the amount of information that can be represented. The formula for this relationship between bits and units of information is  $2^b = i$ , where  $b$  is the number of bits and  $i$  represents the units of information represented. For example  $2^4 = 16$ . High quality photos use RGB color that employs 24 bits to represent over 16 million colors.

Eight bits equal a byte, the standard grouping for representing and storing most data. A byte can represent up to 256 units of information ( $2^8 = 256$ ). A byte provides more than enough storage for every character on a computer keyboard. A byte can represent the values 0 to 255. Bytes can represent different types of information, depending on what encoding is being applied. For example, 01011010 could represent the letter Z using ASCII encoding or the value 90 using the binary number system. It could also represent the color light-green using RGB color encoding or the note C# using sampling. Once the encoding scheme is known, the byte can be decoded and interpreted. Software is used to encode and decode bits and bytes. So, for example, a digital camera encodes an image as a long list of bits, and photo software decodes it and displays it on your computer.

Computers and digital electronic devices may work with thousands, millions, billions, trillions, quadrillions, and even quintillions of bits and bytes. The terminology in the following table is used to express these large quantities.

**Table: Units of Measure**

Prefix	Value	
<i>Kilo</i>	1000	Thousand
<i>Mega</i>	1,000,000	Million
<i>Giga</i>	1,000,000,000	Billion
<i>Tera</i>	1,000,000,000,000	Trillion
<i>Peta</i>	1,000,000,000,000,000	Quadrillion
<i>Exa</i>	1,000,000,000,000,000,000	Quintillion

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Bytes are typically represented with an uppercase *B* and bits with a lowercase *b*. For example, *KB* stands for kilobyte and *Kb* for kilobit. These are important metrics to understand if you want to measure the power and effectiveness of digital technologies. Today's computer hard drives store from hundreds of gigabytes (GBs) to more than a terabyte (TB) of data. High-speed Internet services deliver typically between 4 and 30 megabits of data per second—depending on price, which might seem like a lot until you consider that a motion picture can be more than 8 GBs in size, or dozens of GBs for high-definition movies.

## Digitization

**Digitization**, also called digitizing, is the process of transforming information, such as text, images, and sounds, into digital representation (1s and 0s) so that it can be stored and processed by computers.

### Why This Matters

In order to manipulate and explore information with computers, the information must first be transformed into the digital representation that computers can process. The reason that computers have become a part of so many things that people do is because we have learned how to digitize so many different types of information.

### Essential Information

Information is represented in digital form either using a look-up table or through the use of binary numbers. The look-up table approach maps information without value to numbers, using a table to show the relationships. For example, the American Standard Code for Information Interchange (ASCII) uses a look-up table to show the digital representation of all the characters on a computer keyboard. ASCII declares that 01011010 is the letter Z. Since computer systems developers have

accepted ASCII as a standard—and more modern standards are based on ASCII—01011010 is recognized as the letter Z in all computer systems when dealing with character data.

The binary number system is used to represent values in computer systems. Many of the things we experience with our senses can be represented using values. Digitizing the things we sense typically requires an analog-to-digital conversion (ADC). *Analog* information, such as sights and sounds, varies continuously over time. If the things we see and hear are broken down into their fundamental elements at very short time intervals, it is possible to describe them as values, store them digitally, and reproduce them in a manner that fools our senses into believing they are exact copies of the original.

For example, to digitize sound, a process called sampling measures the amplitude of a sound wave thousands of times per second. Each value is stored as a binary number. The resulting list of numbers is a digital representation of the original sound—not an exact copy of the original sound wave, but close enough for our human ears. Digitizing images is a similar process of breaking down an analog phenomenon—by continuously varying shades of color and light—into fundamental components called pixels, and describing those components using values that represent intensities of red, green, and blue (or RGB color).

Other technologies digitize a person's life. For example, in life casting, individuals wear video cameras that record all their activities in a day. There are also devices that can be worn as bracelets to monitor physical activity, sleep, and diet. Millions of individuals are digitizing their lives by posting photos, videos, and ongoing narratives of their activities and thoughts on Facebook. As GPS become more prevalent, it will be easy to track and record a person's exact location at any time.

Sometimes, digital information in one representation can be transformed into another representation so that the information can be processed in a different manner. For example, robotic book scanners capture digital photos of each page of a book and can digitize entire libraries of books. After the text is digitized, a technology called optical character recognition (OCR) is applied to identify the text in the image and transform it to ASCII representation.

## Character Encoding

Several standards have been designed for **character encoding** – the representation of characters on the keyboard with bytes, most having roots in the earliest standard, ASCII (American Standard Code for Information Interchange).

## Why This Matters

Although memorizing ASCII characters is of little use to most people, recognizing this broadly accepted standard and seeing how characters are represented in computer systems are valuable for understanding how computers process data.

## Essential Information

ASCII was published in 1963 as a character-encoding scheme for the English alphabet and other characters. ASCII maps characters to values that are represented as binary numbers in the computer. For example, in ASCII, 01000001 represents an uppercase *A*, 01000010 is *B*, and 01100001 is a lowercase *a*. The table below shows the ASCII codes for uppercase characters of the English alphabet. The full ASCII chart includes these as well as lowercase letters, numbers 0–9, punctuation, and a wide variety of symbols not found on a computer keyboard.

Although the characters in the alphabet have no particular value, they are sequential and are mapped to a sequence of values. While ASCII is the grandfather of character encoding and serves as a great example of the technique, many other more powerful encoding schemes based on ASCII have been developed. Today another encoding scheme named *Unicode* has arisen to take over for ASCII for many applications. Unicode is able to handle all types of international character sets yet is backward compatible with ASCII.

**Table: ASCII/Unicode A - Z**

100 0001	<b>A</b>	100 1010	<b>J</b>	101 0011	<b>S</b>
100 0010	<b>B</b>	100 1011	<b>K</b>	101 0100	<b>T</b>
100 0011	<b>C</b>	100 1100	<b>L</b>	101 0101	<b>U</b>
100 0100	<b>D</b>	100 1101	<b>M</b>	101 0110	<b>V</b>
100 0101	<b>E</b>	100 1110	<b>N</b>	101 0111	<b>W</b>
100 0110	<b>F</b>	100 1111	<b>O</b>	101 1000	<b>X</b>
100 0111	<b>G</b>	101 0000	<b>P</b>	101 1001	<b>Y</b>
100 1000	<b>H</b>	101 0001	<b>Q</b>	101 1010	<b>Z</b>
100 1001	<b>I</b>	101 0010	<b>R</b>		

## Binary Number System

The **binary number system**, which uses only two digits, 1 and 0, is commonly used for representing values in computers.

### Why This Matters

There are an infinite number of number systems, each as powerful as the next. Decimal, or base 10, serves people well perhaps because we have 10 fingers. Binary, or base 2, serves computers well since a bit has only two states—perfect for the on and off electronic switches in computers. Understanding the binary number system helps us to understand how computers operate.

### Essential Information

Just as the decimal number system is referred to as base 10 since it has 10 digits (0 through 9), the binary number system is called base 2 because it has only two digits (0 and 1). Consider decimal, where each column is a base 10 number; from right to left there is the ones column, the tens column, the hundreds column, etc. Another way to represent decimal (base 10) numbers is the  $10^0$  (ones) column, then the  $10^1$  (tens) column, the  $10^2$  (hundreds) column, etc. When we represent values in binary (base 2), the columns change to the  $2^0$  (ones) column, then  $2^1$  (twos), then  $2^2$  (fours), etc. Consider the equivalencies between binary and decimal numbers shown in the table at the bottom of the page.

By checking the column headings of the binary numbers, it is easy to determine their decimal equivalent. For example, the decimal number 2 is 10 in binary since the second column of binary numbers is the 2s column (which explains the caption of the image on this page). The decimal number 3 is 11 in binary—the 2s column plus the 1s column.

Zero is 0 in all number systems. The number 1 is the same in all number systems as well because any number to the power of 0 is 1. Notice that binary numbers take a lot more digits to express large values than decimal numbers do. The value 9 takes only one digit in decimal but requires four digits in binary, 1001. The decimal number 9999 is 10011100001111 in binary. The lower the base number in a number system, the more digits that are required to represent values.

This page gives only a brief overview of binary numbers—enough to make the point that any mathematical process achievable with decimal numbers is achievable with binary numbers. Since computers can only work with binary numbers—1s and 0s—this is an important fact to realize. As you work with computers, you may run across other number systems. The *hexadecimal number system*, or base 16, is used in digital graphics as a shorthand for RGB color representation. Also known as Hex, this number system includes 16 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. *Octal*, or base 8, is another number system used by computer scientists as a shorthand method of communicating values stored in bytes.

There are volumes of information about binary numbers and other number systems on the web if you are interested in learning more. A few examples are provided in the table below.

**Table: Binary to Decimal**

Binary					Decimal			
$2^3$ 8	$2^2$ 4	$2^1$ 2	$2^0$ 1		$10^3$ 100	$10^2$ 100	$10^1$ 10	$10^0$ 1
			1	=				1
		1	0	=				2
		1	1	=				3
	1	0	0	=				4
	1	0	1	=				5
	1	1	0	=				6
	1	1	1	=				7
1	0	0	0	=				8
1	0	0	1	=				9
1	0	1	0	=			1	0

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## Digital Convergence

**Digital convergence** takes advantage of the fact that digitization standardizes all types of data to 1s and 0s to create devices that combine the functionality of several digital electronics devices.

## Why This Matters

Digital convergence is a trend that illustrates advances in digital electronics. As processors become smaller and faster and telecommunications networks become increasingly pervasive, we can combine the functionality of several devices and technologies. Digital convergence provides convenience and power at a lower price.

## Essential Information

Digital convergence is occurring in many areas beyond mobile phones. Consider Voice over Internet Protocol or VoIP. VoIP allows telephone calls to travel over the Internet. Digital convergence through VoIP will ultimately lead to the complete merging of voice and data networks. Telecom companies are now competing to provide “triple play” services to consumers, consisting of television, phone, and Internet—another example of digital convergence. GPS technology is combining with photographs and geographic information systems to provide augmented reality apps that layer data over whatever a camera is pointed at. Those in the entertainment industry are predicting the convergence of motion pictures, interactive video games, and virtual reality. Looking farther down the road, futurists like Ray Kurzweil speculate that human intelligence and computer intelligence will eventually converge, perhaps within our lifetime.

Digital convergence is made possible because so many different types of data and information can be stored and processed as 1s and 0s. In the 1970s, television programs, music, photographs, news articles, movies, voice communication, photos, and data communication each required a different type of device and media. Television and radio were broadcast wirelessly using analog signals, music was stored on LPs and various forms of tape, news was printed on paper, the analog signals of phone calls were carried over telephone wires, movies were recorded to celluloid tape and projected in theaters, and cameras captured images by exposing film to light. Only computers, then in their infancy, were storing information digitally. Today all of these media have become digital and can be managed by one digital device, using a variety of software.

## Computing Platforms

A **computing platform** describes a computer’s architecture in terms of hardware and software.

## Why This Matters

Many computing platforms have emerged to support computing in different environments for different purposes. Knowing about the variety of computing platforms available is useful when deciding on the best computing tool to support a particular computing need.



## Essential Information

The expression “computing platform” is used in a variety of scopes. It can be used to address small but important differences in one particular kind of computer. For example, in cellular networks, there is the GSM platform and the CDMA platform. GSM phones cannot operate on CDMA networks, and CDMA phones cannot operate on GSM networks. Personal computers are available in several platforms that include Microsoft Windows, Apple Mac, and Linux. Software developed for one of these platforms will not function on another unless it is re-engineered to do so.

“Computing platform” can also be used to describe computers in more general terms (as is done in this section): personal computers in all their varieties, servers, supercomputers, and special-purpose computers. Each of these general categories of computing platforms applies specific kinds of computing power to a particular type of use and environment. For example, the Ford Work Solutions in-dash computer (shown in the sidebar), provides Internet connectivity, hands-free calling, equipment inventory systems, GPS navigation, and access to desktop applications for people whose truck or van doubles as their office.

## Computing Platforms Topics

- Personal Computer
- Mobile Computing
- Synchronization
- Server
- Supercomputer
- Special-Purpose Computer

## Personal Computer (PC)

A **personal computer**, or **PC**, is any general-purpose computer designed to meet the many computing needs of one individual.

## Why This Matters

Personal computers come in a variety of sizes and models to support computing in all environments—from a sofa, to an office desktop, to a subway train, to a mountaintop. Users are limited in what they can do with their computers only by the software that is available, and for most personal computer platforms, applications number in the tens of thousands. Perhaps the most valuable use of a personal computer is its ability to connect to the Internet to access seemingly limitless information and communications and an increasing number of software

services. Because computing is such an important part of all professions, computers have been developed for access in all environments.

### Essential Information

Personal computers are considered general-purpose, single-user computers. They are general-purpose in that they are designed to run all kinds of software to serve a wide variety of needs. Servers and other large computer systems serve many users simultaneously over a network. But the personal computer is designed to serve one user at a time. That's what makes it personal!

There are PCs designed for every environment from a multitude of vendors running a variety of operating systems. Here's a brief rundown of the most common types of PCs.

**Table: Common PC Types**

Type	Description
Desktop PC	The original personal computer; provides computing power through circuit boards housed in a tower case called the system unit or sandwiched in the display case. Controlled through input devices such as a keyboard and mouse, using output devices including a display, speakers, and a printer—all connected with cables or wireless technology. Since desktop PCs are not intended to be portable, computer manufacturers can pack in more computing power. High-end desktop computers are used by those who need a lot of computing power for things like media and gaming.
Notebook PC	Also called a laptop PC; the most popular type of PC. Provides nearly all the power and functionality of a desktop PC in a portable all-in-one case. Notebooks come in a variety sizes. Ultra-portable notebooks are popular with business travelers. Low-priced <i>netbook</i> computers are typically small notebooks, designed primarily to access Internet services such as the web e-mail, and online software like Google Docs. On the other end of the spectrum, <i>ultrabooks</i> are slim and sleek, providing state-of-the-art processing power at premium prices. Deciding on a notebook often comes down to balancing size, weight, portability, and cost against processing power and capabilities to suit your individual usage habits.
Tablet PC	With the popularity of the iPad, today the term <i>tablet</i> is more frequently used to identify iPads and other similarly styled computers. In reality, the tablet was around for years prior to the iPad, in a variety of form factors typically running Microsoft Windows. The key feature of a tablet PC is a touch-sensitive display. Your fingers or a special electronic stylus can be used to write or draw on the screen, select menu items,

	and manipulate the cursor. All that is written and drawn on the display is interpreted, processed, and stored digitally. Tablet PCs are useful in environments where you have to access your computer while on the go or on your feet. Tablets are also popular for viewing movies, reading books, playing games, and keeping up with online communications.
Smart phone	<i>Smart phones</i> are cell phones that possess computing capabilities, including Internet access. A high-end smart phone can offer the benefits of several digital devices in one: a computer, a cell phone, a digital music player, a portable video player, a digital camera and camcorder, a handheld gaming system, a GPS, and much more. iPhone and Android smart phones support hundreds of thousands of computer applications (apps) and have become popular platforms for software development.
Custom PC	PCs have been custom designed to suit many unique needs. There are underwater PCs for use by divers, ruggedized mobile PCs for use in construction and other rough environments, and handheld PCs for collecting census data. There are wearable PCs that clip onto a belt and are controlled with spoken commands. There are PCs designed for cars, aircraft, tanks, and spacecraft.

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## Mobile Computing

**Mobile computing** refers to the use of battery-powered mobile devices that provide access to computing, communication, information, and/or entertainment anywhere, anytime.

### Why This Matters

The mobile phone and Internet revolution, along with pervasive wireless networks, have given rise to an increasingly mobile workforce and lifestyle. Nowadays, digital technologies go with us wherever we roam. This presents new challenges in usability as we explore how to interact with devices as we travel. Many mobile solutions have been developed and many more are sure to follow. Consider Google Glass, a technology added to a pair of glasses utilizing a small display that overlays information on your environment and is controlled via voice commands (see image).

### Essential Information

Personal computers have been developed to suit many mobile uses, including tablets, notebooks, and smart phones. Special input and output technologies have

been developed, which allow users to interact with the devices while in transit and in crowded environments. Touch screens, tiny keyboards, voice recognition, wireless headsets, and even head-mounted displays and Star Trek style communicator badges are being used to provide one-handed or hands-free operations.

Mobile computing extends to special-purpose computers as well. The iPod single-handedly launched a mobile media explosion. The Nintendo DS put mobile gaming into the hands of millions of primary school children. Digital cameras transformed many of us into photography hobbyists. Mobile phones evolved into smart phones that provide all of these mobile applications and more. Tablet PCs expanded the possibilities for mobile computing by providing larger display sizes. The table below provides a list of technologies that make mobile computing possible.

Although mobile computing offers many benefits and enables a more productive workforce, there are significant issues related to the digital lifestyle. Some people feel that they are always on call and on duty, and they become burned out from overwork. There are issues of etiquette, regarding the appropriateness of engaging in mobile computing and communications in social situations. There are also issues of safety surrounding the use of mobile computing and communication devices while driving or operating machinery.

**Table: Mobile Computing Technologies**

Technology	Description
Wireless networks	Although voice communications do not require a very fast network, data communications do—especially media-rich web sites and services. New technologies are being explored to provide wireless networks that are as fast as home Internet connections with the capacity to serve millions of subscribers.
Servers	Powerful computers are required to deliver Internet and cellular services to mobile users. Cloud computing is putting increasing demands on servers to support all kinds of applications and data.
Storage	Mobile devices need to be light and can't be weighed down with hefty hard drives. Fortunately, new solid-state storage technologies are providing gigabytes of storage capacity in a space no larger than a fingernail. Also, personal data and files are increasingly being stored online on servers in the cloud, accessible from any Internet-connected device.

Syncing	Keeping files synchronized (sync'd) on multiple devices is a big challenge. If you update the calendar on your cell phone, it should be reflected on the calendar on your computer. Synchronization can be accomplished by manually connecting devices and using sync utility software or by storing all data on the Internet, utilizing cloud computing technologies.
Rechargeable batteries	Powering wireless devices is an important consideration. The battery must support at least a day's worth of computing between charges. The more powerful the device, the more energy it draws. Developing battery technology that is both efficient and environmentally safe is a top priority.

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## Synchronization

**Synchronization** is the process of maintaining common files and data across multiple devices so that all copies are up to date.

### Why This Matters

It is common for professionals to access and edit data and files from more than one device. A typical professional might use a work PC, a home PC, a notebook or tablet, and a smart phone to access and edit files, calendar appointments, to-do lists, contacts, and other information. Personal users want their contacts, music, and other information available and up to date on all of their devices, too. A big challenge for today's "technorati" (technology enthusiasts) is keeping the data synchronized across all their devices.

### Essential Information

There are two approaches to accessing common files across multiple devices. One method is to store all data and information on the Internet, where it can be accessed from any Internet-connected computer. This approach is part of a trend referred to as cloud computing, where the Internet is perceived as a cloud, and data and services are delivered from the cloud to your computer. Google Drive, Google Calendar, and other Google applications are examples of cloud computing. These rich Internet applications can be used to create word processing documents, spreadsheets, presentations, and calendar items. All of the data and files are stored on Google servers, accessible anytime from any web browser. Microsoft has a similar service called OneDrive for Microsoft Office applications. The danger of cloud computing is that if the cloud fails, or your Internet connection fails, you lose access to your data.

The other approach to accessing common files across multiple devices is to store copies of the files on each device and allow the devices to communicate with each other to update all copies. This is the method known as synchronization. Users of iPods and iPhones are acquainted with the process of synchronization. Connecting an iPhone to your computer will automatically run iTunes and sync music playlists, photos, e-mail, contacts, calendars, and video.

Apple has made synchronizing easier with iCloud. With iCloud, when an iPhone user buys a song, movie, or app on one device, it is automatically distributed over the Internet to all Apple devices owned by that user. Google, Microsoft, Apple, and Amazon all offer cloud storage and synching. Dropbox is another popular source of free cloud storage. Users should use caution when synching over a cellular network since data transfer rates can be slow and costly. It's best to utilize a Wi-Fi network for synching and streaming media.

## **Server**

A **server** is a powerful computer that often utilizes many processors to provide services to many users simultaneously over a network.

### **Why This Matters**

Servers are the past, present, and future of computing. The earliest computers from the International Business Machines (IBM) Corporation were servers that supported employees throughout an organization over a local area network. Today, servers provide everything that is accessible on the Internet and web, not to mention cellular networks, corporate networks, and government networks. Servers are becoming even more important as networks become ubiquitous through cloud computing, providing all software, services, and information that people require anytime, anywhere.

### **Essential Information**

Servers come in many sizes to suit many needs. The term “server” has replaced other older terms, such as minicomputer, midrange computer, and mainframe computer, used to describe various sizes of servers. Today, companies like IBM, HP, and Dell offer servers ranging in price from a few thousand to millions of dollars. Servers can utilize a single CPU or thousands of CPUs and can serve from one person to millions of people. *Mainframe servers* are the largest of all servers, typically serving thousands of users. *Blade servers* pack multiple, perhaps dozens, of motherboard modules into a rack to create a modular server that is easy to maintain and expand.

Servers play a key role in local area and wide area networks. They allow individuals in an organization spread over large areas to access common data anywhere from a central location. Employees at most large corporations do the majority of their work on servers.

The Internet and most of its uses, including the web, are considered client/server networks. The web, email, instant messaging, and many other online applications depend on servers running continuously. Backup servers are often put in place so that if the primary server suffers an outage, the backup can come online to provide uninterrupted service.

Servers are typically designed and purchased for a particular purpose.

**Table: Types of Servers**

Type	Description
Application server	Runs or delivers applications to users on the network
Communications server	Manages network traffic and communications
Database server	Stores data and provides methods for accessing specific data
Email server	Stores and manages email
File server	Stores and delivers files
Print server	Manages jobs sent to a shared printer
Game server	Runs multiplayer games
Web server	Stores and delivers webpages and content

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## Supercomputer

**Supercomputers** are the most powerful type of computer, often utilizing thousands or even tens of thousands of processors to solve the world's most difficult problems.

## Why This Matters

Personal computers assist us in our individual lives, and servers assist groups of people, organizations, and businesses. Supercomputers assist humanity in extending our intellectual capabilities through massively powerful computation.

## Essential Information

Supercomputers are massively parallel processing computers consisting of thousands of processors synchronized to work together to solve complex problems. Supercomputers use specially designed software to distribute a processing task over many processors.

Supercomputers are used for research in industry, government, and academics. They excel in solving highly calculation-intensive problems in many fields. Meteorologists use supercomputers to model environmental conditions that affect weather over the short, mid, and long term. Police departments use supercomputers to simulate crime scenes. The U.S. Department of Defense uses supercomputers for simulating atomic explosions and researching advanced weapons systems design. Auto manufacturers use supercomputers to experiment with the aerodynamics of car designs in virtual environments. Animation studios and motion-picture special-effects artists utilize supercomputers to create virtual 3D environments and animated actors. Financial analysts use supercomputers to predict the ups and downs of the market. Supercomputers are also used to simulate the functioning of the brain to create artificial intelligence.

There are efforts to create supercomputers by joining individual computers together over the Internet. Hundreds of thousands of users have volunteered their computers and game consoles for use by the Folding@home project to simulate protein folding in hopes of curing diseases. Folding@home is recognized as the most powerful distributed computing cluster in the world. Utilizing computers connected to the Internet when not in use by their owners, it claims to have twice the power of today's most powerful supercomputer. The SETI@home project similarly uses Internet-connected computers to search for extraterrestrial life.

## Special-Purpose Computer

**Special-purpose computers** are computers designed to meet a specific need and are more prevalent, yet less noticeable, than general-purpose computers.

## Why This Matters

It is important to recognize the often-overlooked use of computers in millions of electronics devices that we depend on every day.



## Essential Information

Some special-purpose computers are simply general-purpose computers programmed for one particular task. For example, kiosks are increasingly springing up in public places. A *kiosk* is a computer station that provides the general public with specific and useful information and services. Usually equipped with a touch screen, kiosks provide everything from online store catalogs to maps and exhibit information. The ATM where you can withdraw money from your bank account is a kiosk. Kiosks that allow customers to print photos from their digital cameras have become very popular. There are even church kiosks that accept donations and respond with a blessing.

Other special-purpose computers are embedded in consumer electronics, appliances, medical equipment, and a host of other devices. Referred to as *embedded systems*, and sometimes *microcontrollers*, these special-purpose computers are designed to control the electronics devices in which they reside. Here are a few examples of uses for embedded systems:

- Media devices such as MP3 players, iPods, DVD players, and HDTVs
- E-book readers
- Digital cameras and camcorders
- Telecommunications devices such as mobile phones, wireless access points, and routers
- Digital watches and clocks
- Home appliances like microwaves, dishwashers, ranges, washers, and dryers
- Air-conditioning and heating systems
- Medical equipment such as pacemakers and hearing aides
- Hospital equipment such as MRI machines, electronic stethoscopes, and heart-rate monitors
- Traffic lights, elevators, and toll booths
- Automobile, aircraft, and seacraft controls and engines
- Factory assembly lines
- Nuclear power plants

## Personal Information Management

### Lesson Topics

1. The Value of Personal Information Management
2. E-mail
3. Contacts
4. Calendar
5. Tasks

### Overview

Knowing how to efficiently and effectively managing time is a key life skill. No matter what your chosen profession, the ability to use tools such as e-mail, personal contact lists, calendars, and task trackers can help you make the most of your time and personal resources while keeping organized. As more emphasis is placed on using the cloud for computing and storage activities, it makes sense to understand how personal information management might benefit from cloud-based resources.

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#### 1. The Value of Personal Information Management

##### Skills Covered

Today, it's easy to manage your e-mail, contacts, tasks, and calendar online, whether through a web page or through a mobile device. As long as you have a connection to the Internet, your personal information is available around the clock, and around the world.

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#### 2. E-mail

##### Skills Covered

When on the go, many e-mail users now rely on web-based mail programs instead of fixed programs, such as Microsoft's Outlook, on their computers. Known as "webmail," messages are available through a Web browser wherever and whenever there's an active Internet connection. Popular webmail services include Yahoo! Mail, Hotmail and Google's Gmail.

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### 3. Contacts

#### **Skills Covered**

Contacts are an essential part of personal information. Although used primarily for holding names, physical addresses, e-mail addresses, and phone or fax numbers, additional information such as birthdays and anniversaries also can be tracked.

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### 4. Calendar

#### **Skills Covered**

Calendars are central to managing both time and information efficiently and effectively. When the calendar is available in the cloud, you'll have access every time you're online to see your events, share your calendar with others, and even set up reminders via text message to your mobile phone.

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### 5. Tasks

#### **Skills Covered**

Using the features built into Gmail, you can convert e-mails to tasks, track your tasks on a mobile device, create tasks to auto-populate your calendar, and much more. Forget using paper and pencil to track (and misplace) your to-do list. The tasks you set here go with you anywhere, and can be checked off, just like the old-school paper version.

## Ethics

**Ethics** is a branch of philosophy that deals with issues of morality—consideration of which human actions and reactions are morally right and wrong.

### Why This Matters

It is important to make intelligent decisions from an ethical perspective about the actions that we take—that is, to consider whether our actions feel right or wrong to us and why. These actions range in scope from personal actions to the actions of our businesses and organizations, the actions of our governments, and ultimately the actions of our species. Digital technologies have provided new opportunities and dangers for our species and many new ethical considerations.

### Consider This

In recent years, we have seen the rise of a new type of hacker group. Hacker activists, or *hacktivists*, hack computer networks for a perceived righteous cause. Hack collectives such as Anonymous, LulzSec, and AntiSec have claimed responsibility for breaking into the networks belonging to hundreds of businesses, law enforcement agencies, and government agencies, including the FBI and U.S. defense contractors. Typically, hacktivists choose their targets based on some injustice that has occurred or to retaliate against agencies that threaten hacktivists. For example, Anonymous hacked Twitter and Facebook accounts for a North Korean news agency. Instead of delivering the usual pro-North Korea propaganda, Anonymous used the accounts to criticize North Korea and its leader Kim Jong-un for building nuclear weapons (see video).

Once a target is hacked by a hacktivist organization, the group may publish embarrassing or revealing stolen information on the web. For example, Anonymous hackers broke into an online pornography service, DigitalPlayground.com, and published the email addresses, passwords, and credit card numbers of tens of thousands of subscribers.

Today many hack attacks are carried out for some righteous cause rather than for money. In some cases, the result of hacktivist attacks has had the intended effect: embarrassing the targeted company and those associated with it. However, hacking is still illegal. Dozens of young hackers have been jailed for their participation in these hacker collectives. Many law-abiding individuals and businesses live in fear of these digital vigilantes. The web has certainly empowered many to advance righteous causes. What do you think? Should hacktivist groups be condemned by the public or supported? Why?

### Essential Information

This section addresses ethical issues surrounding the use of digital technologies. Although computer ethics is typically defined as relating to ethical issues confronted by computing professionals, this section addresses computer ethics in a broader

sense. Computing touches everyone—not just computing professionals—at home, at work, and in our role as citizens. We confront important ethically charged computer-related decisions in all of these areas. This section discusses personal ethics, professional ethics, and governmental ethics, along with related topics.

### **Ethics Topics**

- Personal Computer Ethics
- Professional Computer Ethics
- Governmental Computer Ethics
- Accessible Computing
- Green Computing
- Digital Divide

### **Personal Computer Ethics**

**Personal computer ethics** refers to the responsible use of computers by individuals outside of professional environments.

#### **Why This Matters**

Computer users face many ethical choices in their casual use of today's technologies. Some software and online services make it possible to engage in, and even encourage, unethical and sometimes illegal behavior. It is important for computer users to consider their actions carefully and intelligently to determine the course of action that best matches their own code of ethics and sense of responsibility. Too many computer users follow the pack and adopt others' sense of ethics, even when it goes against their own beliefs and conscience. Today's best leaders have a solid sense of what they hold to be ethical and unethical, and they exemplify those beliefs through their actions, while remaining open to new ideas and intellectual growth.

#### **Essential Information**

Each person has his or her own sense of what is right and wrong regarding computer use and behavior. Often computer ethics are learned from our parents and teachers. As we mature, those ethics are altered to suit our own belief systems. Personal computer ethics is a highly subjective topic, except in issues of local, state, and federal law, where ethical issues are clearly defined. Using a computer to create and distribute malware, steal credit card numbers, invade privacy with spyware, or steal copyright-protected work or someone else's intellectual property is illegal. Those who participate in such activities might pay a price in terms of jail time and fines.

However, when a significant portion of a population in a democratic society opposes a law, there arises substantial pressure on the government to change the law or change conditions in society. For example, the MP3 music standard and the

availability of P2P file-sharing software and recordable CDs created a situation where many otherwise law-abiding individuals were actively violating copyright law by copying music files. In that case, courts affirmed that owners of the intellectual property, the record companies, deserve compensation. Through a process of court battles, technological solutions, and adjustments in the market, a slow but purposeful change has been occurring in views on intellectual property and the manner in which music and other forms of intellectual property are distributed. Newer approaches accommodate both the public's need for robust, easy, and inexpensive access to intellectual property—such as art, music, and videos—and the creator's need to make a living.

This is how governance and law evolve. These institutions should not be rigid and unchanging, but flexible and responsive to society. Good laws evaluate a situation from all perspectives and implement a solution that provides the greatest public good. If individuals can examine situations intelligently and unselfishly, then personal ethics will also serve the greatest public good.

Personal ethics regarding computer use typically combines legal considerations, what is best for the public good, and what is best for the person in terms of mental, physical, and spiritual well-being. Fear of the law may keep an individual from hacking a computer network. A feeling of social responsibility may guide a computer user to treat others online with respect. A person's own sense of morality may keep that person from becoming involved with web content that has a negative impact. What that content is may be different for each individual. Personal computer ethics requires an examination of one's own conscience and the weighing of benefits against costs in terms of personal, social, and legal considerations.

## **Professional Computer Ethics**

**Professional computer ethics** involves the ethical issues faced by professionals in their use of computer systems as part of their jobs.

### **Why This Matters**

The ethical issues faced by professionals who use computer systems as part of their jobs include a responsibility to customers, coworkers, employers, and others with whom they interact and who are impacted in some way by their computer use on the job. Because computer systems are integral tools in today's businesses, professional computer ethics often equates to business ethics. In today's connected professional environments, businesses need to be concerned with more than the bottom line. They should also be concerned with the ethical treatment of their customers and employees, protecting private information and protecting the interests of investors. Businesses that create technologies need to consider the impact their products have on humanity and the natural world (see video). Business computer systems and computer products provide powerful tools for both unethical and ethical behavior.

## Essential Information

Professional computer ethics involves those who produce computers, software, and information systems as well as those who use them at work. Besides governing personal behavior, laws are also designed to govern professional behavior and the behavior of businesses. For example, the Identity Theft Protection Act of 2005 requires businesses to secure sensitive data physically and technologically and to notify consumers nationwide when such data is compromised. The Children's Online Privacy Protection Act of 2000 prohibits businesses from collecting personal data online from children under the age of 13. This is the primary reason Facebook does not allow children under 13 to become members. This type of ethics is imposed upon a business by the government.

Many organizations and associations go beyond what is required by law and establish their own codes of ethics. Codes of ethical conduct can foster ethical behavior in an organization and give confidence to people who interact with the organization, including clients and customers. Some organizations and associations that have developed a code of ethical conduct include:

- Computer Professionals for Social Responsibility (CPSR)
- Association of Information Technology Professionals (AITP)
- The Association for Computing Machinery (ACM)
- The Institute of Electrical and Electronics Engineers (IEEE)
- The British Computer Society (BCS)

Such codes of ethics typically include consideration for general imperatives, such as avoiding harm to others and being open and honest, as well as more professional responsibilities, such as achieving high quality in your work, respecting intellectual property, and respecting client privacy.

## Governmental Computer Ethics

**Governmental computer ethics** refers to a government's responsibility to create laws to protect citizens from unethical computer use and provide citizens with equal access to computers and information technologies as well as their benefits.

### Why This Matters

Governments face many of the same ethical considerations as businesses with respect to their use of computers and information systems. However, governments have the added responsibility of guiding the influence of technology on their population. They create laws that govern the use of technology so that citizens are protected from those who abuse others through the use of technology. Besides

keeping information and people safe, the government also has a responsibility to give everyone equal access to technology in order to enjoy the associated benefits.

### **Essential Information**

Governments shoulder the computer-related ethical responsibilities of entire countries and cultures. These responsibilities generally fall into two categories: protection and empowerment. A government should protect its citizens from those who wield computing powers in unethical ways. A government should also empower its citizens so that all socio-economic groups can benefit from the power of computing.

Many computer-related social issues are impacted by governmental regulation. Our political representatives are responsible for creating laws that protect us by regulating business use of technologies that are invasive to our privacy. Governments determine what types of information may be dangerous to the population and should be censored. Governments also wrestle with ethical issues when determining what situation constitutes the use of technology for surveillance and how to balance that with a citizen's right to privacy.

The government is responsible for defending a country's critical infrastructure from foreign governments, cyber criminals and terrorist groups. The problem is, in the U.S., much of that infrastructure is owned by private corporations. Some in government believe that companies operating power plants, communication systems, chemical facilities, hospitals, train lines, airlines, and other suppliers of critical national resources should be required to meet performance standards to prove they can withstand attacks or recover quickly from them. However, others in government are against placing unfunded mandates on private corporations, even if it does mean a less secure nation. These are ethical dilemmas that a government faces. In either case, it is clear that the government must partner with businesses to protect the country.

Many governments are also trying to ensure that all citizens have the same basic privileges and opportunities. In the United States and some other countries, these efforts now extend beyond food, housing, and education to include access to computing and information technologies. Many governments are making efforts to extend the reach of the Internet to every citizen, even those living in remote locations. During his time in office, President Obama has supported a broadband expansion plan focused on expanding high-speed Internet to rural areas of the country. The plan provides high-speed Internet to 98 percent of U.S. citizens so that everyone has the opportunity to benefit from what the Internet provides.

At times, some governments have felt compelled to shut down the Internet to stop or slow communication for their citizens. This generally arises in situations where anarchy exists in the population and law and order is needed. Shutting down the Internet is often the last act of a desperate, oppressive regime as it is about to be overthrown by its people (see video).



The ethical issues that governments face are large and have far-reaching effects. One example is the European Union's commission tasked with examining how smart appliances may impact citizens' privacy. It is important for individuals to be informed about technology-related policies and laws and to let their opinions be known to their representatives in government.

## **Accessible Computing**

**Accessible computing** refers to the provision of equal access to computers and information technology for individuals with disabilities.

### **Why This Matters**

Computer and information technologies must be designed in a manner that is easily accessible to all users. Unfortunately, in some cases, designers fail to consider the needs of disabled users, and their valuable products become unusable by individuals who have hearing, sight, or motor disabilities.

### **Essential Information**

There is a growing body of law and policy in many countries that addresses accessibility of information and communications technology (ICT), including the Internet and web. Laws differ from country to country. Some treat access to ICT as a human or civil right; others mandate only that government-controlled ICT is accessible to all, including the disabled; others specify that ICT sold in a given market must be accessible.

Section 255 of the U.S. Telecommunications Act of 1996 requires telecommunications manufacturers and service providers to make their products and services accessible to people with disabilities, if readily achievable. The World Wide Web Consortium (W3C) has developed Web Content Accessibility Guidelines for businesses and organizations to use in making their web content accessible to users with disabilities, such as those who are unable to see, hear, or move (see video).

The U.S. Department of Education has developed Requirements for Accessible Software Design to ensure that all software used in schools is accessible to all students, faculty, and staff. The Americans with Disabilities Act of 1990 requires businesses to provide equal access to individuals with disabilities, including access to web content and services. Many countries and regions, including Australia, Canada, Denmark, Finland, France, Germany, Hong Kong, India, Ireland, Italy, Japan, New Zealand, Portugal, Spain, the United Kingdom, and the European Union, have instituted similar laws and considerations for the disabled.

Numerous software and hardware tools are available to assist the disabled in using PCs. Individuals may use screen enlargement software to make computer screens

easier to read and use. Screen reader software such as JAWS enables blind users to interact with the computer by using text-to-speech technology to read words displayed on the screen. The user manipulates the software, using predefined hotkeys, or shortcut keys. Some phone companies offer a service that uses a webcam attached to a hearing-impaired person's computer. When the person makes a call and uses sign language to communicate, an operator translates the hand signals to a hearing person at the other end of the line.

## **Green Computing**

**Green computing** refers to the efforts of individuals, businesses, and governments to utilize environmentally conscious practices in the manufacturing and use of digital technologies.

### **Why This Matters**

At the same time that many people are spending increasing amounts of their lives online in virtual space, the serious reality of climate change has given many of us a heightened awareness of our natural environment and the dangers it faces. Individuals, organizations, and governments are making efforts to reduce our carbon footprint—the amount of greenhouse gases we produce—and to manufacture and use computing resources in an environmentally conscientious manner.

### **Essential Information**

The Intergovernmental Panel on Climate Change has determined that the buildup of greenhouse gases resulting from human activity, such as burning fossil fuels and deforestation, is primarily responsible for recent trends in global warming. Digital technologies contribute to global warming through the large amounts of energy they require, causing coal-burning power plants to generate increasing amounts of electricity and carbon emissions.

In an effort to improve the world, and perhaps their reputations in the process, many companies are going to great lengths to implement green computing initiatives. Green computing initiatives generally fall into one of two categories: energy efficiency or ecology.

There are many ways that the energy used in the manufacturing and use of computers can be reduced. Many companies that manufacture computers are turning to reusable energy sources for a portion of their energy requirements. They are also streamlining manufacturing processes to be more efficient and less energy demanding.

New computing technologies are being invented that use less energy. For example, the light-emitting diodes (LEDs) used in some newer displays reduce energy use by

80 percent over CRT monitors. Solid-state drives (SSD) are poised to replace hard disk drives, providing faster data access and dramatic energy savings. Finally, processor manufacturers such as Intel are working hard to create new, more powerful processors that require less energy to run.

In addition to creating more energy-efficient hardware, software can be written in a manner that requires fewer processor cycles, decreasing a computer's power consumption, especially for the operating system. Also, operating systems can incorporate energy-saving features used to power down a computer when not in use.

The Energy Star program was created in 1992 by the U.S. Environmental Protection Agency (EPA) to inspire energy conservation in electronics products. Computers that are Energy Star certified save 20 to 30 percent on energy consumption on average. The ENERGY STAR 5 requirements for computers went into effect in 2009 and have the strictest energy requirements to date.

The power consumption of an individual PC is a drop in the bucket compared to that of corporate data centers. Some data centers have power requirements equal to that of medium-sized cities. Data centers require massive amounts of power for processing and especially for cooling. Most companies are working to reduce the energy requirements of their data centers. Many companies are replacing older, power-hungry servers with more efficient models and are using virtual servers that allow a single physical server to behave like several servers. Virtual servers maximize the amount of work that can be managed by a single hardware server.

Computer technologies have not traditionally been very ecologically friendly. Dangerous compounds and chemicals are used in the manufacturing of some computing equipment, and recycling programs for digital electronics components have been far from robust.

*E-waste* refers to discarded digital electronics devices and components. The Environmental Protection Agency estimates that 400,000 tons of e-waste is sent to recycling centers each year. Much of that waste contains dangerous contaminants such as lead, cadmium, and beryllium as well as brominate flame retardants. There is concern that digital electronics are being discarded at a rate that will soon overflow our landfills. There is also a concern about recycling practices that are hazardous to those involved and to the environment. Roughly 80 percent of recycled e-waste is shipped (often illegally) to poorer, developing areas such as Guiyu, China and Lagos, Nigeria. Working for pennies an hour, workers dismantle, burn, or give acid baths to components to salvage valuable metals such as copper and gold, often at the cost of their health and the health of their environment. Children are exposed to dioxins, soil is poisoned with heavy metals, and the water becomes undrinkable.

Computer manufacturers are working hard to reduce the amount of dangerous contaminants in their products and are implementing take-back programs to assist customers with recycling.

## Digital Divide

The **digital divide** refers to the social and economic gap between those who have access to computers and the Internet and those who do not.

### Why This Matters

The digital divide highlights the issue of access and the difference in opportunities between the “haves” and the “have-nots.” Most agree that those without access to digital technologies are seriously disenfranchised in today’s world. The have-nots in this scenario may be unable to access technology due to a physical disability, financial limitations, geographic isolation, or political or social repression. There are digital divides based on gender, ethnicity, race, age, income, location, and disability.

### Essential Information

Although a significant concern, the economic digital divide in the United States has been shrinking since the turn of the millennium. The number of Internet users in the low-income range (earning less than \$25,000 per year) has soared, making them the fastest-growing segment of Internet users. Now the U.S. government is focusing on providing all citizens with high-speed Internet access. One of President Obama’s campaign promises was to bring high-speed Internet access to underserved and rural areas of the country and to elevate the U.S.’s broadband Internet penetration.

The global digital divide provides a greater social and ethical challenge. The World Economic Forum website states that Latin America, the Caribbean, and sub-Saharan Africa continue to suffer from a significant lag in adopting Information and Computing Technologies (ICT). The lack of skills in these areas leaves these populations with poor educational systems that do not support the new age of entrepreneurship and innovation enjoyed by the rest of the globe.

Computer engineers are working on new technologies that can bring computers and the Internet to those who cannot afford them or are in remote locations. A group of not-for-profit developers, called Ndiyo (Swahili for “yes”), has developed an ultrathin client system, which it says could make computing available to billions more people across the planet. Intel is working with the Chinese government to provide Chinese university students with low-priced laptops. An international consortium, including Indian and American companies as well as the World Bank, is building thousands of rural Internet centers in India. Each center connects to the Internet by land lines or satellite links and includes five to 10 inexpensive thin client PCs to provide access to government, banking, and education services in isolated villages.

If humans are to utilize the Internet to build a global community, it is clear that the more affluent “neighborhoods” in this community cannot ignore the needs of the less fortunate. Those seeking to assist developing nations believe that societies must move from “divide” to “include” as the central organizing principle of their analysis and actions. Passing out PCs and providing Internet access is the first step;

providing education is the next step; and including all humans in the information economy is an important last step.

The World Economic Forum is working to provide all required components to bring developing nations into the digital fold. In 2004, the World Economic Forum launched the IT Access for Everyone (ITAFE) initiative to develop new models of collaboration to accelerate digital access and inclusion. Processor manufacturer AMD joined with the Forum to launch the 50x15 initiative, aimed at providing computers and Internet access for 50 percent of the world's population by the year 2015 (see figure).

Bridging global digital divides requires extensive commitment and organization. Many feel that it is an important investment worth the expense and effort. Although the information and communication technology revolution offers genuine potential, there is a risk that a significant portion of the world will lose out if humans do not take a global perspective. As technology reaches out to the world with fiber-optic, wireless, and high-speed connections, the world must be able to respond and participate. The Internet has created a seemingly smaller world and, in so doing, has called attention to social and economic problems. It is up to developed nations to recognize these problems and help develop solutions. However, if countries adopt a self-serving and opportunistic approach to technology, the digital divide will grow as will global unrest.

## Hardware

**Hardware** refers to the tangible parts of a computer or digital device, and typically includes support for processing, storage, input, and output.

### Why This Matters

From large servers that support the needs of thousands of users to the smallest mobile phone, computing devices share certain characteristics. They all manipulate digital data and share the same fundamental processes. By learning about these underlying processes and their components, you can develop a better understanding of what computing devices are capable of and how you can benefit from those capabilities. You can become empowered to competently use digital devices whether they're old or the latest rage. Understanding hardware will also allow you to be a wise consumer, purchasing computers and digital devices that best suit your needs.

### Consider This

Consider all of the computer hardware brands in existence today. Which would you say has had the biggest impact on the market in recent years? If you said Apple, you are on the mark. Apple has grown from the underdog computer platform to the largest PC manufacturer in the world and the largest smart phone manufacturer in the U.S. In fact, Apple is the number one company in the world! Once considered a brand appropriate only for some households, Apple is now a major force in digital technology at home, at school, and in business. Nearly all Fortune 500 companies approve and support iPhones and iPads on their networks.

In many cases, the move to Apple isn't the idea of corporations, but originates with the employees. In a trend called BYOD (for "bring your own device"), workers who have fallen in love with their iPhones, iPads, and MacBooks at home are bringing them to work and pressuring employers to support Apple products at work. Similarly, companies have to deal with employees bringing Android phones and tablets to work.

Many people have multiple digital devices to serve different needs. Apple, Google, and Microsoft all embrace multiple platforms—a mobile phone for computing anywhere, anytime; a tablet for increased productivity while on the go; and notebook and desktop computers for serious work. For an individual, deciding on the best hardware requires a careful analysis of your computing and communication needs as well as the environments in which you live and work. Special consideration must be given to processing power, storage capacity, and input and output requirements for each device. As you read this unit, consider the ideal combination of devices that will serve your needs as a professional. Also consider the computing needs of your personal and home life. Is it possible that one set of devices can serve both? Where should you store your data? How might you separate your work data (email, documents, calendars, contacts, etc.), from your personal data?

## Essential Information

Hardware is the foundation on which digital technologies and services are built. The hardware we use directly impacts our computing experiences. Hardware manufacturers like HP, Dell, Apple, LG, Samsung, Motorola, and thousands of others compete to provide their customers with the best user experience. Whether it's a desktop computer, a mobile computer, a cell phone, or a media player, if your hardware is outdated or not well suited for your activities, your experience is likely to be frustrating. Matching hardware to specific needs is an important skill for getting the most out of digital technologies.

This section explores the intricacies of hardware devices, which can be organized into three categories: processing hardware, storage hardware, and input/output (I/O) hardware. Here you will learn how microprocessors work to power computers, mobile phones, digital cameras, and a host of other digital electronic devices. You will gain insight into how to choose the best computer for your needs. You will learn about different types of storage options that provide convenient access to information and services wherever they are needed. You will also learn about new ways to interact with computers through innovative I/O devices.

## Ethical Dilemmas

In this unit you will once again face the fact that computers are becoming increasingly intelligent, and that humans are becoming increasingly dependent on them for fundamental and essential tasks. While continually increasing processing speeds mean new opportunities for humanity, they also imply a tilt in the balance between responsibilities given to human intelligence and those delegated to computer intelligence.

The growing reliance on mobile computing and cloud computing supports an environment where work and communication can take place wherever and whenever possible. While some find this liberating, others feel that they can never escape the pressures of work. Streamlined interfaces like Apple's Siri have provided the first step toward reliable digital assistants that are able to provide information as soon as it is needed and with very little effort. The current pace of development of hardware (and software) technologies has humanity on the brink of colossal changes in the way we live and work. As you read this unit, consider how new developments in hardware technologies impact the way you live and work.

## Hardware Topics

- Processing
- Storage
- Input/Output (I/O)

## Processing

**Processing** carries out the instructions provided by software using specially designed circuitry and a well-defined routine to transform data into useful outputs.

### Why This Matters

Processing is at the core of computing. Understanding how processors function can help you to appreciate the abilities and limitations of computers and can be of great value when shopping for computers.

### Essential Information

Digital devices process bits of data into useful information and services. The output from processing can include life-changing information like the genetic code for human DNA, or it could be poll results for a presidential election or an entire 3D animated motion picture, a cell phone conversation, or the music you listen to on your way to class. Any type of output from a digital device is the result of processing.

New types of processors are released every year, each one more powerful than its predecessor. Processors are designed to excel in a particular type of activity. There are processors designed for computer graphics, for general-purpose personal computing, for industrial use in mainframe computers, and for use in special-purpose computers like eBook readers, digital cameras, and medical equipment.

This section takes you on a tour of processors: how they work, what different types are available, and how they interact with other components in a computer to process data into information.

### Processing Topics

- Transistor
- Integrated Circuit/Processor
- Central Processing Unit
- Multicore Processor
- Moore's Law
- Multiprocessing
- Motherboard
- Bus
- Machine Cycle

## Transistor

A **transistor** is an electronics component, typically composed of silicon, that opens or closes a circuit to alter the flow of electricity to store and manipulate bits.



## Why This Matters

The transistor has been touted as the most important invention of the 20th century. It allows us to control the flow of electrons, manipulating electricity to do our bidding. There are more than a billion transistors on the processors that control modern computers. Working in harmony, they manipulate the bits that represent our digital world, switching on and off to control the flow of electricity and performing logical and mathematical functions to produce useful information in all of its forms. Transistors are not only key to processing; they are also used in computer storage and many types of electronics devices including radios, telephones, and guitar amplifiers.

## Essential Information

Invented in 1947 at Bell Labs, transistors have become the key ingredient of all digital circuits, including those used in computers. Today's silicon-based transistors use two types of silicon, called n silicon and p silicon for the negative and positive aspects of their electrons (shown as n and p in the figure). By applying and removing voltage to the gate and drain of the transistor, electrons are allowed to flow through the transistor or are stopped. When electricity is flowing through a transistor, it represents a 1; when it is not flowing, it represents a 0. By combining transistors and using the output from one or more transistors as the input to others, computers control the flow of electricity in a manner that represents mathematical and logical operations.

The trend in digital technologies has always been towards smaller, more powerful, and faster devices. Chip manufacturers strive to reduce the size of transistors and the connections between them so that electrons flow more quickly through the circuits. A circuit is created by combining transistors, and sometimes other components, in a manner that accomplishes a specific task. Intel was able to create a circuit for storing data in flash memory that is only 25 nanometers in size. It would take about 4,000 of these microscopic circuits to span the width of a human hair. The transistors in today's processors are so small that over two billion can be stored on a surface the size of your thumbnail.

Most of today's processors use transistors created from silicon. However, transistors are becoming so small that silicon is no longer able to function effectively. Other materials are being explored to further reduce the size of transistors. For example, IBM is experimenting with a new type of transistor that uses electrical and optical nano-devices as transistors for a chip that may rival the speed of human thought.

## Integrated Circuit (Processor or Chip)

An **integrated circuit** (processor or chip) connects tiny transistors and other electronics components on a thin piece of semiconductive material such as silicon.

## Why This Matters

The invention of the integrated circuit multiplied the power of the transistor and launched a technological revolution by making it possible to mass-produce thousands of transistors in one wafer-thin package.

## Essential Information

In the late 1950s, Jack Kilby of Texas Instruments and Robert Noyce of Fairchild Semiconductor developed a method to integrate multiple transistors into a single module called an integrated circuit. Integrated circuits, also called *chips* or *microchips*, are used in most electronics devices and are used in computers to store and process bits and bytes.

Chips are mass-produced by building millions of transistors and other processing components one layer at a time. Metal is then layered on to make the electrical connections. Manufacturers can then etch microscopic patterns on the chip to create integrated circuits.

Before integrated circuits, transistors and other electronic components were connected using wires. The size and complexity of the resulting circuitry were unwieldy and the end result was functionally weak. The invention of the integrated circuit allowed electrical engineers to create more complicated electrical circuits in a much smaller package, leading to history-shaping inventions like computers, computer-controlled rockets, and all the other digital marvels of the computer age.

Chips are created to serve many functions. There are chips in most electronic devices and appliances. Chips are used to store data in Random Access Memory (RAM), Read Only Memory (ROM), solid-state storage like flash drives, and other types of storage. Perhaps the most valuable chips are the ones designed for processing. Processing chips, called *processors*, provide the functionality behind all types of computers. These include general-purpose computers like PCs, as well as special-purpose computers such as the ones that control aircraft, robotic assembly lines, digital cameras, hi-def televisions, and tens of thousands of other useful devices.

## Central Processing Unit (CPU)

The **central processing unit (CPU)** is a group of circuits that perform the processing in a computer, typically in one integrated circuit called a microprocessor.

## Why This Matters

The development of the CPU enabled computer engineers to further consolidate transistors from several chips and circuit boards to a single chip called a microprocessor. The CPU is a microprocessor that governs all actions that a computer of any type carries out.

## Essential Information

Over time, the number of transistors on a chip increased as technology enabled them to be produced on increasingly smaller scales. Processing became faster because electrons had shorter distances to travel. In the early 1970s, it became possible to fit all the circuitry needed for a computer on one chip. The CPU, or microprocessor, was born.

Today, advanced manufacturing processes enable hundreds of tiny chips to be produced on a single large round wafer, which is then divided into its individual microprocessors. Each microprocessor can contain more than two billion transistors. Current CPUs use transistors as small as 22 nanometers, and they are getting smaller all the time.

Most of today's computers use microprocessors that contain multiple CPUs or cores. Multicore processors, such as dual core (two processors) and quad core (four processors), use an architecture that allows the cores to work together for faster processing. Intel has recently developed 3D processing technologies that allow multiple surfaces of circuits to be joined together in 3D connections (see video). Rather than a single plane of circuits, 3D processing utilizes processing cubes.

CPU performance influences the quality of the device that it powers. No one enjoys waiting for information to be delivered. A state-of-the-art CPU can deliver information and services nearly instantaneously. For this reason, devices using top-of-the-line CPUs are more expensive than others with less powerful CPUs. Other components can also impact device performance, including size and type of RAM, bus speed, size and type of graphics processor and memory, and network bandwidth. Of these components, the processor has the greatest impact on quality and price.

The CPU is made up of many components. The quality of its components establishes the quality of the CPU. The following table lists the main components of a CPU along with their functions.

**Table: CPU Components**

CPU Component	Function
<i>Control unit</i>	Sequentially accesses program instructions, decodes them, and coordinates the flow of data in and out of the ALU, the registers, RAM, and other system components, such as secondary storage, input devices, and output devices
<i>Arithmetic/logic unit (ALU)</i>	Contains the millions of circuits created to carry out instructions, such as mathematical and logical operations

<i>Registers</i>	Hold the bytes currently being processed
<i>Cache</i>	A temporary storage area for frequently accessed or recently accessed data; speeds up the operation of the computer; size measured in megabytes (MB)
<i>Clock speed</i>	Speed of the processor's internal clock, which dictates how fast the processor can process data; usually measured in GHz (gigahertz, or billions of pulses per second)

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## Multicore Processor

A **multicore processor**, such as a dual-core, triple-core, or quad-core processor, combines multiple CPUs on one chip to share the workload and speed up processing.

### Why This Matters

Multicore processors process more quickly with slower clock speeds than single-core processors. The invention of multicore processing enabled processor manufacturers to take computing speeds to the next level and meet the expectations of Moore's Law.

### Essential Information

In 2005, Intel and AMD produced the first dual-core processors. The additional processing power required the companies to slow the clock speed of these processors. The result was more powerful processors with slower clocks requiring less power—a win-win situation.

Before dual-core processors, clock speed was a prime indicator of a processor's power. The most powerful single-core processors have clock speeds of more than 3.2 GHz (cycles per second). The initial dual-core processors used slower clock speeds of less than 2 GHz. Clock speeds for multicore processors have sped up as engineers continue to refine the technology.

Today, clock speed alone is not a reliable gauge of the power and speed of a processor. Intel has turned to a numbering system that represents several processor characteristics—all of which impact the processor's performance—including processor technology stated in nanometers, cache size in megabytes, clock speed in

gigahertz, front side bus speed in megahertz, number of cores, and other Intel-specific technologies.

For example, Intel's Core i7 processor with processor number i7-740QM has four cores, a 1.73 GHz clock, a 12 MB L2 cache, 45 nm manufacturing technology, and dozens of other specifications that describe its performance capabilities. Looking up the processor number at Intel's Web site reveals the processor specifications. AMD uses similar specifications, except that, in addition to dual-core and quad-core, AMD also includes 3-core and 6-core processors. Both Intel and AMD have recently released 8-core processors. Intel has gone as far as developing a prototype for an 80-core processor.

Multicore processors are also used in computers other than PCs. The latest generations of smart phones are equipped with quad-core or even 8-core processors that offer desktop processing speeds for mobile gaming and other demanding applications. Some of the fastest multicore processors are used in graphics processors (GPUs) powering game consoles. They are also used in servers, supercomputers, and embedded systems.

## **Moore's Law**

**Moore's Law** states that the number of transistors on a chip will double about every two years.

### **Why This Matters**

Moore's Law provides an understanding of the exponential rate of advancement in processor technologies. A processor that has double the amount of transistors is twice as fast and powerful. Using Moore's Law, we can gauge how fast processors might be in coming years.

### **Essential Information**

Moore's Law states that the number of transistors on a chip will double about every two years. This is illustrated by the fact that in 2006, there were 1 billion transistors on Intel's most powerful chip; and in 2008, Intel announced a chip with 2 billion transistors. Similarly, in 2008 CPUs were engineered using 45 nm technology, in 2009 it shrunk to 32 nm, and now we're at 22 nm processors built in 3D processing cubes for even faster processing. Utilizing Moore's Law, one could guess at processor size and speeds over the next decade.

It is important to note that there is some confusion as to the time frame for Moore's Law. Until recently, Gordon Moore was quoted as saying the number of chips will double every 18 months. Moore has corrected the quote by stating that he had said every two years. Many references to Moore's Law in published works still use 18 months as the time frame.

It is also important to note that most experts, including Moore himself, believe that Moore's Law will eventually exhaust itself as transistors become too small to be created out of silicon. Intel started using hafnium in place of silicon to create transistor gates and reduce the scale of transistors from 75 nm to 32 nm. Such a reduction would have been impossible using silicon gates due to the physical properties of silicon. Many other materials and processing technologies are being studied in order to continue, if not speed up, the progress of technological innovation. For example, IBM was able to store one bit of data using only 12 iron atoms using an unconventional form of magnetism. Japanese scientists built a processor from a single layer of molecules that calculates in parallel like the human brain. The table below lists some of the most promising new processing technologies.

**Table: New Processing Technologies**

Technology	Description
<i>High-k materials</i>	The use of materials with a high dielectric constant (k), such as hafnium and zirconium, creates smaller transistors than silicon can support.
<i>Optical computing</i>	Some companies are experimenting with chips called <i>optical processors</i> that use light waves instead of electrical current. The primary advantage of optical processors is their speed. It has been estimated that optical processors have the potential to be 500 times faster than traditional electronic circuits.
<i>Three-dimensional processing</i>	Recently, Intel has made the transition from two dimensions on a thin wafer to three dimensions on a cube. Stacking wafers into 3D arrays speeds processing by allowing it to occur horizontally and vertically simultaneously.
<i>Quantum computing</i>	Quantum computing proposes the manipulation of quantum states to perform computations far faster than is possible on any conventional computer. A quantum computer doesn't use bits, but rather a fundamental unit of information called a quantum bit or

	<i>qubit</i> . The qubit displays properties in adherence to the laws of quantum mechanics, which differ radically from the laws of classical physics.
<i>DNA computing</i>	DNA computing, or molecular computing, is a very promising new technology emerging from nanotechnology and based on DNA. Israeli scientists built the first “programmable molecular computing machine,” composed of enzymes and DNA molecules, that can perform 330 trillion operations per second—more than 100,000 times the speed of the fastest PC.

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## Multiprocessing

**Multiprocessing** is processing that occurs using more than one processing unit to increase productivity and performance.

### Why This Matters

The most powerful computers in all categories rely on multiple processors working together to solve problems. From the Mac Pro PC, which can be configured with two 6-core processors, to Japan’s K supercomputer, which utilizes over 7 million processors, multiprocessing defines ultimate processing power.

### Essential Information

There are a few different types of multiprocessing. *Parallel processing* refers to systems that divide processing equally among multiple CPUs. Such is the case with the Titan computer at the Oak Ridge National Laboratory—the world’s fastest supercomputer at the time of this writing—which distributes processing over 560,640 cores.

*Massive parallel processing* systems utilize hundreds or thousands of CPUs working together to serve either many users or a few users processing large data sets. IBM’s Roadrunner supercomputer utilizes 12,960 IBM PowerXCell 8i CPUs and 6,480 AMD Opteron dual-core processors to crunch the numbers necessary for modeling the decay of the U.S. nuclear arsenal.

Other multiprocessor systems combine a CPU with special-purpose processors such as graphics processors (GPU) to excel at a particular type of function. Workstations—very high-end PCs that are specialized for motion picture special effects and animation—often include multiple CPUs and graphics coprocessors. Machines of this magnitude can render a 3D scene in minutes while the same job might take hours on a typical PC.

Multiprocessor systems require a special operating system and software that can take advantage of multiple processors. Because of the growing need for multicore and multiprocessor systems to manage and process the huge amounts of data in the world today, the software industry is in need of computer programmers who can create software to run on these next-generation powerhouses.

## **Motherboard**

The **motherboard** is the primary circuit of a computer to which all components are connected, including the CPU.

### **Why This Matters**

The motherboard connects all of a computer's components and enables them to communicate. Both general-purpose and special-purpose computers utilize motherboards.

### **Essential Information**

Desktop PCs, notebook PCs, mobile phones, iPads, servers, supercomputers, and almost all digital electronics devices have a motherboard that holds system components and allows outside devices to be connected to the system components.

A typical personal computer motherboard includes a socket for the microprocessor, RAM, ROM, expansion slots, and many other components, along with electrical pathways called buses that connect the components.

The motherboard dictates the form factor of the system components. It may be small and tightly packed with components for tablets or smart phones. Or it can be large and spacious with powerful components and advanced cooling systems, like the Alienware Aurora desktop computer with liquid cooling.

## **Bus**

The **bus** is a subsystem on the motherboard that transfers data among system components.



## Why This Matters

The bus connects the various components of the computer system. The speed of the bus, especially the front side bus (FSB), can impact the overall performance of a CPU.

## Essential Information

There are all kinds of buses on a computer's motherboard, connecting different system components. The most important bus is the *front side bus*, or *FSB*. On Intel processors, the FSB connects the CPU to the northbridge, a memory controller hub that controls access to RAM and graphics systems (see figure).

The FSB feeds data and instructions to the CPU at least as quickly as the CPU can process those instructions. For that reason, FSB speed is important and is typically listed with the specifications of a computer. A Core 2 Duo processor from Intel, for example, has an FSB of 1333 MHz.

Other buses include the internal bus, the PCI bus, and the LPC bus. The *PCI bus* connects external devices to the core system components through expansion slots, or USB or PCI connections. The *LPC bus* connects ROM and sometimes other input devices to the CPU.

Intel introduced a speedier bus technology called PCI Express. Rather than expressing its speed in Mbps or Gbps, PCI Express utilizes BT/s, which translates to gigatransfers per second.

## Machine Cycle

The **machine cycle** provides a CPU with an orderly method of processing software instructions.

## Why This Matters

The machine cycle provides the CPU with a step-by-step method for carrying out sequential instructions provided by software. Without the machine cycle, the processor would be unable to execute software code.

## Essential Information

The CPU, specifically the control unit of the CPU, carries out software instructions using the four-step sequence of the machine cycle (see figure). It records the location of the current instruction—called the instruction pointer—and fetches that instruction from RAM or its cache memory. The control unit decodes the instruction and then sends it to the arithmetic logic unit (ALU) to execute. The results of the instruction are then stored back in RAM. The instruction pointer is then incremented to move to the next instruction and the cycle begins again.

Each step of the machine cycle is carried out in time to the beat of the system clock. Today's processors can overlap machine cycles and even execute multiple instructions simultaneously. Still, the machine cycle keeps processing orderly and the computer's systems running smoothly.

## Storage

In computing and digital technologies, **storage** refers to the ability to maintain data within the system temporarily or permanently.

### Why This Matters

Breakthroughs in storage technologies have empowered individuals to access information anywhere and anytime, easily share information with others, and maintain huge libraries of documents, music, photographs, movies, and other digital information—sometimes in a device no larger than a thumb.

### Essential Information

Many different types of storage are available to support a wide variety of computing needs. From fast access RAM that supports today's fastest processors to robotic-delivered magnetic tape cartridges storing petabytes in storage silos, storage is accessed at varying speeds. From ultra-portable USB flash drives to optical CDs, DVDs, and Blu-ray discs, to huge terabyte hard drives accessed directly on a device or wirelessly in the cloud, storage has many forms and various capacities.

Storage devices and technologies vary in terms of access speed, capacity, portability, and price. Storage media that provide faster access speed are generally more expensive than media that provide slower access. For example, a 500 GB solid state drive with low energy requirements and a fast data transfer rate costs around \$300 while a traditional magnetic hard drive that is slower and uses more energy costs around \$50.

The term *storage device* is used for the hardware that stores and retrieves data. The term *storage media* is used for the material on which the data is stored. A DVD drive is the storage device, and the DVD is the media where data is stored. In some cases the device and media are considered one and the same, such as with USB drives and hard drives.

RAM, Random Access Memory, is also called primary storage because it is the main store for data being processed. Secondary storage refers to permanent storage that holds data without the need for electricity. Other forms of storage include ROM (read only memory) and graphics memory.

Secondary storage can be classified as either sequential access, as in the case of tape, or direct access, as with disks. Methods of storage include magnetic storage, optical

storage and solid-state storage. Storage devices may be located on the computer or device in use, in which case it is considered *local storage*; or it may be accessed over a network, in which case it is considered *network storage*. Data may also be stored on Internet servers, in which case it is called cloud storage. This section covers these technologies and shows the benefits and drawbacks of each.

### Storage Topics

- Random Access Memory (RAM)
- Video Memory
- Read Only Memory (ROM)
- Magnetic Storage
- Optical Storage
- Solid-State Storage

### Random Access Memory (RAM)

**Random access memory (RAM)** is temporary, or volatile, memory that stores bytes of data and program instructions for the processor to access.

#### Why This Matters

RAM acts as the primary storage area in a computer for software and the data that it works with. RAM plays a crucial role in computer systems and can contribute to or detract from a computer's performance. Having too little RAM, or using low-quality RAM that cannot deliver instructions quickly enough to the processor, can cause a computer to drag. Typically, computer manufacturers install RAM in a computer to match the processor's abilities. Today's PC operating systems and software require at least 1 GB of RAM for minimal performance quality. Even the most basic computers today come with at least 2 GB of RAM.

#### Essential Information

The CPU works closely with RAM as it executes the machine cycle to run software applications. RAM capacities in new PCs typically range from 2 GB to 8 GB. Today's multicore smart phones use 1 GB to 2 GB of RAM. Data flows back and forth between the CPU and RAM across the front side bus. The front side bus (FSB) consists of electronic pathways between the CPU and RAM and is capable of transporting several bytes at once.

RAM exists as a set of chips grouped together on a circuit board called a *single in-line memory module (SIMM)* or a *dual in-line memory module (DIMM)*. Most of today's PCs use DIMMs, which have a 64-bit data path—twice that of a SIMM. RAM DIMMs are inserted into slots in the motherboard near the processor. A new desktop computer typically comes with two or four RAM slots, half of which are occupied with DIMMs and half left available for future expansion. Notebook computers

typically have two RAM slots. Tablet computers and smart phones have embedded RAM not designed for access by users.

There are many different types of RAM: DRAM, SDRAM, RD-RAM, DDR-SDRAM, FPMRAM, EDO-RAM, BEDO-RAM—the list goes on. Each type of RAM reflects a manufacturer's effort to use a new technology to get data to the processor more quickly. Today's desktop and notebook PCs typically use DDR-SDRAM, DDR2 SDRAM, or DDR3 SDRAM. DDR2 doubles the speed of DDR, and DDR3 doubles it yet again. When upgrading RAM, you should consult your computer documentation or contact the manufacturer to find out what type of RAM your computer uses.

## Video Memory

**Video memory**, sometimes called video RAM, VRAM, or graphics memory, is used to store image data for a computer display in order to speed the processing and display of video and graphics images.

### Why This Matters

Video memory and graphics processing provide important capabilities for today's graphics-intensive computer systems. Microsoft Windows, Mac OS X, and today's demanding 3D computer games require high-capacity video memory and sophisticated graphics support to provide a rich and realistic graphics environment for work and play.

### Essential Information

Video memory acts as a buffer or intermediate storage area between the CPU and the display. When images are to be sent to the display, they are first read by the CPU from RAM and then written to video memory. From video memory, the data is converted to signals that are sent to the display. Most of today's PCs come equipped with at least 512 MB of video memory and may include a *graphics processing unit (GPU)* to process the graphics and take the load off the CPU. Video memory is provided on a video card or graphics card on most desktop computers and integrated on the motherboard on mobile devices.

In recent years, the GPU has increased in importance as graphics and media are becoming more important to computer users. AMD's latest processors integrate CPU and GPU processing together for more powerful processing. The iPad 3 increased its performance by increasing the power of the GPU. Most popular current computer architectures are making better use of GPUs to complement the work of the CPU for better overall system performance.

## Read Only Memory (ROM)

**Read-only memory (ROM)** provides permanent storage for data and instructions that do not change, such as *firmware*—programs and data from the computer manufacturer, including the boot process used to start the computer.

### Why This Matters

Because both the CPU and RAM require electricity to store data, both are empty when a computer is initially powered up. The computer requires a place to permanently store the instructions needed to start up the computer and load the operating system into RAM. ROM fulfills this purpose.

### Essential Information

ROM stores data, using circuits with states that are fixed. Therefore, the data represented by this combination is not lost if the power is removed. ROM stores a program called the *BIOS* (basic input/output system). The BIOS stores information about your hardware configuration along with the boot program. The boot program contains the instructions needed to start up the computer. After running some system diagnostics, the boot program loads part of the operating system into RAM and turns over control of the processor to the operating system.

Many of today's computers use *flash BIOS*, which means that the BIOS has been recorded on a solid-state memory flash chip rather than a ROM chip. Flash memory stores data permanently, like ROM, but can be updated, or "flashed," with new revisions when they become available.

The software stored in ROM in many different types of digital devices is sometimes called firmware. Firmware can be updated over time to correct bugs or provide additional functionality. ROM may also store application software in some mobile phones and other special purpose devices.

## Magnetic Storage

**Magnetic storage** is a storage technology that uses the magnetic properties of iron oxide particles rather than electrical charges to store bits and bytes more permanently than RAM.

### Why This Matters

Data stored in a computer's RAM is temporary and only available while the computer is powered on. Magnetically stored data lasts years, even decades, before deteriorating. Magnetic storage, in the form of a hard disk drive, provides an inexpensive, high-capacity form of permanent storage that acts as the main storage medium in most desktop and notebook computers.

## Essential Information

In magnetic storage, a surface is coated with a layer of particles that are organized into addressable regions (formatted). In the process of reading and writing data, a read/write head passes over the particles to determine, or set, the magnetic state of a given region. Two types of media use magnetic storage: disks and tapes.

*Magnetic disks* are thin steel platters. When reading data from or writing data onto a disk, the computer can go directly to the desired piece of data by positioning the read/write head over the proper track of the revolving disk. Thus, the disk is called a *direct access* storage medium.

Magnetic disk storage varies widely in capacity and portability. Fixed hard disk (hard drive) storage has large storage capacity—storing hundreds of gigabytes on most new notebook and desktop PCs—and fast access time. For these reasons, personal computers rely on the hard drive as the main secondary-storage medium. External hard drives connect to a computer through its USB port and provide a convenient extension to storage or a backup medium to safeguard data.

*Microdrives*—tiny hard drives that can store gigabytes of data on a disk one or two inches in size—revolutionized portable media players and were used in early iPods. Microdrives launched the mobile computing era by allowing handheld portable devices to store hours of music and video, and hundreds of photos, data files, and software applications. Today, solid-state storage has replaced microdrives in most mobile devices.

*Magnetic tape* is used by businesses and organizations that need to store and back up large quantities of data. Similar to the kind of tape found in the old audio or video cassettes, magnetic tape is Mylar film coated with iron oxide particles. Magnetic tape is an example of a *sequential access* storage medium because data is written and read in sequential order from the beginning of the tape to the end. Although access is slower, magnetic tape is usually less expensive than disk storage. For applications that require access to very large amounts of data in a set order, sequential access is ideal. For example, government agencies, such as the U.S. Census Bureau, and large insurance corporations store large quantities of data on tape.

Businesses and organizations often provide large quantities of storage to employees over a network. Server computers can provide a central store for important corporate data for employees to share. Arrays of disks can be formed and used in groups to handle terabytes of data. A technology called a *storage area network* or *SAN* links many storage devices over a network and treats them as one huge disk. Cloud storage utilizes magnetic disk drives connected to Internet servers to make them accessible anywhere, anytime.

## Optical Storage

**Optical storage** media, such as CDs, DVDs, and Blu-ray discs, store bits by using an optical laser to burn pits into the surface of a highly reflective disc.

## Why This Matters

Optical storage provides an extremely portable storage medium for quantities of data up to several gigabytes. Although it does not match the high capacity and data access rates of magnetic and solid-state storage, it is ideal for storing music, movies, photos, software, and data for mobile access and sharing.

## Essential Information

The 1s and 0s stored on optical discs are read from the disc surface by using a low-power laser that measures the difference in reflected light as it passes over pits burned into the disc surface. Audio CDs that store music, data CDs that store software and computer files, and DVDs and Blu-ray discs that typically store motion pictures and high-def movies all use the same fundamental technology. See the table at the bottom of this page for more details.

The popularity of the CD and DVD has soared since the introduction of recordable optical discs. The process of writing to an optical disc is sometimes called *burning*. A number of different CD and DVD burners are available at reasonable prices. Different manufacturers support different standards and formats in efforts to win customers over to their products. Manufacturers use *R* to indicate that a medium is recordable; that is, it can be written to only once. *RW*, for rewritable, is used to indicate that a disc can be rewritten numerous times just like a hard drive. Most new PCs come with a combination drive that functions as a CD and DVD burner. Some support Blu-ray as well.

One of the important specifications to consider when purchasing a CD or DVD burner is the time it takes to read and write data from and to the disc. Specifications for a typical CD-RW/DVD combo drive may read “52x32x52 CD-RW & 16X DVD.” The *X* stands for “times the original transfer rate” of a disc. This drive can burn a CD-R disc at 52 times the original transfer rate and a CD-RW at 32 times the rate. It reads data from a CD at 52 times the original transfer rate of CDs and reads DVDs at 16 times the original transfer rate of DVDs.

Some companies are researching the use of holographics to store huge quantities of data on optical discs. Holographic discs from InPhase can store more than a terabyte of data. Unfortunately, the price of more than \$20,000 for this new technology will make it affordable only to businesses.

**Table: Optical Media**

Media	Description
CD	A <i>compact disc read-only memory (CD-ROM)</i> , commonly referred to as a CD, is an optical medium that stores up to 700 MB of data. CDs are used for music distribution, software distribution, and various forms of data storage.

DVD	A <i>digital video disc read-only memory (DVD-ROM)</i> stores more than 4.7 GB of data in a fashion similar to CDs, except that DVDs can write and read much smaller pits on the disc surface and can sometimes write to and read from multiple disc layers. Unlike a CD, a DVD can store an entire digitized motion picture.
Blu-ray	<i>Blu-ray discs (BDs)</i> make use of the shorter wavelength of blue light to read and write even smaller pits on the optical disc surface for higher capacity. Just as the DVD was developed primarily for motion picture distribution, Blu-ray was developed for high-definition movie distribution. A single-layer disc (25 GB) can hold a 135-minute high-definition movie and still have room for two hours of bonus material in standard definition. Two-layer discs storing 50 GB are available, and there is talk of 100 and 200 GB versions coming soon.

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## Solid-State Storage

A **solid-state storage** device stores data using solid-state electronics such as transistors, and unlike magnetic and optical media, does not require any moving mechanical parts.

### Why This Matters

Magnetic storage devices have high capacity and are convenient in terms of read and write ability, but they have slow data access rates due to the use of mechanical moving parts. Optical storage media is convenient in terms of mobility but has limited storage capacity and is slow to write to. Solid-state storage offers fast access times because it has no moving parts. It is also increasing in capacity each year and can store nearly as much as hard drives—unfortunately, at a much higher price. As the cost of solid-state storage continues to decrease, it will continue to replace uses of magnetic storage on many devices.

### Essential Information

Solid-state storage devices store data permanently without any moving parts or the need for electricity. *Flash memory* is a form of solid-state storage that updates (flashes) the data it holds in large blocks. Unlike other secondary storage such as magnetic disks and tapes and optical CDs and DVDs, flash memory requires no moving parts to read and write data. It is therefore much faster and much quieter, requires less power, and produces less heat. Because of these significant benefits, solid-state storage looks to be the wave of the future. The high price of the technology is the only thing holding it back from replacing other forms of secondary



storage; however, prices are rapidly dropping. Solid-state storage devices include flash memory cards, USB flash drives, and solid-state drives.

A *flash memory card* is a small chip encased in a plastic housing that stores data permanently without the need for power. Flash chips are small and can be easily modified and reprogrammed, which makes them popular in computers, mobile phones, digital cameras, and other products. When used in devices such as digital cameras, camcorders, and digital music players, flash memory cards are sometimes referred to as *media cards*. Secure Digital (SD) cards, Mini SD cards, and Micro SD cards are popular flash memory cards for mobile phones, digital cameras, and other devices that need to store a lot of data in a tiny package.

A *flash drive*—also called a *USB drive* or *thumb drive*—is a small flash memory module about the size of your thumb or smaller that conveniently plugs into the USB port of a PC or other digital electronics device to provide convenient, portable, high-capacity storage. Although they are called *drives*, they contain no moving parts. A 16 GB flash drive can be purchased for around \$15.

As flash drives grow in capacity and capability, they are threatening the future of magnetic hard drives as the first choice for secondary storage in PCs. Samsung produced the first solid-state disks (SSD) using flash technology to replace the traditional magnetic hard drive in PCs. An SSD reads data 300 percent faster and writes data 150 percent faster than a traditional hard drive. It boots up a computer much faster, is lighter and more durable, uses less power, and runs cooler and quieter than a hard drive (in fact, it is silent). SSDs are being used in small, light sub-notebook PCs designed for business travelers and are making their way into the mainstream market. SSDs are also used as the storage media for tablets, smart phones, and digital media players.

## I/O

**I/O** refers to **input and output**—the manner in which data is received into a computer system, and the manner in which information and the results of processing are provided to the user.

### Why This Matters

Users interact with computers through input and output (I/O) devices. Of all the computer hardware components, I/O devices have the most direct impact on a user's computing experience. To accommodate a wide variety of data and the many environments in which data is processed, there are literally hundreds of different input devices on the market. By learning about input devices, you also learn what computers are capable of. Output devices connect directly with our senses. Although most output from a computer is visual, much is auditory, and some more exotic devices even affect our other senses.

## Essential Information

Personal computers typically use only a handful of I/O devices. There is a good chance that you have used a keyboard, mouse, display and printer for much of your life. Using these devices is second nature to many people. New personal computing devices and product designs can present new methods of input. Touch pads are easy to become accustomed to on notebook computers. Touch screens on tablets and mobile phones make working with a computer so simple a toddler can manage it. These basic I/O devices are a small subset of all the specially designed input devices available. From drawing tablets used by graphics artists, to magnetic ink character readers used by banks, to bar code readers at the supermarket, a variety of input devices have been designed to accommodate the unique needs of professionals.

In addition to input and output devices, many computers accommodate other types of devices, such as wireless adapters and external storage. Many different types of devices can be connected to computers and mobile devices to expand their capabilities. One example is a sensor that can be connected to an iPhone to test food for allergens. The ability to increase the capabilities of a computer system by connecting external devices, referred to as peripherals, is called expansion.

## I/O Topics

- Input Device
- General Purpose Input Device
- Special Purpose Input Device
- Output Device
- Video Card
- Display
- Printer
- Audio and Special Media
- Expansion

## Input Device

An **input device** assists in capturing and entering data into a computer system.

### Why This Matters

Getting data into a computer system rapidly and accurately is the purpose of input devices. Some activities have very specific needs for input, requiring devices that perform specific functions. For example, many reporters use input devices that record and transcribe human speech to ease the stress of typing late-breaking stories. The more specialized the application, the more specialized the associated I/O device.

## Essential Information

Different types of input devices are designed to accept different types of data. *Human-readable* data can be directly read and understood by humans. A sheet of paper containing lists of customers is an example of human-readable data. In contrast, *machine-readable* data is read by computer devices. Customer data that is stored on a disk is an example of machine-readable data. It is possible for data to be both human-readable and machine-readable. For example, people and computer systems can both read the scantron sheets used for some multiple-choice exams.

Regardless of how data gets into the computer, it is important that it be captured near its source to avoid data entry errors. *Source data automation* involves automating data entry where the data is created, thus ensuring accuracy and timeliness. Source data automation is used by librarians, who use scanners to check out and check in library materials. Rental-car companies use automated scanners that scan vehicles as they exit and enter the rental lot. The scanner collects data on the vehicle, including gas gauge data, mileage, date, and time, and prepares a customer invoice before the customer returns to the counter.

Input devices can be classified as either general-purpose or special-purpose. A *general-purpose input device* is designed to be used for a wide variety of computing activities. This category of I/O devices includes keyboards and mice. A *special-purpose input device* is designed for one unique purpose. An example of a special-purpose input device is the pill-sized camera from Given Imaging called the PillCam, which, when swallowed, records images of the stomach and the small intestine as it passes through the digestive system.

## General-Purpose Input Device

A **general-purpose input device** is one that is designed to be used for a wide variety of computing activities.

### Why This Matters

Many computing activities across platforms have common input needs. For example, many computer devices require a way in which to input characters and to select items on the display. For these purposes a keyboard and pointing device are ideal. There are many different variations of these two common general-purpose input devices. On mobile devices, input is increasingly being implemented with a touch screen and voice commands.

## Essential Information

*QWERTY keyboards*, named after the first five characters used in the keyboard's design, are alphanumeric data entry devices used on all types of personal computers as well as mobile devices. They provide fast, one-character-at-a-time input for users

who develop keyboarding skills. Some variations on the traditional QWERTY keyboard are available, including Microsoft's ergonomic keyboard, which was designed to reduce the risk of carpal tunnel syndrome (CTS). Soft keyboards (or software keyboards) provide a picture of a keyboard for typing on touch-sensitive displays. They are used primarily on tablet computers and smart phones. Some people have difficulty typing on soft keyboards due to the lack of tactile feedback. Soft keyboards also take up valuable screen real estate. External keyboards can be connected to tablets to make typing easier and to reclaim screen space (see video).

Several types of *pointing devices* are used to select objects on a display. A mouse is used on desktop and notebook PCs to move the mouse pointer on the display. On notebook PCs, a touch pad can be used in place of a mouse. On mobile phones, a navigation keypad is used make selections. On devices with touch screens, a pointing device isn't necessary, since the user simply touches the display to select items.

*Touch screens* used on some smart phones, tablets, and kiosks, allow the user to select items on the screen by touching them directly with a finger or stylus—a pen-like device—to select points on the display. Some touch screens support handwriting recognition, enabling the user to write letters or words on the display with a stylus and automatically translating them into ASCII characters through the use of artificial intelligence.

*Multitouch displays* allow the user to use two or even three fingers on a touch display to manipulate objects on the display. For example, two fingers moving apart on the screen causes an object to zoom in. The opposite motion zooms out, and a twisting motion rotates an object. Multitouch technology has been key to the success of the iPhone and iPad. Apple has implemented multitouch on its MacBook trackpad and wireless mouse, which support more than 12 multitouch movements. Microsoft has taken multitouch a step further with Windows 8, which supports ten-point multitouch interaction; that is, the display recognizes the unique input from all ten fingers simultaneously. Carnegie Mellon researchers are working on displays that can tell the difference between a tap with a fingertip and a tap with a knuckle or fingernail to provide even more options for control. Touchscreens in some Cadillac cars recognize touches or hand gestures in the air. Touch and gesture input are fertile areas of current research.

Microphones serve as yet another general-purpose input device. Microphones can take human speech as input, digitize the sound waves, and use natural language processing to translate the input into dictated text that appears on the screen or into commands.

Apple's Siri app, introduced on the iPhone 4S, was the first successful implementation of an AI-driven personal assistant. Users speak to Siri to send messages, schedule meetings, place phone calls, and complete other tasks. Siri understands what the user says and replies with its own computer-generated voice.

Speech recognition software can also be used to take dictation, translating spoken words into text. Voice recognition, a similar technology, can be used by security systems to allow only authorized personnel into restricted areas.

## Special-Purpose Input Device

A **special-purpose input device** is designed to provide input for one specific type of activity.

### Why This Matters

Many software applications require unique input devices to input specialized types of data in a convenient and reliable manner. The medical profession utilizes hundreds of such devices to collect biological information. Businesses use varying types of scanners to automate the collection of standardized information. Special-purpose input devices are available for nearly every industry and for many personal applications.

### Essential Information

Video game enthusiasts enjoy specialized input devices that let them quickly react to game action. Most gamers prefer to use a *game controller* device to control game characters and objects; some games, such as flight simulators, are easier to navigate using a *joystick*, a device resembling a stick shift. The Nintendo Wii brought entirely new forms of input to gaming, utilizing motion sensors in handheld controllers to control gaming action, and with Wii U, a tablet controller with a second display. Microsoft developed Kinect, a motion detecting controller for the Xbox that allows gamers to control game characters just by moving their body. The Kinect can also be used to control television programming with hand gestures and voice. Games designed for smart phones make use of the built-in accelerometer, which allows for controlling game-play by holding the device at different angles. Guitar Hero and Rock Band video games make use of toy instruments that act as input devices to play virtual instruments in the game.

A digital camera can be connected to a PC or embedded in a notebook computer to provide photo and video input to the computer. A *webcam* is an inexpensive video camera that has become popular for video chat over the Internet.

You can input both image and character data using a scanning device. Both *page scanners* and *handheld scanners* can convert monochrome or color pictures, forms, text, and other images into digital images. Biometric scanners and software can verify an individual's identity by examining biological traits such as retinal or iris patterns, fingerprints, or facial features.

Businesses and organizations use a number of special-purpose scanners and optical readers to collect data. A *magnetic ink character recognition (MICR)* device reads special magnetic-ink characters such as those written on the bottom of checks. *Optical mark recognition (OMR)* readers read “bubbled-in” forms commonly used in examinations and polling. *Optical character recognition (OCR)* readers read hand-printed characters. *Point-of-sale (POS)* devices are terminals or I/O devices connected to larger systems, with scanners that read codes on retail items and enter the item number into a computer system.

Card swipers are yet another way to collect data into a computer. Card swipers are used to verify the identity of individuals wishing to access secure locations. Card swipers are also used to facilitate credit card transactions. Devices from Square and PayPal allow smart phone users to use their phones as card swipers to conduct credit card transactions over the Internet.

## Output Device

An **output device** allows a user to observe the results of computer processing with one or more senses.

### Why This Matters

Output devices communicate the results of processing to the computer user. Output devices are evaluated by the efficiency and effectiveness with which they communicate different types of information in different types of environments. A good output device delivers information—visual, audio, or other—in a manner that allows the information to be interpreted easily and, in some situations, enjoyably.

### Essential Information

Computer output consists of the results of processing produced in a manner that is observable by human senses or that can be used as input into another system. Output can be visual (on a display or printed page) or audio (through speakers); in the case of virtual reality systems, output can even be tactile and olfactory to recreate realistic environments. High-quality output can provide realistic impressions. Telepresence uses large high-def displays and surround sound to allow individuals to meet around a virtual conference table and hold meaningful remote discussions without the need for travel.

Output from one system can be fed into another system as input. For example, a smart phone can be used as a remote control for a television and a GPS navigation system can be used to control an auto-pilot system on an aircraft or ship.

## Video Card

A **video card** (graphics card) combines video processing and storage onto an expansion card, or integrates them onto the motherboard to manage video images for display.

### Why This Matters

Video cards provide important capabilities for today's graphics-intensive software. Microsoft Windows, Mac OS X, and today's demanding 3D computer games require powerful graphics processing to support a rich and realistic 3D graphics environment for work and play.

### Essential Information

Video cards manage all images sent to a computer's display. A displayed image may be a simple computer desktop, in which case a video card has very little work to do. In other cases, it may be a motion picture requiring the video card to display dozens of images per second. In extreme cases, it may be a 3D environment requiring the video card to calculate physics equations for shading 3D characters and environments at 30 frames per second.

Today's high-end graphics cards include a graphics processing unit (GPU) to process the graphics and take the load off the CPU. They also include video memory, video BIOS, and a RAM digital-to-analog converter or RAMDAC. Support for special 3D processing in high resolution and highly detailed colors and shading may also be included.

Desktop systems often use a graphics circuit board, called a graphics card or video card, which contains the graphics memory, GPU, and other graphics hardware and is plugged into the motherboard. On notebooks and mobile devices the graphics hardware is typically integrated on the motherboard and referred to as an integrated graphics processor. Graphics support specifications are often listed third in computer ads, after processor and memory, because so many users enjoy 3D graphics animations and video games. A top-of-the-line graphics card can make a computer come to life!

## Display

A **display** provides visual computer output for observation on a monitor or screen.

### Why This Matters

The most common form of computer output is visual on a display. There is a wide assortment of displays and display technologies, each designed to provide an appropriate quality image for specific environments and applications. From check-out counter displays to hi-def television displays, from small smart phone displays

to jumbo LCD displays at stadiums, displays are an ever-increasing part of our daily lives.

### Essential Information

Remarkable progress has been made with display screens (sometimes called monitors) including those used with personal computers. With today's wide selection of monitors and displays, price and overall quality can vary tremendously. The table below lists the primary types of display technologies used today.

The first consideration when selecting a display is typically size, measured diagonally across the screen. Many sizes are available to meet every computing and media need. Smart phone displays range roughly from two to four inches; tablets, e-Book readers, and netbooks from 5 to 10 inches; 12 to 17 inches for notebook computers; and 17 to 27 or more inches for desktop displays.

There are several types of display technologies in use today (listed in the table at the bottom of this page). Most computers use LCD (liquid crystal display) technology, although LED (light-emitting diode) and OLED (organic LED) are becoming more common on high-end notebook PCs. The trend has been toward technologies that provide clearer, crisper images that require less power. Perhaps the only exceptions to this trend are eBooks. The original eBook reader, the Kindle, sacrificed image quality for lower power consumption. The e-ink displays used in the early e-Book readers do not use a backlight, are easy to read in outdoor light, and provide a monochrome image that is ideal for displaying the pages of a book.

Traditional computer displays use a 4:3 format: four units wide and three units tall. More recently, a widescreen format has become popular that uses either a 16:9 or 16:10 ratio. Widescreen formats are used by motion pictures and are also handy for viewing documents side-by-side on the display.

The quality of a display image is often measured in *pixels*—picture elements that combine to form an image on a display. *Display resolution* is a measure, in width by height, of the number of pixels on the screen. Display resolutions range from 320 x 480 for a Blackberry smart phone display, to 1136 x 640 for an iPhone 5, to 1344 x 840 for a 15" notebook display, to 1920 x 1080 for a large desktop display or hi-def TV (HDTV). The wide variety of display sizes and resolutions makes it difficult to design apps and websites that look good on all. A recent trend in web design uses CSS3 technology to create *responsive designs* that adapt to any size display (see figure).

Today's display technologies offer many options for televisions as well as computers. *High definition TV (HDTV)* uses a resolution that is at least twice that of traditional television displays for sharper, crisper images. HDTV uses a widescreen format, which means it uses the same height and width ratio used in movie theaters. HDTVs have begun using OLED technology to produce even sharper images, with deeper blacks on large displays that consume less power than plasma or LCD TVs.



The latest TV display technology provides Ultra HDTV (UHDTV) with twice as many pixels on the screen for resolutions of more than  $3840 \times 2160$  pixels.

*3D displays* use polarization technologies that generally require the viewer to wear special glasses to experience the 3D effect. These displays add depth and realism to sports, movies, and computer games. Content providers are working hard to create content that takes advantage of 3D displays. Manufacturers are working to refine 3D technologies so that viewers need not wear special glasses. Nintendo 3DS is a 3D handheld gaming system that does not require the use of special glasses. Since the game is used only by a single player, and the distance and angle of the user's eyes to the display can be assumed, the 3D effect can be more easily applied. 3D technology has been incorporated into some notebook computers and desktop displays as well as a few smart phones. Dell has a 3D display with a built-in webcam that supports 3D video phone calls.

*LCD projectors* are designed to project presentations from your computer onto a larger screen. Typically costing thousands of dollars, these portable devices are a must-have item for businesspeople that make presentations to large audiences. LCD projectors can interface with most desktop and notebook computers and even with smart phones. Some people use LCD projectors at home to project HDTV onto a white wall. One drawback is that LCD projection only works well in a semi-darkened room.

New display technologies are being developed and delivered every year. Augmented reality displays layer information over and in front of your view of the real world. Heads-up displays, or HUDs, are used by fighter pilots and are popular in science fiction movies. Google has developed a consumer-grade HUD called Glass that takes the form of glasses frames equipped with a small display, video camera and wireless networking. Using Google Glass, a person is able to view a building or intersection and see relevant information displayed across the lenses. A U.S. and Finnish team of bioengineers have gone a step further and are working on contact lenses that provide a similar experience.

**Table: Display Technologies**

Technology	Description
<i>Liquid crystal display (LCD)</i>	A thin, flat display that uses liquid crystal—an organic, oil-like material—placed between two pieces of glass to form characters and graphics images on a backlit screen. LCDs are popular for all types of personal computers and televisions.
<i>Plasma display</i>	A thin, flat display that uses plasma gas between two flat panels to excite phosphors and create light. Plasma displays are used primarily for televisions and compete head-to-head with LCD in that market.

<i>Light emitting diode (LED) display</i>	A thin, flat display that utilizes LEDs to provide the backlight for the display rather than the fluorescent light used in traditional LCDs. LED is gaining in popularity as a green technology that uses less energy, does not require the use of mercury in its production, and presents a bright, brilliant image.
<i>OLED (organic light-emitting diode)</i>	Similar to LED, with the ability to create the best picture quality of any technology with deep blacks and brilliant colors on a super-thin display.
<i>Electronic paper (e-paper)</i>	A technology that does not use backlighting like other display technologies but instead uses pixels made of particles or oils that reflect light to more closely resemble the pages of a book. E-paper requires less energy and is easier to see in outdoor lighting but is impossible to read in the dark. E-paper is used for e-book readers like the Kindle, although some more recent e-book readers use color LED displays.
<i>Flexible display</i>	Samsung and others are working on delivering flexible displays that provide color images on a flexible film of plastic. The new technology not only provides some interesting new display applications but also provides us with displays that won't shatter if you drop them.
<i>Cathode ray tube (CRT) display</i>	Deep, relatively bulky display that uses a large vacuum tube in which an electron gun shoots an electron beam rapidly across a fluorescent screen to create moving images. CRT displays have effectively been replaced by thin display technologies.
<i>HUD – Heads Up Display</i>	A transparent display that presents data as a layer on top of a normal field of view. Used by fighter pilots, and more recently by the general population with the release of Google Glass - a glasses-mounted display.

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## Printer

A **printer** is an output device dedicated to providing computer output on paper or three-dimensional output in plastic.

## Why This Matters

Computer users often wish to create printed copies of the work they've created. It may be output that is as simple as a grocery list, or it may be something as serious as

a work of art ready for framing. There are many types of printers that provide varying quality of paper-based output, as well as specialized printers that produce three-dimensional output.

### Essential Information

A useful and popular form of output is called *hard copy*, which is paper output from a printer. A variety of printers with different speeds, features, and capabilities are available.

The speed of a printer is typically measured by the number of *pages printed per minute (ppm)*. The quality of resolution of printers is similar to the resolution of displays. A printer's output resolution depends on the number of dots printed per inch. A printer with a 600 dot-per-inch (dpi) resolution prints more clearly than one with a 300-dpi resolution. When shopping for a printer, consider the quality of the output (judged by resolution specs and personal evaluation of printed copy), the speed of the printer (pages per minute or ppm), the price of the printer, and how quickly the printer consumes toner or ink, along with the price of toner refills. The initial investment in a printer typically pales in comparison to the price of toner or ink cartridge refills over time.

Some printers combine printing capabilities with other useful functions. All-in-one, or *multifunction* printers combine printing, copying, and faxing functions. Wi-Fi printers connect to your home or work Wi-Fi network so that they are accessible to any device on the network. More recent innovations, such as Google's Cloud Print, allow printers to connect to the Internet so they can be accessed from any computer with an Internet connection. HP is also developing printer technology that auto-formats webpages to look good when printed, including removing the ads.

3D printers are becoming popular as they become more affordable. 3D printers are able to create 3D objects from CAD drawings by building up layers of particles from the bottom up. These amazing devices are ideal for creating rapid prototypes or for do-it-yourself enthusiasts. Desktop 3D printers are available for as little as \$1200.

**Table: Types of Printers**

Printer Type	Description
Laser printer	A <i>laser printer</i> uses techniques similar to those of photocopiers to provide the highest-quality printed output. Color laser printers can be rather expensive, so many home users settle for either a less expensive black and white laser or a color ink-jet printer.
Ink jet printer	An <i>ink-jet printer</i> sprays droplets from ink cartridges onto paper to create pixels. Although ink-jet printers create good-looking hard copy, it is not quite as polished as what laser printers provide. Also, ink may run if it gets wet, so use care when

	printing addresses onto envelopes and hope they aren't delivered on a rainy day.
Photo printer	A <i>photo printer</i> is an ink-jet printer that is specially designed for printing photo-quality images on special photo-quality paper. Cameras can be connected directly to the printer and sometimes photos can be previewed and edited from the printer's display.
Large format printer	Also called a <i>plotter</i> , this is a type of printer used for printing large graphics designs. Businesses typically use plotters to generate paper or acetate blueprints and schematics, or to print drawings of buildings or new products on paper or transparencies.
3D printer	<i>3D printers</i> use CAD blueprints as input, and they output an actual 3D color scale prototype model in a matter of hours. Models are created through an additive process that repetitively adds thin layers of resins, corn starch, or plaster. 3D printers are useful in a variety of fields, from product design and manufacturing to architecture, education, health care, and the arts.

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## Audio and Special Media Output

There are a number of **audio and special media output** devices designed to provide output to all of the senses.

### Why This Matters

Since the early days of the PC, speakers have been used to provide audio output to users. With the development of mobile digital media devices and their rapid adoption by the public, headphones have become popular for enjoying audio output. As computer scientists work to create more realistic virtual environments, output devices have been designed to provide information to all of the senses.

### Essential Information

Most of today's personal computers include at least low-quality speakers to output sound. Sound is used by the computer's operating system and other software to cue the user to certain events—for example, the flourish of music that plays when Microsoft Windows starts up and shuts down. Other event-driven sounds draw the user's attention to important information, such as a beep when something goes wrong, or a ding when a new e-mail message arrives.

Sound systems also support entertainment applications such as CD/MP3 music players and DVD/Blu-ray disc players. Headphones are used for portable digital music players and mobile phones or in situations where the user wishes to listen to media without disturbing others.

Multimedia and video gaming enthusiasts often purchase more expensive sound systems for their computers. For example, a surround sound system with a subwoofer can provide additional realism to games in a virtual reality simulation or to a hi-def movie.

A computer's ability to output sound is particularly important to make computing more accessible to individuals with limited vision. Screen-reader programs, such as JAWS by the Freedom Scientific Corporation, read aloud the text displayed on the screen.

Output devices have been designed for every human sense. When you silence your mobile phone, you may set it to vibrate to alert you to arriving calls. Output that you can feel is referred to as *haptic* output. The Scent Dome from TriSenx is a USB device that can deliver millions of fragrances as commanded by the computer. There is even a printer designed to print flavored pieces of paper for tasting samples sent over the Internet.

The area of virtual reality has produced a number of unique and interesting I/O devices as well. For example, the virtual reality headset—a type of head-mounted display—can project output in the form of three-dimensional color images. Spatial sensors in the headset act as input devices, and when you move your head, images and sounds in your headset change. Virtual reality devices allow architects to design and “walk through” buildings before they begin construction. They allow physicians to practice surgery through virtual operations and pilots to simulate flights without ever leaving the ground. Head-mounted displays have entered the consumer market in the form of opaque spectacles that allow the user to view video from a media player or computer.

## Expansion

**Expansion** refers to a computer's capacity to interface with a variety of external devices such as I/O devices, network devices, and storage devices by connecting through ports, slots, and wireless technologies.

### Why This Matters

Many computer systems accommodate different types of I/O devices as well as network connections and external storage. The ability to increase the capabilities of a computer system by connecting external devices, referred to as peripherals, is called expansion. Expansion allows computer users to enjoy computing benefits above and beyond those provided by the computer alone.

## Essential Information

Most computers provide users with the means to add devices and expand their computer's functionality. A desktop computer user might wish to add a video card; a notebook user might want to add a cellular connect card to gain access to the Internet; and a tablet user might want to add a Bluetooth keyboard for more convenient typing.

One fact that has traditionally complicated system expansion is that peripheral devices use a variety of cables and connectors. The *universal serial bus*, commonly referred to as *USB*, was invented to standardize computer interfaces around one type of connection. Today's computers come with a number of USB ports that all kinds of devices can use. It is not unusual to find six or more USB ports on a new computer, into which you can plug the keyboard, mouse, and additional devices of your choice, such as mobile phones, digital cameras, network devices, musical instruments, joysticks, memory modules, and other devices, all using a common connector design. USB provides not only a connection to the computer for data transfer but also a power line that can be used to power a number of useful and entertaining gadgets, such as keyboard lights, fans, hard drives, and even miniature Christmas trees. There are three versions of USB, each faster than the previous. The fastest, USB 3.0, is used on many of today's new PCs.

More specialized peripheral devices may come with their own circuit board, called an *expansion board* or *expansion card*, to be installed in a desktop computer. Installation of these devices is not as convenient as simply plugging in a USB connector, but typically it is straightforward. The method of installing expansion cards varies from machine to machine, so users should consult their owner's manual for specific instructions. To access expansion slots on a desktop PC, the cover of the system unit must be removed. The bank of *expansion slots* is located at the rear of the computer's motherboard. One or more of these slots typically contain cards installed by the computer manufacturer. Different size cards fit in different size slots. By viewing the width of the card to be installed, it is easy to determine which slot can accommodate the card. After installing the card according to instructions, the port on the card is exposed at the back of the computer for use.

Wireless technologies can also be used to expand the capabilities of a computer. For example, a cell phone can be connected to a headset over a Bluetooth wireless connection to provide hands-free operation.

## Software

**Software** refers to the electronic instructions that govern a computer's actions in order to provide a computing service.

### Why This Matters

Today, software goes by many names, including applications, apps, and programs. The 21<sup>st</sup> century has seen an explosion of all sorts of software. The mobile computing revolution and cloud computing have created opportunities for all kinds of new software to provide services anywhere, anytime for every need. While a decade ago the thousands of apps developed by professional software companies for PCs seemed excessive, today there are millions of apps, many of which are created by students like you. Traditional apps for PCs and businesses are as important today as ever, but now they are joined by hundreds of thousands of mobile apps for iPhones, iPads, Android phones and tablets, and Windows phones and tablets. In addition to apps installed on devices, there are thousands of web apps that run in browsers on all Internet-connected devices, and apps designed to run in and with popular online services like Facebook and Twitter. Today it's more important than ever to learn about the apps that are available, how they work, and how they are created.

### Consider This

Apps are becoming a major force in the U.S. and global economies. The most innovative and successful companies—Apple, Google, Facebook, Microsoft, Zynga, Groupon, and dozens of others—have made fortunes off seemingly simple apps that serve a valuable purpose. The U.S. is looking to its youth for the entrepreneurial spirit that can continue innovating and help the country to maintain its leadership role in the global economy. But, is the U.S. educational system supporting these expectations?

There is a big push to encourage students to study STEM subjects: Science, Technology, Engineering, and Math. However, programming and computer science have not become core subjects in the K–12 curriculum. Is it possible for young entrepreneurs to carry their visions through to reality without understanding computer code? If programming, like math, was taught to all students at an early age, would it impact the amount of interesting software produced in the U.S. in the next decade or two? How about you? Do you have any ideas for a cool new app? Do you have the skills to implement it? Are you interested in learning how?

### Essential Information

If you boil down all of the millions of apps available for all the different types of computers and devices, you end up with two basic types: system software and application software. System software assists *computer hardware* with the work it is designed to do. Examples include operating systems and antivirus software. Application software assists *people* with work and activities that people do.

Examples include spreadsheet software and social media software. There are many different types of system and application software as well as various methods of acquiring them.

Software is designed and developed by software engineers who use programming languages to encode the logic of the software in a manner that a processor can execute. Software usually consists of a number of files, ranging from a single file to dozens of files or more. At least one of the files associated with a program is an executable program file— the file that contains the processing instructions for the processor to execute.

There are many ways to start or run software. The most common ways are to click or tap an icon on the desktop or in a program's or application's menu to launch the executable program file. When a program such as a word processor is started, machine-level program instructions are copied from the executable program file in permanent storage into the computer's RAM. Once in memory, the instructions are transferred to the CPU and executed.

This section provides information on how software is created, acquired, used, maintained, and managed.

### **Ethical Dilemmas**

Apple and Google have very different approaches to controlling the software allowed onto their mobile devices. Apple applies strict controls over what software is allowed in its App Store, where hundreds of thousands of apps are available for download. Applications that are ethically or morally questionable are not allowed. You will not find any porn apps in Apple's App Store, nor will you find any apps that promote hate crimes, warn you of police speed traps, or insult the sensibilities of law-abiding, ethically minded citizens. Apple has been criticized for censoring its app selection. But, because Apple is a private company, its software is proprietary, and it is not obligated to support freedom of expression. The iPhone remains the best-selling smart phone on the market.

Google, in contrast, has an open-door policy in its Google Play store, where hundreds of thousands of apps are available for users of Android smart phones, tablets, and netbooks. Android is an open-source operating system, and Google figures its app store should be open as well. All kinds of possibly offensive apps can be found in Google Play. It also has hundreds of apps that are written specifically to hack users' phones and make off with their data. As Google learns of apps that have illegal intentions, or malware, it removes them from its store. However, Android has become a popular target for hackers and suffers from more virus attacks than Microsoft Windows, while the iPhone remains relatively unscathed. Nonetheless, Android fans appreciate the freedom that Google provides its developers and users. The many varieties of Android phones on the market combined outsell the iPhone.



Which approach do you prefer for your own smart phone needs? Which do you think is a better business model? Which is the best model to drive innovation in the market?

## Software Topics

- Software Development
- System Software
- Application Software
- Managing Software

## Software Development

**Software development** is the systematic process of transforming a software idea into functional software.

### Why This Matters

Software begins as a concept or idea for some new or improved use for a computer. Today's software developers, sometimes called software engineers, create software for many different types of computers, including PCs, tablets, smart phones, servers, and supercomputers. Understanding what computers are capable of is very useful in determining if a software concept is feasible. A developer who specializes in mobile software needs to understand the platforms: Apple iOS, Google Android, and Microsoft Windows Phone. The developer also needs to know the capabilities of the handsets, including processor capabilities, storage capacity, display size, wireless technologies, and whether they have GPS, an accelerometer, a compass, or other sensors. Understanding these capabilities provides the developer with ideas for new apps. For example, the Samsung Galaxy S4 includes a pedometer. This functionality allowed software developers to create health apps that can tell you how many calories you burn each day and make health recommendations based on that information. Apple, Google, Microsoft, Facebook, and others provide tools to make it easier to develop software for their platforms. Today, all types of people are developing new apps.

### Essential Information

Software development is a process typically guided by a model that provides sequential steps to take software from concept to reality. The most common model is called the software development life cycle, or sometimes the software life cycle.

The *software development life cycle (SDLC)* is a five-stage process that begins with requirements analysis, proceeds to the design stage, and is followed by implementation, verification (testing), and maintenance. The SDLC is sometimes referred to as the waterfall model because development flows from one stage to the next.

The SDLC is a cycle because often when software is in its final stage, the maintenance stage, an improved version of the software begins development in the first stage. In this manner, many software packages are in a continuous improvement cycle over many years. Also, although the SDLC is like a waterfall in most ways, when errors are identified and corrections are needed, it requires the water to “flow uphill,” back to a previous stage.

Although the waterfall model is popular and has been in use for many years, newer models are finding favor with some developers. Agile software development techniques such as Extreme Programming (XP) use an iterative process where development steps are small and incorporate frequent testing and user feedback to verify that each step is successful.

Whether software is being developed by a team of dozens of software engineers for a major software vendor or by an individual in his or her free time, using an orderly stepwise development process is the key to effectively and efficiently developing software.

**Table: The Five Stages of the SDLC**

SDLC Stage	Description
Requirements	Software begins typically as an abstract idea of some end result or output. Requirements analysis is the process of transforming an abstract description into a concise and complete list of input requirements and a full description of how the software should behave from the user’s perspective.
Design	From the requirements analysis, software developers create the software specification. Use cases—various ways that the software will be used—are explored. Tools such as flowcharts and pseudocode may be used to create an algorithm for processing the input to create the desired output.
Implementation	In this stage, the detailed software specification is translated into actual programming code, using a programming language.
Verification	Sometimes called testing, verification may use in-house alpha testing and external beta testing to expose errors in the code. Errors may be either syntax errors (a misuse of the programming language) or logic errors (flaws in the programming logic and algorithms).
Maintenance	Maintenance refers to repairs or enhancements to software that are applied after the software has been formally released.

## Software Development Topics

- Computer Programming
- Programming Languages
- Application Programming Interface (API)

## Computer Programming

**Computer programming**, or **coding**, is the process of creating software through the use of logic, algorithms, and programming languages.

### Why This Matters

In the very early years of computing, computer programming was accomplished by manually setting various switches and circuits within a computer. Later, programmers encoded software instructions as a series of holes punched on cards that were fed into the computer. After punched cards, the development of programming languages allowed software to be typed as a series of commands that the computer interpreted into binary code. Since then, software has been created to assist programmers in writing code and finding errors. More recently, toolkits have been released that make coding for specific platforms, such as Facebook or iPhones, even easier. Computer programming has gotten substantially easier over the years, making it increasingly accessible to people in every profession.

### Essential Information

*Program code* is the set of statements that instruct the CPU to perform circuit-switching operations. Software exists as sets of program code with a specified purpose. *Computer programmers*, sometimes called *coders*, are people who write or create the instructions or statements that become complete software programs. Within the computer industry, programmers are often called *software engineers*. In recent years, many people outside the computer industry have begun programming. Computer programming, or coding, has become a valuable skill in many professions. It teaches logical thinking and problem solving, useful skills no matter what your profession.

Before writing program code, software developers map out the logical design of software, using a variety of tools. When the logical design for the software is complete, it is time to code it using instructions that the computer can follow. All software, including system software and application software, is written using coding schemes called programming languages.

Many tools are available to assist programmers with the coding process. Code editors are text editors that assist the programmer in using a particular programming language. A code editor often features automatic command

completion, the ability to suggest useful commands, and color-coding that illustrates the relationship between commands. Debugging software is able to evaluate programming code to determine if and where errors, or bugs, occur. An *integrated development environment (IDE)* integrates all of the above tools and provides other helpful features. But, no matter how helpful an IDE, a programmer still needs to be thoroughly educated in programming languages.

## Programming Languages

**Programming languages** provide a set of symbols, commands, and rules (syntax) used to write program code.

### Why This Matters

Programming languages automate the tedious process of creating the detailed step-by-step machine instructions used in software. Programmers or coders use programming languages, or code, to create software, using English-like statements and high-level logic that are then translated into the low-level machine instructions that run in the CPU. Programming languages have transformed the programming process from tedious labor to a creative intellectual endeavor for problem solving.

### Essential Information

Software typically solves some problem or need through a logical sequence of steps. Whether the software is intended to create an online presentation, calculate a tax return, post a message for friends to view, or navigate a game character through a virtual landscape, logic plays a huge role in the development process. Since computers process software instructions sequentially in tiny steps, software development requires programmers to step through the process of problem solving logically. Talented programmers are masters of problem solving with logic.

All programming languages share a core set of tools (see the table below), with each language excelling in some type of application. Each language has a particular *syntax*—the rules that guide how programming statements are constructed. By combining these common programming tools in unique ways and taking advantage of special traits of specific programming languages, developers create useful new apps.

**Table: Programming Language Tools**

Tool	Description	Example
Variables	named storage for specific types of data	<code>x = 12</code>  assigns the value 12 to the variable named x
Strings	a collection of characters	<code>str = "algeron"</code>  assigns the word algeron to the variable named str
Arrays	a collection of variables	<code>myCars = ["Saab","Volvo","BMW"]</code>  <code>myCars[0]</code> is Saab, <code>myCars[1]</code> is Volvo, etc.
Arithmetic operations	The ability to carry out math equations with variables	<code>x = 12 + 3</code> <code>y = x + 8</code>  x holds 15, and y holds 23
Comparison operations	The ability to compare data using comparison operators	<code>(x &gt;= 12)</code>  would be true only if the value in x is 12 or greater
Conditional statements	The ability to choose different operations depending on a condition	<code>if (x &gt;= 12) {print x}</code>  x will be printed to the screen only if it is 12 or greater
Iteration	The ability to repeat an operation as long as a condition remains true	<code>while (x &lt; 12){</code> <code>  print x</code> <code>  x = x+1</code> <code>}</code>  prints x repeatedly until x is 12 or greater

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*Object-oriented programming (OOP)* has become the dominant programming paradigm. In object-oriented programming, data, instructions, and other programming procedures are grouped together, or encapsulated, in reusable *objects*. Objects are linked in a manner that creates a useful program: one object's output

serves as another object's input. Objects can be connected in different ways to create different applications. Object-oriented programming is popular because it approaches problem solving in a manner that mimics the real world, and also because it saves development time.

Utilizing a programming language's syntax, programmers create a *source code* file that is translated into an *object code* file containing the machine-level instructions that the processor carries out. Most software is developed using a software tool called a compiler. A *compiler* takes source code—a program written in a programming language—and produces object code, which contains an executable file and supportive files, as output (see illustration). Some programming languages use an *interpreter* rather than a compiler to create object code. An interpreter translates source code to object code one command at a time, while the software is executing.

**Table: Popular Programming Languages**

Languages	Description
C	General-purpose language popular on UNIX and Linux platforms
C++, Java, Python	General-purpose object-oriented languages; Java is perhaps the most popular programming language and is used for developing Android apps. Python is a popular beginner's language that is easy to learn.
JavaScript, JQuery, AJAX	Based on JavaScript, these languages are used mostly for client-side web programming
PHP, Ruby, Perl	Popular web server-side programming languages
SQL, MySQL	Database manipulation languages
C#, VB, .NET	Popular for Microsoft Windows programming
Objective-C	Used to develop iOS apps for iPhone and iPad

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## Application Programming Interface (API)

An **application programming interface (API)** is a set of programming tools specifically designed for developing apps for a particular platform.

### Why This Matters

An API allows others besides the manufacturer to develop software to run on the system or device. Without APIs, only Microsoft would develop software for Windows computers, only Apple would develop software for the Mac and iPhone, and only Sony would develop software for the Playstation. APIs provide users with a rich variety of software and provide an opportunity for less experienced programmers to make valuable software contributions.

### Essential Information

An API might be restricted to one particular programming language, or it could support many languages. For example, Facebook designed its API to require the PHP scripting language. Microsoft Windows, however, supports many programming languages that can manipulate the Windows environment using the programming tools provided by the Windows API.

Some APIs are combined with an SDK. A *software development kit*, or *SDK*, is a programming environment designed to write software for a particular computing platform. Facebook, the iPhone, Google Maps, and Google Android all provide SDKs for software developers. The iPhone SDK is shown in the figure. Notice that the SDK provides an iPhone simulator that allows developers to test code.

APIs may be made publicly available or may be licensed to specific software developers. For example, the Playstation API is available only to software companies that Sony has approved for developing software for its gaming console.

SDKs make software development less complicated. For example, to develop applications for the iPhone, Android, or Facebook, the SDKs require only basic programming skills and learning the capabilities of the device or environment. This provides opportunities for amateurs to try their hand at software development. Many of the hundreds of thousands of iPhone apps were designed, developed, and published by amateurs. Amateurs may not have the skills to develop a full desktop application, but they often can learn the smaller skill set required to use the SDK.

## System Software

**System software** is any software that coordinates the activities of the hardware and assists the computer in functioning safely, effectively, and efficiently.

### Why This Matters

Controlling the operation of computer hardware is one of the most critical functions of system software. System software includes operating systems that interact with the computer hardware and application software, creating a layer of insulation between the two and keeping computer systems running smoothly and safely.

System software also includes utilities like security software, file management software, and DVD burning software. System software is essential for all types of computers from smart phones to supercomputers, to special purpose computers and other digital devices.

### Essential Information

System software includes operating systems, such as Microsoft Windows, Mac OS X, Android, and iOS, that are essential for all computers to operate. Other system software, such as disk management tools and antivirus software, isare designed to keep the computer running safely, smoothly and effectively. System software, especially the operating system, is written for a specific set of hardware and CPU. The hardware configuration of the computer system combined with the particular operating system in use is known as the *software platform*. For example, a mobile software developer might specialize in developing apps for the Android platform.

### System Software Topics

- Boot Process
- Operating System
- User Interface
- File Management
- Microsoft Windows
- Mac OS
- Linux
- Virtual Machine Software
- Mobile Operating Systems
- Industrial Operating Systems
- Embedded Operating Systems
- Utility Software

### Boot Process

The **boot process**, also known as booting, booting up, or bootstrapping, is the sequence of instructions in the BIOS that is executed when a computer is powered on to check the system and load the operating system into memory.

### Why This Matters

When computers are powered off, all instructions are cleared from the CPU and memory. When the computer is powered back on, there are no instructions available in the CPU or memory to execute. The boot process instructions are part of the BIOS (the basic input/output system), which is burned into ROM rather than stored electronically so that it is always ready for the processor to execute when the computer—server, PC, smart phone, or tablet—is powered on.



## Essential Information

The boot process is stored and managed slightly differently in different types of computing devices. The boot process requires permanent storage since it is seldom changed and needs to remain fixed while the power is off. For this reason, it is typically stored in some form of ROM or solid-state storage. The boot process includes a set of instructions called the boot sequence. The boot sequence for a standard PC includes the following steps:

1. Perform power-on self test (POST) to check that all devices are functioning
2. Search storage devices for bootable device
3. Load boot sector for operating system into memory
4. Execute operating system kernel

From this point, the operating system takes over. After a few seconds or minutes, it turns control over to the user.

Mobile devices like smart phones and tablets typically go into a sleep mode when powered off. In sleep mode, the operating system remains in memory so that the device quickly turns on when the power button is pressed. At times, a mobile device may malfunction. Resetting the device by shutting it down and rebooting it typically will clear up the problem. The owner's manual of the device provides instructions for rebooting or resetting the device.

## Operating System

An **operating system (OS)** is a set of computer programs that runs or controls the computer hardware, and acts as a user interface.

### Why This Matters

The operating system plays a central role in the functioning of any computer system. Operating systems run on most digital devices. Nearly all operating systems perform certain similar tasks, such as controlling computer hardware, managing RAM, managing the processor(s), controlling input and output devices, storing and managing files, and providing a user interface. Most operating systems today also provide networking functionality.

## Essential Information

Operating systems control many common hardware functions, such as providing a user interface, managing the processor and memory, managing files and storage, communicating with peripheral devices and accessories, capturing user input, and providing output. Operating systems are designed to work with specific types of

computers and processors. Application software is written to operate on a particular type of operating system, not on a particular type of computer. For example, there are apps that run only on Android, and others only on iPhone. PC apps run exclusively on Windows, Mac, or Linux platforms. If a developer wants to have an app on all the popular platforms, he or she needs to create multiple versions of it, using at least three APIs and programming languages—one each for iPhone, Android, and Windows Phone. The number of apps available for a platform has a large impact on the popularity of the platform. A decade ago, Windows computers vastly outsold Macs, primarily because of the amount of software available for each. Today, the iPhone vastly outsells Windows Phones, primarily for the same reason.

The operating system provides a user interface that allows the user to interact with the system. The user interface is what defines the user's computing experience and causes some users to prefer Windows over Mac, or iPhone over Android.

The operating system also provides a structure for system storage. Typically, data is stored in files, and the files are organized with folders and subfolders. Recent versions of Windows add the ability to store commonly used files in Libraries. File management is hidden on most mobile platforms.

“Underneath the hood,” so to speak, the operating system controls processing and memory use. The OS retrieves instructions from the running software, decodes it, and sends it to the CPU for execution, storing any resulting data. Most PC and mobile operating systems *multitask*, running multiple applications at the same time.

The OS also controls input and output. It receives input from a keyboard, mouse, touch screen, microphone, or other input device, and then returns the results of processing to the display, printer, speakers, or other output device. The OS can communicate with many different external devices and accessories, called peripherals, such as scanners, printers, keyboards, and displays. To do so requires a *device driver*—software that is installed for each device connected to a PC, which allows the OS to communicate with that device.

Mobile versions of operating systems for tablets and smart phones are lightweight versions of their PC equivalents. They require fewer system resources, and so can run on smaller processors with less storage and provide a streamlined user interface for smaller touch screens. Microsoft, Apple, and Google have all recently unified their operating systems across devices so that users can have a common experience across their PCs, tablets, and smart phones. Using cloud computing, a user could share apps, data, and media between all three types of devices utilizing a common OS: Mac OS X, Windows, or Android.

## User Interface

A **user interface** (UI) allows one or more people to have access to and command of a computer system or computer software.

## Why This Matters

One of the most important functions of any operating system is providing a user interface. An OS user interface allows one or more people to have access to and command of the computer system. The user interface defines the computing experience for the user.

## Essential Information

The first user interfaces for servers and personal computers were command based. A *command-based user interface* requires that commands be typed at a prompt in order to perform basic tasks. Most operating systems still provide access to a command prompt to allow system administrators and advanced users to interact more directly with the operating system. However, the default user interface today is the graphical user interface.

A *graphical user interface (GUI)* uses a keyboard and mouse, touch screen, joystick, or other pointing device to manipulate graphics images on the display to issue commands to the computer system. A graphical user interface offers many advantages over a command-based user interface. For example, a GUI is very intuitive. Often you can simply explore to figure out how to perform some task; and if you can't figure it out, help menus and wizards can assist you. A multitasking GUI allows you to view several applications at once and copy data between applications.

The most popular graphical user interfaces on personal computers include similar features and functionality; however, the style of those features may differ from OS to OS. GUIs generally include icons, a desktop, windows, menus, dialog boxes, an information bar (taskbar or dock), program launch area, file viewer and organizer, system viewer, and system settings. It typically doesn't take long for an experienced computer user to switch to a new computer platform. Many Windows users have switched to Mac computers in recent years, and increasing numbers of users are trying Linux.

There is a GUI battle raging on smart phones. The iPhone ushered in the age of smart phones with a user interface that featured pages and pages of app icons. The Android operating system introduced the notion of smart- phone "widgets" that allow applications to display information on the home screen along with app icons. Microsoft introduced "live tiles" that provide app information on tiles and a new way of interacting with information and apps. Blackberry has developed a similar interface and has criticized Apple for its now outdated GUI. Ubuntu for Phones, which is a mobile version of Linux, provides a similar approach to Windows and Blackberry.

Wearable user interfaces are the next big trend. Google Glass utilizes a head-mounted display and voice commands to interact with mobile apps. Apple, Samsung, and Google are developing smart wristwatches that connect wirelessly to a smart phone for easy access to text messages and mobile apps.

## File Management

**File management** refers to the physical and logical storage system and practices provided for managing data on a computer.

### Why This Matters

The operating system keeps track of files stored on disk and manages all storage devices within and attached to the system. Some OSs also manage files stored on network drives and in the cloud. When you save a file to a hard drive or flash drive, or burn it to a CD or DVD, the operating system finds space on the device to store the file in an efficient manner and records the location so the file can be accessed. Maintaining an organized file system makes it easy to find files and information.

### Essential Information

The storage-management portion of an OS converts a logical request for data into the physical location where the data is stored. A *logical view* of data is the way a user thinks about data—for example, C:/Documents/Homework/report.doc. That is, the report.doc file is stored in the Homework folder, which is in the Documents folder on the C drive. With a logical view, the user doesn't have to know where the data is physically stored in the computer system. However, a computer can translate the logical view of data into the *physical view* of data—for example, hard disk, track 1, sector 3.

The operating system performs this task through the use of a *file system*—a way of organizing how data and files are physically stored and how they are logically manipulated. Windows operating systems use the *New Technology File System (NTFS)*. The Linux and UNIX operating systems use several different file systems such as ext3 and UFS. Mac OS X uses a file system called HFS+ (HFS stands for Hierarchical File System).

Operating systems provide tools for managing files. Microsoft Windows 8 uses File Explorer (called Windows Explorer in earlier Windows versions) to manage files, while Mac OS X uses Finder. Computers of all types and sizes store and manipulate files that can contain data, program instructions, or both. Operating systems allow you to organize files into folders, sometimes referred to as directories. Folders can hold one or more files. Organizing files into folders or subfolders makes it much easier to locate files, compared to having all files in one large folder or directory. Windows 7 and 8 also provide Libraries, which allow you to view files and folders from various locations as a single collection. Lists of folders and files on a computer can be viewed alphabetically, by size, by type, or by the date they were created or last modified. Operating systems typically provide several types of views of files, including list view, icon view, thumbnail view, or cover flow view (see image).

Operating systems allow files to be copied from hard disks to portable media such as USB drives and CDs and DVDs. Most popular operating systems allow files to be

transferred from desktop or notebook PCs to mobile devices. For example, you can transfer your favorite music files and photos from a Windows PC or Mac to an Android smart phone. Increasingly, files are being stored in the cloud, where they can be accessed from many locations and devices.

Each OS has conventions that specify how files can be named and organized. In Windows, Mac, and Linux, file names can be up to 256 characters long, both numbers and spaces can be included in the file name, and upper- and lowercase letters can be used. Windows and Mac permit spaces in file names while Linux does not. Mac and Linux file names are case sensitive while Windows file names are not. Certain characters, such as \, \*, >, and <, cannot be used in file names. File names may have an extension such as .docx, .html, .jpg, or .txt. Extensions help identify the type of file, such as Word document, web page, photo, or text file.

## **Microsoft® Windows**

**Microsoft Windows** is the most popular operating system for personal computers.

### **Why This Matters**

Microsoft Windows runs on roughly 82% of all personal computers. The most recent versions of Windows provide a high-quality graphical user experience that supports all types of computer activities from business applications to video games and digital media production on all types of Windows devices, including PCs, tablets, and smart phones. Since Windows is the dominant OS and is found in most business environments, it is useful for everyone to be fluent in its use.

### **Essential Information**

Over the years, there have been many versions of Microsoft Windows, such as Windows NT, Me, 2000, XP, Vista, 7, and 8, each adding features and improvements over previous editions, including new graphical interfaces and networking capabilities. The most recent version is Windows 8, released in 2012 with major innovations and improvements.

Windows 8 offers many improvements over previous versions of Windows, including:

- The Metro user interface that provides fluid interaction with apps and is consistent across PCs, tablets, and smart phones
- A Windows app store for downloading new apps
- Cloud computing (OneDrive) that allows users to work and access data from any computer
- Full-screen apps and integrated social apps

Microsoft completely reimagined the user interface in Windows 8, designing it for easy manipulation from touch screens on all different types of devices. Windows 8 uses live tiles rather than desktop icons to provide constantly updated information on the start screen that can include weather, Facebook updates, Twitter tweets, text messages, email notifications, calendar reminders, and more. Windows File Explorer is redesigned for improved convenience, and computer settings can be easily accessed without having to sort through the Control Panel.

Consumer reaction to Windows 8 has been mixed, as is typical with any major software redesign. Over time, as consumers become comfortable with navigating the new interface and using touch screens, Microsoft hopes that Windows 8 will provide an innovative alternative to Apple and Android, especially on mobile devices.

## **Mac OS**

**Mac OS** is the native operating system for Apple PCs.

### **Why This Matters**

The Mac OS has gained popularity as Mac computers have grown in market share. The most recent version of the Mac OS is called OS X Mountain Lion, and it is competitive with Windows 8 in terms of performance and capabilities. Mac users prefer OS X over Windows because of its ease of use and relative safety from viruses and other malware.

### **Essential Information**

Like Windows, Apple operating systems have gone through revisions and changes to make them more useful. Easy-to-use graphical user interfaces have always been a hallmark of Apple systems. The latest version of Mac OS continues to be easy to learn and use. Simplicity does not mean that Apple's latest operating system is not powerful, however. Macintosh operating systems offer outstanding graphics capabilities and are popular with professionals working in art, photography, motion pictures, animation, and music. Because high-end Macs offer powerful processing, they are also popular with mathematicians and scientists.

The most recent Mac OS, named OS X (ten), is built on the UNIX operating system, an industrial-strength OS originally developed for mainframe systems and renowned for its stability and security. Mac OS X has undergone several updates, each named after large cats: Puma (2001), Jaguar (2002), Panther (2003), Tiger (2005), Leopard (2007), Snow Leopard (2009), Lion (2011), and Mountain Lion (2012). Each update has implemented improvements and expanded features. Like Windows 8, OS X Mountain Lion is designed to provide a seamless user interface between platforms: Macs, iPads, and iPhones. It incorporates several mobile apps, including Notification Center, Game Center, and Reminders. Also like Microsoft Windows 8, Mountain Lion utilizes cloud computing to share apps, media, and files across devices. Mac OS X and

Windows both incorporate social media into their design. For example, Mac OS X has a dedicated app for Twitter, and the ability to post photos and comments to Facebook from inside apps.

Mac users often use apps from Apple, downloaded from the App Store. Safari is Apple's web browser, Mail is the Mac e-mail program, Address Book stores contacts, and iChat is for instant messaging with or without video. These and many other useful software tools are provided free with Mac OS X. The Mac iLife suite of apps (sold separately) includes iChat, iPhoto, iMovie HD, iDVD, iTunes, iWeb, and GarageBand. Mac iWork software (also sold separately) includes the Pages word processor, Numbers spreadsheet, and Keynote presentation software. These apps can be downloaded independently from Apple's App Store for between \$15 and \$20 each. Many Mac users also use Microsoft Office for Mac for their productivity software. By doing so, they can share files and interact with Windows users without compatibility issues.

Because Apple makes both the hardware and the operating system for its computers, and because Mac OS X is built on UNIX technology, Macs have a reputation of being more stable and secure than Microsoft Windows PCs. Mac users also do not face as large a threat from viruses and spyware as do Windows users, although that is changing with some Mac users being tricked into downloading malware on the web. Mac OS X provides file encryption, password protection, and a firewall to keep hackers out of your files, and some Mac users install additional antivirus software, like Sophos Antivirus as recommended by Apple.

On the down side, many software titles are available for Microsoft Windows that are not available for Macs. Because Windows has such a large market share, and is favored by most businesses, most software companies favor Windows over Mac. However, virtual machine software, like Parallels and VirtualBox, for Mac makes it possible to run Microsoft Windows or other operating systems either instead of Mac OS or along with Mac OS.

## **Linux**

**Linux** is a free, open-source operating system for PCs, servers, and other types of computers.

### **Why This Matters**

Linux owns a small percentage of the PC operating system market, but is very popular with technically inclined individuals, with users looking for free and open-source software, and with some corporations. Because it is open-source, Linux can be customized to meet specific needs. Businesses and organizations appreciate this feature. Linux is growing in popularity as a lightweight and inexpensive operating system for mobile computing devices such as netbooks, tablets, and smart phones. Google's Android OS is based on Linux.

## Essential Information

Linux was developed by Linus Torvalds in 1991. It was designed to provide a powerful, free, UNIX-like operating system that would run on desktop PCs. As with UNIX, Linux can be used as a command-line operating system or through a graphical user interface such as GNOME. Today, it is used on computers ranging from smart phones to servers. The operating system is available for free to users under a General Public License (GPL) arrangement. Some vendors also offer commercial (not free) versions of Linux that include more features and offer user support.

Many versions, called *distributions* or *distros*, of Linux have been designed by the user community. Because Linux is open- source, it has many more customized versions than Microsoft Windows or Mac OS. Distributions based on Debian Linux feature free, unencumbered software and have a reputation for being very stable; the popular Ubuntu distro falls under this category. Red Hat Enterprise-based distributions are designed for large corporate systems and servers, with a free community version called Fedora. Slackware-based distributions are highly customizable and are favored by techies. Specialized distributions are created for specific devices such as smart phones. Ubuntu for phones and tablets has received notoriety recently for providing a free alternative to the big three smart phone platforms: iPhone, Android, and Windows Phone. Ubuntu won the Best in Show award at the 2014 Mobile World Congress, the world's largest mobile technologies convention.

Linux has a big advantage over proprietary operating systems such as Windows and Mac OS X: People can not only get copies of Linux free of charge or at low cost, but they can also develop utilities, applications, and enhancements to the operating system. Besides including all the standard OS functionality, settings, and support, Linux Ubuntu comes loaded with free open-source applications. Ubuntu includes several productivity applications, Internet apps, references apps, graphics and media apps, accessories, and games. The downside of using Linux is that it does not support many of today's popular software titles. Some Linux fans get around this by setting up their PC to dual boot—that is, to have the option of running either Linux or Windows on a single PC.

## Virtual Machine Software

**Virtual machine software**, also referred to as **virtualization software**, allows one operating system to run on top of another by creating a virtual machine on which the guest operating system can run.



## Why This Matters

*Virtual machine (VM)* software is useful for users who wish to run more than one operating system on a computer. This includes programmers who need to develop software for multiple platforms. It also includes professionals who wish to access specific software that is only available for a certain OS. Also, home users may enjoy having access to multiple operating systems to support diverse interests and needs.

## Essential Information

There are several virtual machine applications available for PCs and Macs. VirtualBox software from Oracle allows Linux to run in a window on a Windows PC or Mac. It can allow Windows to run on a Mac, and practically any OS to run on any other. Parallels Desktop VM and VMware are other popular virtual machine software packages. Because of the amount of resources required for two operating systems to run simultaneously, VM software is most successful when run on more powerful PCs.

Virtualization is also used on servers to make more efficient use of server resources. Server virtualization allows one physical server to run several individual virtual servers and different server operating systems. Virtual servers have become very popular in data centers as a means of getting more computing out of the hardware, reducing the number of physical servers needed, and supporting green computing by saving energy and helping the environment.

## Mobile Operating Systems

**Mobile operating systems** are lightweight operating systems designed for mobile devices such as smart phones and tablets.

## Why This Matters

Not that long ago, mobile phones were used only for voice and text communications. Today's mobile phones have become information and entertainment centers—handheld computers with access to the Internet and hundreds of thousands of software applications. The reason that cell phones have become so powerful is that cellular networks have become more robust, and mobile operating systems have evolved to support versatile functionality.

## Essential Information

With the advent of smart phones and tablets, mobile operating systems have become some of the most important software in use today. The RIM BlackBerry smart phone revolutionized the use of cell phones in business by providing users with access to email and corporate information systems. The Apple iPhone opened up a whole new world for personal mobile phone users by providing access to

popular websites such as YouTube and Facebook, games, maps, GPS navigation software, and hundreds of thousands of other apps. In so doing, Apple stole the smart phone market from RIM. Shortly after, Google released Android, the first open-source smart phone OS to gain massive public support and dig deeply into the iPhone's market share. Microsoft was a latecomer to the smart phone market, and is working to get a piece of the pie with its innovative Windows 8 OS. BlackBerry has recently fired back at Apple with a redesigned BlackBerry 10 operating system and slick smart phone designs like the z10. Today, Apple and Android phones are battling for the number one spot in the market, leaving a very small percentage of the market on which for Windows and BlackBerry to try to gain a foothold.

Manufacturers of cell phone and smart phone operating systems work closely with handset manufacturers and cellular carriers to create capabilities that are desirable, feasible, and profitable. Today's smart phones feature many forms of communication, including phone, text, video and social networks, web browsers, maps and navigation, music, movies, photos, email, calendars, contacts, and thousands of special-purpose applications.

Microsoft and BlackBerry have designed new-generation mobile operating systems that go beyond a collection of independent apps to focus on information and the user experience. Using these OSs, users can access useful dynamic information right from the start screen, and glide seamlessly between apps to find related information. For example, using a Windows 8 Phone, users can access information about all the people in their lives, using the People app, where they can view any friend's interactions with social media, photos, shared calendars, and contact information. In other words, they can communicate through multiple means with one click. Now the onus is on Apple and Android to innovate in order to catch up and then take the user experience to the next level.

Today's mobile phone operating systems can be classified as one of three types, shown in the following table.

**Table: Mobile Phone Operating Systems**

Type of OS	Description
Proprietary operating system	Owned and kept private by the handset manufacturer. Software is installed on devices at the discretion of the manufacturer. Examples: Symbian and Blackberry
Proprietary operating system with software development kit (SDK)	Owned by the handset manufacturer, but an SDK is provided to allow developers to develop software for the OS. The software may or may not be vetted by the handset

	manufacturer. Examples: Apple iPhone OS and Windows Phone
Open operating system	Follows the open-source model, making the OS source code available to handset manufacturers and software developers. Examples: Google Android OS and Ubuntu

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## Industrial Operating Systems

**Industrial operating systems** control large networked systems and servers.

### Why This Matters

Industrial computers operate in a much more complex manner than PCs and require an operating system that can manage multiple processors—sometimes hundreds or even thousands of processors—and many users. Companies that manufacture the systems, such as IBM and Oracle, typically design and provide the operating system with the hardware.

### Essential Information

Some operating systems are designed specifically for larger computer systems or computer systems that require a server. Network management functions are an important element, as is the ability to manage multiple processors, complex storage architectures, massive amounts of RAM, and many users. Today's industrial OSs support the latest trends in technology, including virtual machine functionality and cloud computing. Windows Server, Linux, Novell NetWare, and Oracle Solaris are examples of network operating systems. Windows Server 2012 is the most recent version of Windows Server and contains many of the client features of Windows 8.

Oracle Solaris is the most popular version of the UNIX operating system for industries. The online marketplace eBay uses Solaris servers, software, storage, and services to run its operations. The Idaho National Laboratory uses the Solaris operating system to conduct research in its work to design more efficient and safe nuclear reactors.

Large mainframe server manufacturers typically provide proprietary operating systems with specific hardware, such as z/OS, a 64-bit operating system for IBM's large mainframe servers. MPE/iX is an operating system used by Hewlett-Packard's mainframe computers. Enterprise Systems Architecture/370 (ESA/370) and Multiple Virtual Storage/Enterprise Systems Architecture (MVS/ESA) are older operating systems used on IBM mainframe computers.

## Embedded Operating Systems

**Embedded operating systems**, or just **embedded systems**, are hardwired into a computer component, such as ROM or flash memory, to control a special-purpose computer.

### Why This Matters

There are several thousand different types of special-purpose computers and computer-driven devices in the world. Computers control medical equipment, cars, elevators, kitchen appliances, media players, televisions, and most of the electronic devices that we interact with on a daily basis. Every computer is controlled by an operating system. While general-purpose computers use operating systems stored on disk, the many special-purpose computers typically employ an embedded operating system, or embedded system (for short).

### Essential Information

Embedded systems typically are designed to perform a relatively limited number of tasks. Consider the functions of a GPS navigation system. Compared to a general-purpose computer, GPS navigation is very limited. Or consider the fuel injection system of a car that regulates the flow of fuel to the engine. The embedded system that controls it has an even more limited set of instructions than that of a GPS.

Because embedded systems are developed for specific tasks, they can be optimized more easily, which increases reliability and performance, and reduces size and cost. Some embedded systems are classified as real-time operating systems. A *real-time operating system (RTOS)* is an operating system that has time constraints placed on its functionality: When a button is pushed or a command is delivered, the system must execute the command within a certain amount of time. Consider systems that control an aircraft or the scheduling of online airline ticket sales. In both examples, when a command is given—extend left flap, or reserve seat—the amount of time it takes for that command to be executed is crucial.

## Utility Software

**Utility software** is any system software besides the OS that assists in maintaining, managing, and protecting computer system resources.

### Why This Matters

Utility software helps keep computers running smoothly and safely. With operating systems growing more complex, and risks associated with Internet-connected computers increasing, utilities are more important than ever before.

## Essential Information

Utility programs often come installed on computer systems; a number of utility programs can also be purchased. As operating systems have developed, they have incorporated features that were originally found in separate utility programs, such as disk maintenance.

The following are common utilities that protect computer systems and keep them running smoothly:

- Defragmentation and disk utilities: Maintain files on disk and arrange them in a manner that allows for fast access
- Backup utilities: Safeguard files by creating backup copies
- Security software: Search for and remove malware such as viruses and spyware from computers, and guard against attacks
- Spam and pop-up blockers: Identify and remove unwanted junk mail and ads
- Windows cleaners: Remove unwanted programs and leftover traces of programs from the system, and maintain the Windows Registry for smoother OS operation (see video)
- Diagnostic software: Provide a view of system resources in a graphical format to see how the CPU, RAM, and other resources are performing

A number of utilities are designed to assist users in managing and transferring files:

- File management utilities: Provide tools for copying, deleting, renaming, and organizing files
- File compression utilities: Allow files to be bundled together into one compressed file to save storage space and allow for easier transfer
- CD/DVD burners: Copy and store files on CDs and DVDs
- File transfer utilities: Move and share files across computer networks
- Search utilities: Find files on a computer system
- Synchronization software: Synchronize files across multiple computers, such as a desktop and a notebook and a smart phone

Other utilities provide a way to customize your computing environment and make computing resources more convenient to access:

- Desktop enhancements: Provide customization tools for desktop, icons, shortcuts, color schemes, and other visual elements of the desktop

- Screensavers, skins, themes, and wallpaper: Provide a visual style for the desktop
- Automation software, macros, and shortcut keys: Allow the user to automate frequent commands and command sequences and assign them to a shortcut key or group of keys (i.e., Ctrl+Alt+R)

## Application Software

**Application software** consists of programs written to perform tasks or solve problems for people, groups, and organizations.

### Why This Matters

You've learned that there are two general categories of software: system software and application software. In the last section you learned all about system software. Now it's time to turn your attention to application software. While system software is useful to the machines that run them, application software is what makes computers useful to people. Millions of applications have been developed to assist people in all professions and in their personal lives.

### Essential Information

The primary function of application software is to apply the power of the computer to give people, groups, and organizations the ability to solve problems and perform specific activities or tasks. The most popular type of application software is productivity software. Productivity software is any software that helps people to be productive. It includes business software, like word processing, spreadsheet, database, and presentation software, as well as other types of software that support all kinds of professions.

Information management has become a key use of application software. Personal information management (PIM) software has become increasingly popular in managing individuals' calendars, address books, and to-do lists. Information management in business is the primary goal of many different types of management information systems (MISs).

Although many of today's applications are designed to be used by a single individual, it is becoming increasingly common to work on electronic documents in groups. *Collaborative software* is any software that facilitates group collaboration within the software. Google Docs is a good example of collaborative software, as it supports multiple users editing a common document from different locations over the web. Microsoft Office has adopted similar online collaborative features in Office 365.

Many types of application software are provided through a web interface. Utilizing new technologies that include AJAX and HTML5, developers are able to create powerful applications that run in a web browser without the need for any

installation on the local computer (see figure). Web apps are a popular form of cloud computing since they run on web servers, and they typically also store user data on web servers so that it can easily be shared with collaborators and others. As Internet connections are becoming more pervasive, web apps are becoming the norm.

As computing has gone mobile, software designed for mobile devices, commonly referred to as mobile apps, have become very popular. Billions of apps have been downloaded from the Apple App Store for use on iPhones and iPads. Whole software industries are growing up around mobile apps. Mobile games, sometimes called casual games, are very popular with mobile users as are PIM apps, social apps, GPS apps, and others.

Besides full-blown installed applications and web-delivered applications, gadgets and widgets are yet another form of application software. A *gadget* or *widget* is a small application that is conveniently accessible from the computer or mobile desktop. Popular gadgets include weather reports, dictionaries, calculators, calendars, social media feeds, and to-do lists.

In this section you will learn about application software that assists people in both their professional and personal lives. You will also learn about the fastest growing area in the software industry: mobile apps.

### **Application Software Topics**

- Business Software
- Personal Software
- Mobile Apps

## **Business Software**

**Business software** is any software designed to assist individuals and groups to be more productive at work and is often used in reference to software suites that include word processing, spreadsheet, database, and presentation software.

### **Why This Matters**

Business software supports the productivity that fuels today's global economy. It is made up of a combination of custom developed software (designed for a specific business' needs) and mass-produced software (designed for well-identified general business needs). This page discusses mass-produced software that is popular in many businesses. The most popular are office suites.

### **Essential Information**

A *software suite* is a collection of applications sold together as a package. Office suites typically include word processors, spreadsheets, and presentation software,

and they sometimes include database-management systems, personal information managers, and other applications (see the table below). Office suites aren't just useful for business use; they also assist individuals in managing home life, school work, and other activities that benefit from professional organization and presentation.

Microsoft Office is by far the most popular software suite. Microsoft Office is available for Windows and Mac platforms. Other office suites include Apple iWork, Corel WordPerfect Office, IBM Lotus SmartSuite, and Oracle Office. Apache OpenOffice, a free open-source productivity suite, is compatible with Microsoft Office and available for Microsoft Windows, Solaris, Linux, and Mac OS X. Zoho Office Suite is a free web-based suite of applications, including Writer, Sheet, Show, Wiki, Notebook, Projects, CRM, Creator, Planner, and Chat.

**Table: Office Suite Applications**

Application	Description
Word processing software	Word processing software allows users to create formatted text documents varying in complexity from simple notes to professional magazine layouts.
Spreadsheet software	Spreadsheet software supports complicated numerical analysis and calculations, and allows users to perform “what-if” analysis on financial and other numeric data.
Presentation software	Presentation software supports formal presentations by providing “slides” that can accompany and embellish a live presentation or present the material without the use of a human speaker.
Database software	Database software is used to store, manipulate, and manage data in order to find and present useful information.

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The primary task of many business applications is to manage information and uncover valuable insight from data collected. Databases and Information Management are covered in other Emerge with Computers units. Personal information management (PIM) has become an important software activity for all professionals. PIM is the practice of managing information about an individual. Microsoft Outlook is the most popular PIM software for businesses and is included in the Microsoft Office suite. Google and Apple provide PIM software as well. PIM typically includes calendaring applications to keep track of appointments, contact lists to keep track of contact information of those you deal with, to-do lists, and e-mail. PIM software needs to be accessible from both PCs and mobile devices so that



it can be accessed anywhere, anytime. PIM data is often shared among colleagues to allow the easy scheduling of meetings and to provide support for collaborative work.

Besides managing information, another essential business activity is communication. Cellular networks and the Internet provide many options for communication, which are all covered on the Internet Communications page.

Project management software helps project leaders organize complex projects that involve many resources and coordinated activities. It is used to plan, schedule, allocate, and manage people and resources (money, time, and technology) to complete a project according to a schedule. Microsoft Project is the most popular project management software. There are several alternatives, including OpenProj, which you can download and use for free, and SeeNowDo, (see image), which is a free lightweight app for managing tasks.

There are many other business applications that are critical to professionals in specific industries and professions. Computer aided drawing (CAD) software is essential to many engineers and product designers. Desktop publishing software is used by publishers. Statistical software and math software like MATLAB are useful to scientists and engineers. Financial management software packages and tax preparation software are critical to accountants.

## **Personal Software**

**Personal software** is any software designed for personal benefit, including home management, entertainment, and education.

### **Why This Matters**

Computing and information technology has impacted our lives at every level. They not only allow us to be more productive not only at work, but also in our home and personal lives. Software assists people in balancing budgets, learning new skills, finding apartments and houses, organizing digital photos, finding and keeping in touch with friends, planning vacations, and organizing daily activities. Software also plays a major role in providing entertainment and leisure time activities. From trying new recipes to planning a weekend, software is integral to our daily lives.

### **Essential Information**

Consider the software you use each day outside of work. Most likely, much of it is provided on the web. Managing bank accounts, interacting with friends, scheduling activities, and looking up information are all supported with online services and apps. If you are like many students, you probably use apps on your phone as much as, if not more than, you do on your PC. Consider the personal app categories available for the iPhone: Books, Education, Entertainment, Finance, Games, Health &

Fitness, Lifestyle, Medical, Music Navigation, News, Photo & Video, Reference, Social Networking, Sports, Travel, and Weather. Personal apps have pervaded our lives, providing opportunities to expand our knowledge and skills, tools to manage our lives, and abundant options for fun and entertainment.

**Table: General Categories of Personal Software**

Software Category	Examples
Home & Financial Management	Do-it-yourself help, home inventory, parenting, landscape design, gardening, home improvement, personal finance, budgeting, tax returns, pet care, cooking
Relationships and Communication	Mapping ancestry, finding old friends and classmates, meeting new friends, dating, wedding planning, crisis support, social media, and a host of Internet communications
Educational	Free online courses, youtube.com/edu, reference, libraries, books, music lessons
Entertainment	Television, movies, music, games, and other digital media
Health & Fitness	Health monitoring, diet, exercise programs, medical information, spiritual practice, psychological analysis, and support
Leisure and Travel	Weather reports, local night life, travel planning, flight reservations

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## Mobile Apps

**Mobile apps** are software that is designed for smart phones and tablets.

### Why This Matters

More and more computing is being done on mobile devices. It is useful to consider what computing activities are appropriate for each device size: PC, tablet, and mobile phone. Also consider apps that can work across devices with slight modifications, and which are best suited for a single size and/or environment.

## Essential Information

Besides voice and text communications, perhaps the most useful software found on mobile devices is personal information management (PIM) software. It is extremely valuable to be able to consult your calendar, to-do lists, and contacts while away from your desk. Besides PIM, the web and web-delivered services such as YouTube, Facebook, and Google Maps have become very popular on mobile devices. The ability to connect to the Internet is what transforms a cell phone into a smart phone. Social media apps are perhaps the most popular mobile apps.

Geographically sensitive applications are popular on smart phones due to their mobile nature and GPS capabilities. The ability to track yourself on a map and easily find businesses and friends near your location is a great convenience, though some worry that this capability could lead to privacy issues. Mobile games and movies are popular on smart phones, since they provide an enjoyable way to pass the time when held up in traffic, in flight, in a waiting room, or in between meetings.

The success of Apple's iPad — the first tablet to capture public interest — was partially due to the success of apps on the iPhone. iPhone users became enamored with mobile apps, and the iPad allowed some apps to be enjoyed even more on its larger display. Now there are many brands of smart phones and tablets, along with apps that are well-suited to each platform. Games, movies, and media are well-suited to tablets, which combine a relatively generous screen size with the touch and motion technologies. Tablets are also convenient for basic computing functionality, such as taking notes in meetings and interacting with productivity apps and web apps. Tablet covers with built-in keyboards provide tablets with near-notebook-like capabilities, utilizing the touch screen to select items rather than a mouse or touch pad.

Today, nearly any type of application that is available for PCs is also available for mobile devices. Microsoft Office applications are available on several mobile platforms. The Apple App store, Google Play, and Windows Phone Marketplace offer hundreds of thousands of apps in dozens of categories.

## Managing Software

**Managing software** refers to activities required to acquire, install, maintain, and remove software from a computer system.

### Why This Matters

Computers and mobile devices are only as useful as the software that runs on them. In order to maximize the benefits of owning a mobile phone, tablet, or PC, users should research software that will be most useful to their lifestyle, interests, and activities. Selecting and managing software is one of the most important responsibilities of a computer user.

## Essential Information

Although computers and mobile devices typically come with many software applications (or apps) preinstalled, most users find it beneficial to add software selected to meet their individual needs. Smart users spend considerable time and effort seeking out new and useful software for use on both computers and mobile devices. The process typically entails reading reviews, consulting with friends, finding the source where software is available, downloading the software, and installing it. Once installed, the software must be maintained and eventually uninstalled when it is no longer useful. This section discusses all of these software management activities.

## Managing Software Topics

- Acquiring Software
- Software Licensing
- Installing Software
- Maintaining Software
- Uninstalling Software

## Acquiring Software

**Acquiring software** refers to the several methods by which software can be purchased or accessed, including packaged software, downloaded software, cloud apps, and custom designed software.

## Why This Matters

The manner in which software is acquired has changed over the years. At one time, it was delivered on floppy disks; then, as software required more storage space, it was made available on CDs and DVDs. Today, new software is often downloaded from an online app store or market. Increasingly, software is run on web servers and accessed through a web browser. It is useful to consider the many ways in which software is made available for business and personal use.

## Essential Information

Today's PC users typically use both installed software and apps accessed on the web. They might use Microsoft Office applications installed on their computers, as well as Gmail, Facebook, Google Docs, and YouTube on the web. Apps accessed on the web are called cloud apps because they run on web servers that exist on the Internet or in the cloud. The data files created in cloud apps are typically stored in the cloud as well. Businesses are increasingly turning to cloud apps for enterprise applications like Customer Relationship Management and Supply Chain Management. Cloud apps are convenient because they require no installation or maintenance, they are accessible from any Internet-connected device, and data is

easily shared among users. Even Microsoft Office has transitioned to the cloud, with Office 365. Office 365 charges users a yearly subscription fee and automatically updates Office on the user's PC while storing data files in the cloud and providing access to web versions of Office apps. The downside of cloud apps is that you must be connected to the Internet to use them.

While most apps may soon become cloud apps, many of today's most popular and powerful apps require installation on your computer or mobile device. Installing software on computers allows the software to take advantage of specific hardware features. For example, software installed on mobile devices can take advantage of hardware features such as GPS and accelerometers. Traditionally, installed software was purchased in stores or ordered online, arriving in a box with installation disks and manuals. Placing the CD in your PC would begin the installation process. Although software is still sold in this fashion, it has become more common to download software from the software vendor, a retail outlet, or an app store.

Apple was the first to offer an app store dedicated to distributing apps for a specific platform. At first it was for the iPhone, and then it extended to the iPad. Finally, Apple created an app store for its Mac software. Google followed Apple's example with its Android Market, which later became Google Play. Microsoft joined in with the Windows Phone Marketplace and later with the Windows Store. Since Google Android is an open platform, Amazon was able to set up its own App store for Android. App stores and marketplaces are convenient for users. They also provide control of app availability to the manufacturer who typically takes a percentage of each sale and controls which apps are available.

Sometimes a business has unique needs that can't be addressed by cloud apps, packaged software, or downloaded software. In such cases, a business might create its own custom-designed software by hiring programmers or outsourcing the work to a software development company. Software has become central to business effectiveness, and often gives a company a competitive advantage. Because of this, businesses invest heavily in software development and information management systems and guard such systems as trade secrets.

## **Software Licensing**

**Software licensing** defines the permissions, rights, and restrictions assigned to the person who purchases a copy of software.

### **Why This Matters**

A license is the primary tool used to protect intellectual property. Individuals and companies that create software can support themselves as businesses by setting a price for the use of their software by individuals and groups. A software license allows the owners of the software (their intellectual property) —to define legal use of the software and exercise legal authority over its distribution and use. Software

may be protected by a traditional license, may incorporate a more liberal license policy like Creative Commons or the General Public License (GPL), or may be freeware.

### Essential Information

A *copyright* defines exclusive rights legally granted to the owner. A software license defines the permissions, rights, and restrictions provided to the person who purchases a copy of the software. The two are legally tied together in that the copyright certifies certain rights to the owner, and the license informs the buyer of what he or she can legally do with the software according to the copyright.

A software license typically addresses questions such as how many users can access the software, and how many computers the software can be installed on. Software licenses are typically written to protect and favor the software company. Penalties and fines for violating the terms of a software license can be severe. U.S. copyright law allows for penalties of up to \$150,000 per infringed software title.

**Table: Software Licenses**

License	Description
Single-user license	Permits the user to install the software on one or sometimes two computers used by one person—typical for software on PCs
Multiuser license	Specifies the number of users allowed to install the software on their computers
Concurrent user license	Designed for network-distributed software; specifies the number of users that can use it concurrently (at the same time)
Site license	Permits the software to be used anywhere and by everyone on a particular site, such as a college campus

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- **No Derivative Works:** You let others copy, distribute, display, and perform only verbatim copies of your work, not derivative works based upon it.
- **Non-Commercial:** You let others copy, distribute, display, and perform your work—and derivative works based upon it—but for non-commercial purposes only.

*Freeware* is software that is made available to the public for free. Some examples of freeware include the Thunderbird e-mail client, Pidgin instant messaging software, Adobe Reader, AVG antivirus software, all web browser software, and OpenOffice productivity software. Also, many popular web applications are provided free of charge, like Facebook, Picasa, and Google Docs. There are several reasons software developers might give away their product. Some wish to build customer interest and name recognition, and some make money from sponsors that advertise within the software. Freeware may use a software license to impose some restrictions on the use of the software.

Freeware differs slightly from a classification of software known as free software. Freeware simply implies that the software is distributed for free. Freeware typically is proprietary software that cannot be altered. The term *free software* was coined by Richard Stallman and the Free Software Foundation, and implies that the software is not only freeware, but it is also open-source.

*Open-source software* is distributed, typically for free and with the source code so that it can be studied, changed, and improved by its users. Open-source software evolves from the combined contributions of its users. Linux, the most well-known open-source software, is an operating system based on the original GNU operating system. Businesses and governments have been attracted to open-source software because it gives them more control over the software. Open-source software can be altered to meet a business's particular needs.

Open-source software is not completely devoid of restrictions. Much of the popular open-source software in use today is protected by the *GNU General Public License (GPL)*. The GPL grants users the right to run the program for any purpose, study how the program works and adapt it to their needs, redistribute copies, improve the program, and release improvements to the public.

## Installing Software

**Installing software** is the process by which software is added to a computer so that it is available for use.

### Why This Matters

Installing software on PCs, tablets, and smart phones is a common activity for computer users. Installing software allows computers to be customized to meet the user's needs. All computer users should be familiar with the process.

### Essential Information

Much of today's software is able to run in a web browser. This includes software like Facebook, Gmail, Google Calendar, and YouTube. Some software for desktop and notebook computers still comes on a CD or DVD or, more likely, is downloaded as a compressed file from the web. Software for tablets and smart phones is typically installed from an online app store, which automates the installation process to a greater degree. To install new software on a mobile device, you often just agree to the conditions of the license and click an Install button. The app store approach so popular with mobile devices is being adopted for PCs as well. The most recent versions of Mac OS X and iOS allow software to be installed once across all Apple devices owned by the same user. So, if you download the latest version of Angry Birds to your iPhone, it will automatically be available on your iPad and Mac. Google and Microsoft plan to offer similar options.

Installing large applications on a PC can be a little more complicated. The table below shows the steps of a typical PC installation process. Once the software is installed, you will find a launch icon on your desktop, the Start menu, or wherever your particular operating system stores its applications.

**Table: Typical PC Software Installation Steps**

Installation Step	Description
1. Run the installation file	Place the disc that contains the software in the computer's CD/DVD drive, or double-click the installation file that you downloaded. In most cases, the software installation process will start immediately. If not, the instructions that come with the software will lead you through what is needed, depending on your computer and its operating system. Software that is downloaded from the web will include instructions for installation at



	the web site or in an associated README text file.
2. Interact with the installation wizard	Once the installation process has begun, follow the instructions as they appear on the screen. You likely will be given choices during the installation. Most software products have recommended default installation settings. Default settings are those chosen in advance for you as typical settings.
3. Agree to the license terms	You will probably be asked to agree to the terms of the software license. You have no choice if you wish to install the software; you cannot progress without agreeing.
4. Select the install location	You may be asked where on your hard drive you wish to install the software. Unless you have an unusual system, the default choice is best.
5. Choose standard or custom	You may be asked to choose Standard installation or Custom installation. Standard installation installs the most commonly used components of the software, or perhaps all of it. Custom installation allows you to select which components of the software you wish to install.
6. Register and/or activate the software	Once the software is installed, you might have to register or activate the software before it can be used. This is usually done over the Internet.

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## Maintaining Software

**Maintaining software** involves applying software updates to correct software bugs, improve the software, or add new features.

## Why This Matters

To get the most out of your software investment, and to keep your computer safe and secure, it is wise to update both system software and application software as soon as updates are made available. Updates are provided by software companies in order to fix bugs, patch security holes, improve functionality, and add features. Updates to apps on tablets and smart phones are important as well.

## Essential Information

There are a number of reasons why software is updated throughout its lifetime. Software is often complex, involving tens of thousands of lines of code. Developers often discover improvements that can be made after the software is released. Most updates are intended to make software run more effectively or to add new features. Most operating systems, including mobile operating systems like iOS and Android, have built-in notifications for software updates. It's not unusual for smart phone users to approve updates for a few apps each week.

Software patches are intended to secure holes caused by software bugs. *Software bugs* consist of one or more defects that prevent the software from working as intended or working at all. Software bugs are classified as “critical” when they allow hackers to take control of a system. Microsoft issues software patches for Windows on the second Tuesday of each month. Apple releases patches as needed.

Here are some things you can do to overcome pesky software bugs:

- Be careful when buying or acquiring the latest software. Some people prefer to get software that is a year old or older to make sure that most errors have been found and fixed.
- After you install the software, check any README files or documentation that may be included with the software. These files often contain last-minute updates or disclosures, including bugs and how to deal with them.
- Register the software with the software company. Software companies will often alert you if there is a problem or bug and give you steps to follow to eliminate it.
- Check the web site of the software vendor often. There can be updates that eliminate any known bugs. In addition, vendors often list bugs that have been found and offer patches or fixes that can be downloaded over the Internet.
- Many software applications offer an option to manually or automatically check for updates over the Internet from within the software. For operating systems, you should select the automatic update feature in order to protect your system from hackers.

- If software is malfunctioning, try running the setup program again. Sometimes it contains a utility to fix software problems. If it doesn't have such an option, you can try uninstalling and reinstalling the software.
- Use search engines to find information on specific software bugs and possible solutions.

If all else fails, carefully document exactly what happened when you found the bug and then contact the software vendor for a solution.

## **Uninstalling Software**

**Uninstalling software** refers to the process of completely removing software from a computer.

### **Why This Matters**

Because installed software maintains a presence in many areas of an operating system, it is important to use proper procedures to remove all of it. Removing software requires a special process that deletes all files and references related to the software. The process varies slightly between computing platforms and mobile platforms.

### **Essential Information**

Operating systems provide a method for safely and completely removing software from the system. In Microsoft Windows, you use the "Uninstall a program" feature in the Control Panel. In Mac OS, you simply drag the program icon from the Applications window to the Trash. On iPhones and iPads, you press and hold the program icon, and then click the (X). On Android devices, you go to the uninstall menu and select the app you wish to remove.

On desktop and notebook PCs, even the proper procedure sometimes does not uninstall the software correctly, which creates system problems. This is especially a problem for Windows users and is addressed by a number of system utilities. For example, Norton SystemWorks and McAfee Registry Power Cleaner help eliminate unwanted elements of software you have removed to help your system run smoothly.

## Digital Life

**Digital life** refers to the influence of digital technologies on the manner in which people live their lives.

### Why This Matters

The digitization of just about everything, from arts to information to communication, has had a dramatic impact on life. Pervasive networks—especially cellular and other wireless networks—allow people to access all kinds of information, services, and entertainment, and to communicate with friends and colleagues, anywhere and anytime. Ready access to so many resources has caused many to plunge into a digital lifestyle where more time is spent online than off. This major shift in behavior has had a profound impact on the productivity of individuals and organizations, as well as on our mental and physical states. It is wise to consider all the implications of our digital lifestyle in order to make informed decisions on how best to incorporate digital technology in our lives.

### Consider This

Google has developed Glass, Internet-connected, augmented reality glasses. Glass is a pair of lens-free glasses that hold a small transparent display that sits just above one eye. The lens is used to overlay the user's surroundings with useful information such as maps, turn-by-turn navigation, and text messages, and you can bet it will eventually include ads. The augmented reality glasses are controlled using voice commands. Augmented reality glasses, called "heads-up displays," have been used by fighter pilots to provide pertinent information during flights and battles. Analysts have expected this technology to make its way to the consumer market for years, and now it appears to be knocking at the door. Not only does Google Glass display information, but it can also record information—photos and sounds. Users of Google Glass can collect images of anything they see at any time, with a simple voice command. Other devices, like Memoto, can be clipped onto a shirt to take automatic photos every 30 seconds in a practice known as lifelogging (see video). What types of beneficial apps can you imagine being created for Google Glass? What are the benefits and drawbacks of Google Glass and lifelogging? How will wearable computers move lives into a more digital existence? What, do you imagine, will come next?

### Essential Information

As people spend increasing amounts of time online, changes occur in social structures and mechanisms. These personal and social changes have both benefits and costs. A student benefits from the ability to talk with a friend on a mobile phone at the conclusion of class but may miss out on an opportunity to meet someone sitting in a neighboring seat. Citizens benefit from the use of technologies in law enforcement to create safer living conditions but might pay a price in terms of personal privacy. Big businesses benefit from outsourcing labor at the expense of the

shrinking job market at home. The benefits and costs range in scale from personal to global. Balancing the benefits of digital technologies against the costs, and determining which outweighs the other, is a highly personal and subjective but important activity for individuals and our society.

The digital revolution has left the global population with numerous challenges to address. Most people feel pressure from the growing mountain of information and online relationships to manage. Many are unable to find time away from technology and its demands. New types of etiquette are being defined for acceptable and unacceptable online behavior. New laws are being created, including those that address distracted driving, to keep people safe in our new digital environment. Professionals are learning to collaborate with partners and team members scattered around the globe. We are testing the boundaries of what is required for living a healthy, productive digital lifestyle, with some individuals crossing the line into unhealthy behavior. This section studies all of these digital lifestyle phenomena and more.

### **Digital Life Topics**

- Information Overload
- Ubiquitous Computing
- Etiquette
- Distracted Driving
- Flash Mob
- Repetitive Stress Injury
- Ergonomics
- Computer Addictions

### **Information Overload**

**Information overload** refers to individuals and organizations' inability to cope with the huge and growing amount of information being collected, stored, analyzed, and delivered.

### **Why This Matters**

One of the greatest challenges of the information age is managing the huge and growing amount of data collected from every transaction and activity taking place online. Businesses and governments recognize the importance of gleaning actionable knowledge from collected information and so collect as much data as possible. The problem is, information systems can't keep up with the amount of data being collected and stored. Individuals are struggling as well. As people become increasingly connected, they must maneuver through increasing amounts of information and communications to quickly determine how to make the best use of their time and energy. The most valuable technologies that will be developed in

coming years will be those that are able to store, organize, and quickly extract valuable information from mountains of data.

### **Essential Information**

The digital lifestyle is chock-full of information. The amount of digital information is now measured in zetabytes; that's

1,000,000,000,000,000,000 bytes:

a 1 followed by 21 zeroes! And the amount of digital information is doubling every year. The amount of digital information is surpassing the capacity of storage devices available to store it all. Each person's digital shadow—that is, the digital information generated about a person by businesses and organizations on a daily basis—surpasses the amount of information that an individual person generates in a lifetime. Finding specific information at a specific time among this much data can be like finding a needle in a haystack.

IDC—a provider of market intelligence for the information technology, telecommunications, and consumer technology markets—warns that unless businesses implement enterprise-wide data storage and management procedures and policies, the amount of information will outpace our ability to manage it.

Information overload is impacting individuals as well. One example is email. The average professional spends roughly 28% of their week managing email. The average CEO gets 200 to 300 emails per day! Email has become such a distraction that some businesses are banning email and replacing it with social-media style systems. .

Finding information online can be challenging. A Google search yields thousands of results. Hopefully the user is able to find useful resources on the first couple pages of those results. Many of us have to keep track of numerous sources of communication; email, text messages, Facebook and Twitter posts, and others compete for our attention throughout the day.

The next generation of web technologies is confronting information overload by applying artificial intelligence and better organized data to get users the information they need more quickly and with less effort. Technologies like Google Now for Android and iPhone study a user's behaviors and then offer useful information before it is even requested. For example, if Google Now knows a user has purchased airline tickets online, it can report flight delays on the day of travel. It will also provide information about weather at your destination. When driving home from the airport, Google Now will automatically guide the user along the least congested route.

## Ubiquitous Computing

**Ubiquitous computing** refers to a culture where digital technologies are embedded in the environment, making interaction with the technologies second nature.

### Why This Matters

Digital information and services are essential commodities in today's world. The goal of those that provide such commodities is to make them available to customers anywhere, anytime, with maximum convenience. Digital services of all kinds delivered by numerous Internet-connected devices are increasingly becoming part of our environment. For example, QR codes such as the one in the photo are embedded in billboards, business logos, and products. People snap photos of the codes with their smart phones to quickly access the website of the code's owner. It is useful to consider how the ways in which we access computing and communication resources have changed over time, and where these changes are leading us.

### Essential Information

*Pervasive computing* refers to the ability to access computing and information technologies at any time, in any place. Ubiquitous computing goes beyond pervasive computing to the point where computing is a part of the environment. Ubiquitous computing has ushered in the age of “calm technology”—technology that is so much a part of existence that it is no longer even noticed. Just as we can stroll a city street without consciously noticing the dozens of signs and billboards that our eyes are automatically taking in, in the age of ubiquitous computing we take for granted the digital technology that surrounds us.

For many people, computing and digital communications have become pervasive. Mobile phones put us in near continuous contact with colleagues, family, and friends as well as give us instant access to information on the web. Mcommerce enables mobile phones to be used to purchase merchandise and services online as well as in person.

Public and private kiosks provide special services to pedestrians and customers from embedded computer terminals. Radio frequency ID (RFID) chips are embedded in products and everyday objects, giving them the ability to connect to networks and other devices to provide information and services. For example, parking spaces in San Francisco have the ability to announce their availability to cars trolling in the area. While an average person in the developed world owns two or three Internet-connected devices, by 2015, that number is expected to increase to seven as more household devices go online. Equipping physical objects with networking capabilities and connecting them via the Internet is referred to as the “Internet of Things.” By the end of the decade it is anticipated that there will be 50 billion devices connected through the Internet of Things.

Perhaps the greatest challenge of calm technology is managing information to provide the services people need at any given instant or in any situation. In this way, ubiquitous computing is intimately connected to the semantic web that promises to anticipate a person's needs and to offer the needed information just as the person realizes the need.

## Etiquette

**Etiquette** refers to using digital technologies in a manner that is respectful to others.

### Why This Matters

People are spending more time interacting with each other through digital technologies. These new forms of remote communication bring with them new opportunities for misunderstanding, rudeness, and hurt feelings. It is important for people to consider which types of communication over digital devices are acceptable, and which are not, and to learn to treat each other with respect online.

### Essential Information

The concept of digital etiquette first arose around issues in email and chat rooms. Email users are well aware of misunderstandings that can arise from poorly worded email messages. Users of chat rooms, online discussion groups, and other forms of Internet communication have experienced rude behavior from anonymous sources wishing to stir up trouble. With experience, users learn how to carefully word text messages to avoid misunderstandings, and to go out of their way to be courteous and respectful to others online while ignoring those with no manners. This type of network etiquette is often referred to as *netiquette*.

As with all forms of etiquette, levels of tolerance vary from person to person. In general, consideration should be shown to those with whom we interact and those around us.

The use of mobile phones in public places sometimes offends traditional notions of courtesy and etiquette. Cell phone users should be mindful not to inconvenience or disturb those around them. They should also remember not to make important calls over unreliable connections.

Netiquette has extended to social media as well. Many users of Facebook and other social media have experienced or witnessed embarrassing interactions. The table below provides some useful tips for safely navigating relationships on social media.



**Table: Social Media Etiquette and Safety**

Topic	Tip
Friends	Select friends wisely. Make sure your posts are mindful of who is in your collection of friends. It may be unwise to mix your friends with your business associates and superiors.
Sharing	Be conservative on the number of posts and the topics you post on. If you post frequently and on issues of little interest, your friends may soon tune you out or block you. Do not argue with friends in a public forum; save it for private communication when necessary.
Photos	Use discretion with the photos you share. Make sure they show you and others in the photo in a positive light.
Consideration	Do nothing to embarrass your friends on the network. Many friendships have been ruined due to poor judgment in photos and posts.
Chat	Just because friends are online doesn't mean they are interested in chatting. Don't infringe on your friends' time and privacy with trivial chat.
Tag lightly	Don't tag your friends in photos unless you are certain they won't mind.
Settings	Make sure to go through every privacy and security setting on your social network and share your content only with those you are comfortable sharing with.
Games & Apps	Think twice before allowing games and apps to share info with your friends. Many users don't appreciate friends that use their relationship for app ads. Also be mindful that most apps can access your personal profile information and that of your friends.

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## Distracted Driving

**Distracted driving** occurs when drivers focus on their cell phones or other distractions rather than on the road.

### Why This Matters

Digital life and ubiquitous computing and communications mean that people are spending increasing amounts of time online. While anywhere-anytime text messaging, mobile web browsing, and phone conversations provide substantial conveniences and an increase in productivity, they also pose some risks. The largest risk occurs when attempting to operate heavy machinery while engaged online.

Many governments have passed laws prohibiting people from driving while using digital devices.

### **Essential Information**

Around the world, law enforcement agencies are finding increases in cell phone related automobile accidents. Many of these accidents are the result of texting while driving. Dialing a mobile phone while driving is dangerous enough, but typing or reading text messages takes drivers' eyes off the road for several seconds at a time. At 30 to 60 miles per hours, a six-second lag in attention can take a vehicle one-tenth of a mile, providing many opportunities for accidents.

Some governments have passed laws banning the use of cell phones while driving. In the U.S., more than 30 states have laws against text messaging while driving. Some states, like California, New Jersey, and Oregon, ban the use of any handheld device while driving. Other states, like Alaska, New Hampshire, and Wyoming, ban text messaging. Still others ban cell phone use only for novice drivers and/or school bus drivers. The U.S. federal government has banned cell phone use while driving for all military personnel. The U.S. Department of Transportation has banned texting while driving for all U.S. commercial truck drivers.

Statistics show that distracted driving due to cell phone use is as dangerous as drinking while driving. Despite anti-texting efforts and distracted driving laws, texting while driving increased 50 percent in 2011. Research shows that a texting driver is 23 times more likely to get into a crash than a non-texting driver. While laws may vary, drivers are wise to pull off the road to use their cell phones.

### **Flash Mob**

A **flash mob** is a group of people who utilize digital technologies to assemble suddenly in a public place, do something unusual, and then disperse, in order to gain attention or to create confusion and sometimes amusement.

### **Why This Matters**

The ability to communicate with others from anywhere at any time makes it possible to assemble people very quickly. This capability has been useful to those wishing to organize a group around an issue. In some cases, protests have been organized in a matter of minutes. In the case of flash mobs, individuals are typically called together as a practical joke or to have fun. Sometimes flash mobs have been used to make a public statement. Whatever the case, flash mobs are a good example of the capability of technology to empower individuals to combine their efforts with dramatic effects.

## **Essential Information**

On June 3, 2003, the first recorded flash mob occurred when more than 100 people converged upon the ninth floor of Macy's New York City department store and gathered around a very expensive rug. When asked by sales assistants what they were doing, each individual answered that they lived together in a warehouse on the outskirts of town and were shopping for a rug. The group dispersed as quickly as it had arrived. Later, more than 200 people flooded the lobby of the Grand Hyatt New York, applauded for 15 seconds, and then disappeared. In both cases, most of the participants had never even met. These episodes marked the beginning of a new fad called flash mobs.

Flash mobs organize through mobile phone text messaging and email. Participants are given precise instructions on where to meet, how to act, and what to say if questioned. Since 2003 many flash mobs have appeared around the world, confused the general public, and then disappeared. Flash mobs serve as an interesting example of the impact of digital technologies on the concept of community.

Correspondence between friends and acquaintances increasingly takes place electronically through text messaging, cell phones, email, and other Internet communications. Many of today's relationships are maintained more through electronic than face-to-face communications.

Virtual communities and "anywhere-anytime" communications are also affecting traditional social mechanisms. The cell phone generation is less concerned with making formal social plans and tends to be more spontaneous than previous generations. Meeting times and locations can change en route. The days of being stranded or stood up due to miscommunication are all but over: Just pick up your phone and get an update.

## **Repetitive Stress Injury (RSI)**

**Repetitive stress injury (RSI)** occurs when a particular physical motion is repeated frequently, to the point of injury.

### **Why This Matters**

One downside of leading a digital life is the amount of time physically spent on digital devices. While engaged and interacting online, portions of the body are sometimes placed in awkward positions for extended periods of time, which can lead to repetitive stress injuries. For example, your wrists can suffer when you type on a keyboard, your thumbs when you text message, and your eyes and neck as you focus on a display. Being aware of common ailments and how to minimize them can help users avoid RSI.

### Essential Information

Working and living with computers and digital technologies can lead to potential health problems. As people increasingly use computers at work and at home, more people are suffering from computer-related health problems. Along with increases in computer use, insurance claims relating to repetitive stress injury have increased greatly in recent years. RSI is an injury, such as tendinitis and tennis elbow, caused by a repetitive motion. The most common RSI for computer users is carpal tunnel syndrome. *Carpal tunnel syndrome* (CTS) is the aggravation of the pathway for nerves that travel through the wrist (the carpal tunnel), typically caused by long hours at the computer keyboard with wrists cocked and fingers typing. CTS can cause wrist pain, a feeling of tingling and numbness, and difficulty in grasping and holding objects. CTS can be difficult to correct. Use of a wrist brace is typically prescribed, and sometimes surgery is needed.

Staring at a computer screen without proper light for many hours can cause a variety of vision problems. In some cases, your eyes get tired, itch, or even burn. In more severe cases, double or blurred vision can result, making it unpleasant to work and reducing your efficiency. In addition to wrists and eyes, you can get a sore back, sore arms, and headaches from long hours working with computer systems without taking adequate breaks. The solution to avoiding repetitive stress injury is to carefully gauge the amount of time spent carrying out repetitive motions, take frequent short breaks or change positions, and practice ergonomic methods for reducing strain on the body (see video).

### Ergonomics

**Ergonomics** is the study of designing the work environment and positioning computer equipment in a healthy manner.

#### Why This Matters

Knowing how to address the strains and stresses on your body from using digital technologies will help you to lead a healthier digital lifestyle. Ergonomics studies all possible ill effects of digital technologies on your body and recommends ways to avoid them.

### Essential Information

There are many ergonomic approaches to reducing computer-related health problems. The slope of the keyboard, the position and design of displays, and the placement and design of computer tables and chairs have been carefully studied. Flexibility is a major component of ergonomics and an important feature of computer devices. People of different sizes and tastes require different positioning of equipment for best results. For example, some people want to have the keyboard in their laps; others prefer to place the keyboard on a solid table. Because of these

individual differences, computer designers are attempting to develop systems that provide a great deal of flexibility.

Notebook computers, mobile phones, and other mobile devices have their own ergonomic issues. Ergonomic experts assist in designing user interfaces as well as input/output devices so that mobile computing does not lead to repetitive stress injuries.

## **Computer Addictions**

**Computer addictions** refer to the compulsive use of digital technologies such as the Internet, video games, online gambling, and pornography.

### **Why This Matters**

Too much of any activity can lead to an unbalanced life and, sometimes, to a lack of control over your own actions. To some people, the rich virtual environment of the Internet and its many applications is preferable to their own lives and physical environments. Some become obsessive and spend increasing amounts of time engaged in online activity. When a person is unable to control an impulse to engage in some activity, that person is addicted. Addictions may require psychological treatment to cure.

### **Essential Information**

The use of the Internet can be addictive. Some people spend most of their time connected to the Internet and staring at the computer screen. When this behavior becomes compulsive, it can interfere with normal daily activities, including work and relationships. Often, Internet addiction means that a person is isolated and doesn't interact with other people, unless they are also online. Internet addiction may exist if people are online for long periods of time, cannot control their online usage, jeopardize their career or family life as a result of excessive Internet usage, and lie to family, friends, and coworkers about their Internet usage. Scientists studying Internet addiction categorize several types: pornography, gambling, online multiplayer gaming, e-shopping, and social networking addictions.

The abundance of free pornography on the web has caused some individuals to become addicted. It has been estimated that 12% of Internet content is pornography. Viewing and sharing pornography in large quantities can alter an individual's perception of what is socially acceptable and normal. Also, in efforts to supply increasingly outlandish pornography, some have crossed the line into unhealthy and illegal practices. Many individuals from a variety of backgrounds have sought professional help in dealing with Internet-based pornography and sexual addictions.

Compulsive gambling is a problem for some people using the Internet. Compulsive gamblers find using the Internet much easier than driving to a gambling casino. Internet gambling is becoming legal in some states in the U.S. and has been legal in other countries for quite some time. Online gambling has grown into a \$12 billion industry, one of the biggest businesses on the Internet. In 2006, President Bush signed the Unlawful Internet Gambling Enforcement Act, which makes it illegal for U.S. citizens to gamble on the Internet, no matter where the online casino is located. In 2011, President Obama signed an opinion stating that the Unlawful Internet Gambling Enforcement Act only applies to bets on sporting events. Since then several states have drafted legislation to allow online gambling.

Other Internet users become addicted to massively multiplayer online role-playing games (MMORPGs). Some gamers find the virtual worlds of online games more interesting and rewarding than real life and spend increasing amounts of time in virtual worlds. Others are addicted to online shopping and online social media. Although these activities are not unhealthy in reasonable quantities, spending more time online than offline can become problematic.

Many feel that the best way to avoid or recover from any computer-related health issue—physical or mental—is to live a balanced life. A balanced life includes technology time and time away from technology; time alone and time spent in the company of others; time on the phone and time in face-to-face interaction; time indoors and time with nature. Some psychologists feel that many young people suffer from nature deficit disorder. They believe that people tend to stay healthier when they stay in touch with nature. The more balance you have in your life, the more balanced your mental and physical health and development will be. If you feel that you suffer from any of the above mentioned health problems, you should seek help from a physician or counselor as soon as possible before the condition worsens.

## Internet

The **Internet** is the world's largest public computer network, a network of networks that provides a vast array of services to individuals, businesses, and organizations around the world.

### Why This Matters

The Internet provides a platform for billions of people to share knowledge and views. If two heads are better than one, billions of heads sharing knowledge and perceptions are powerful indeed! The Internet brings the power of global community to computing.

### Consider This

The Internet is becoming everyone's computer. Increasingly, data and software are migrating from individual PCs to huge online data centers. People are becoming increasingly dependent on Internet connections to maintain relationships and for success in their careers. People interact with their social networks, email, games, calendars, music, videos, and a wide assortment of apps on PCs, tablets, and smart phones, many times a day from wherever they may be. Cloud services from Google, Amazon, Apple, and Microsoft allow individuals to store music, media, and data in the cloud to access with all of their Internet-connected devices.

Businesses are also shifting more and more services to the cloud. Cisco predicts that cloud traffic will grow four-fold by 2016, when it will reach 6.6 zettabytes a year. Cellular companies are investing heavily to roll out faster and more robust data networks to meet the skyrocketing demand for mobile data access. Global mobile data traffic grew 70 percent in 2012 and is projected to surpass 10 exabytes per month in 2017. Whoever owns the "pipes" over which the data flows will likely end up being the wealthiest of companies. Google and Microsoft continue to improve search engines in hopes of providing direct answers to user queries rather than long lists of links to possibly related webpages. All of these efforts will soon result in having answers to every question at our fingertips, and an increasingly heavy reliance on the Internet for information and services. How will this rapidly approaching reality impact your future career? Will your career involve providing services online? How will you use your insight about an online lifestyle to provide value to your industry?

### Essential Information

People are using the Internet to communicate, share, learn, entertain, enhance productivity, and make new friends. Professionals use the Internet to collaborate on projects. Businesses invest in the Internet to leverage competitive advantage. Products are marketed and sold, and creative works are published and distributed over the Internet. The Internet has become an essential part of daily life for many of us.

Internet technologies support many applications and services, such as the web, email, instant messaging, social media, Google Docs and Microsoft Office Web Apps, streaming music and video, and Bing Maps, to name a few. Software and storage are increasingly moving from PCs to the cloud, an expression that refers to Internet-accessed servers.

Today's Internet joins together networks of hundreds of millions of computers, called Internet hosts. *Internet hosts* are servers that provide information and services to Internet users. There are more than 2.4 billion Internet users today. Internet use has grown exponentially since the early 1990s and continues to grow.

### **Ethical Dilemmas**

The Internet touches all of our lives and provides power to governments, businesses, and individuals of all political and philosophical persuasions. Such a powerful tool is bound to have significant ethical dilemmas, and indeed the Internet does. The Internet has become a favorite resource for criminals, radicals, and terrorists. It provides a global audience for lessons in hate along with a treasure trove of victims. Some governments attempt to censor Internet content and may stifle freedom of speech. Google maintains a list of countries that request to have search results censored. The list contains some countries that are well known for censorship and many others that pride themselves on their respect for civil rights.

The Internet is used by some to illegally distribute copyrighted materials like music, movies, and books. The recording and motion picture industries continuously work to pass legislation to stop illegal file sharing. Bills such as the Stop Online Piracy Act (SOPA) have failed because, so far, the courts have favored Internet user privacy over Internet Service Provider snooping. Courts are also battling businesses that wish to collect as much user information as possible in order to target consumers. Google has rolled all of its privacy policies into one in order to combine all of the data it collects about users over its dozens of applications. Governments and privacy advocates around the world are working to limit Google's data collection. Google sees its data collection as a way to provide users with better services and raise its profit margins from advertising. The Internet provides new challenges in ethics, mostly concerning freedom of speech, privacy, and intellectual property rights. What types of speech and expression do you feel should be censored? Where should the line be drawn about what information Internet companies are allowed to collect about visitors? How can intellectual property be protected in the digital age?

### **Internet Topics**

- Internet Technologies
- Web Technologies
- Cloud Computing
- Web Resources



## Internet Technologies

Many different **Internet technologies** work together to provide information and services over the Internet, including a variety of protocols, hardware, and software.

### Why This Matters

Understanding fundamental Internet technologies enables users to get more value out of their Internet use and to make intelligent decisions regarding purchases and social issues such as privacy and freedom of speech. Depending on the service and service provider, an Internet connection might be blazing fast or snail-like slow, filtered or unfiltered, limited or unlimited. It is important to understand the underlying technologies of the Internet in order to make informed decisions about your Internet use and improve your user experience.

### Essential Information

The Internet is a global, public network of computer networks. A computer network is a collection of computing devices connected together to share resources such as files, software, processors, storage, and printers. There are millions of privately owned networks around the world. Joining networks together into larger networks so that users on different networks can communicate creates an *internetwork*.

The combination of protocols, hardware, and software is what makes up the Internet. Protocols allow different types of networks to communicate. Hardware such as cables, satellites, and routers transfer the packets of data that travel over the Internet, such as email, webpages, photos, music, video, and more. Software transforms data into a form that can travel over the Internet and guides it to its destination. This section discusses the most important of those technologies.

### Internet Technologies Topics

- Internet History
- Internet Backbone
- TCP/IP
- Internet Service Provider (ISP)
- Client/Server
- Peer-to-Peer (P2P)
- Router
- Domain Name System (DNS)
- Port
- Voice over IP (VoIP)
- Internet2

## Internet History

**Internet history** is relatively short, dating back only to around 1970. In that time, the Internet has had as great an impact as any invention, and its story has only just begun.

### Why This Matters

Understanding the origin of the Internet, and its growth from 13 connected computers to nearly a billion, helps to put into perspective the huge impact it has had on civilization. In the same way that the printing press improved communication and the Industrial Revolution improved productivity, the Internet has improved both communication and productivity, making it perhaps the most singularly important invention ever.

### Essential Information

In 1957, most computing was done on large mainframe computers accessed from within an organization through a network of terminals. Government agencies, universities, businesses, and other large organizations used this type of networking environment. In that same year, the U.S.S.R. surprised the world by launching Sputnik, the first artificial earth satellite. The United States viewed the launch as a challenge. The following year, President Eisenhower reacted by forming two government agencies under the Department of Defense (DOD) to advance space technologies, weapons, and, communication systems: the Advanced Research Projects Agency (ARPA) and the National Aeronautics and Space Administration (NASA). Many amazing achievements were to come from these organizations, but among those that had the most social impact were placing the first man on the moon and the Internet.

In 1969, ARPA commissioned ARPANET for research into networking. Its initial goal was to establish closer communications for research by connecting the computer networks of four research institutions: the University of California at Los Angeles, Stanford University, the University of California at Santa Barbara, and the University of Utah. The growth of the Internet has been exponential, increasing from 13 hosts in 1970 to roughly 1000 hosts in 1980, to 313,000 in 1990, to one hundred million in 2000, and to nearly a billion since. The World Wide Web, introduced in the early 1990s, provided a graphical user interface to the Internet that launched the digital information revolution.

With the birth of the web, the Internet exploded, with a 341,634% annual growth rate in Internet hosts. Internet service providers sprouted up all over the world. With consumers flocking to the web, businesses found a powerful new marketing and sales tool. The Internet's focus expanded from supporting primarily academic and government interests to supporting public and commercial interests. Today, roughly a third of the world's population has Internet access. Among those who are not connected are populations that cannot afford computers and connections. This

important social issue is referred to as the digital divide. There are also cultures and individuals who resist technology because of personal or religious philosophies.

In around 2003 and 2004 new web technologies and services emerged that created a paradigm shift on the web, and Web 2.0 was born. Web 1.0 was the “one-way” web, with information traveling in one direction from servers to consumers. Web 2.0 is the participatory web, where users are contributors as well as consumers.

Web 2.0 was inspired by the growing popularity of blogs. Through blogs, the web community discovered that the web was not just something to observe, but something in which to participate. Wikipedia fueled the Web 2.0 trend, and social networks like Facebook and Twitter lit it on fire.

There are many features and technologies associated with Web 2.0, and experts often disagree on which are the most defining. It is generally agreed that Web 2.0 is defined by social applications like social networking sites, blogs, and micro-blogs, media-sharing sites, wikis, and social bookmarking sites. These types of websites are referred to as social media.

Technologists generally define Web 2.0 by the technologies that support it. Technologies like Ajax, Adobe Flex, and Microsoft Silverlight allow web developers to develop high-quality applications that are delivered through the web browser. Rich Internet applications like Google Docs, Microsoft Office Web Apps, Acrobat.com, Photoshop Express Editor, eyeOS, and Hulu allow the web browser to act like an independent computing platform. These new web development technologies have transformed the web into a much more valuable resource, providing new applications and platforms for social interaction.

## Internet Backbone

The **Internet backbone** refers to the main Internet pathways and connections, made up of the many national and international communication networks that are owned by major telecom companies such as Verizon, AT&T, and Sprint—the same companies and networks that provide telephone service.

### Why This Matters

The Internet backbone consists of mostly fiber-optic cables that span the globe over land and undersea to provide connections between individuals, companies, organizations, and governments. Businesses and the global economy depend on the proper functioning of the Internet backbone.

### Essential Information

In the early days of the Internet, the major telecommunications (telecom) companies around the world agreed to connect their networks so that users on all the networks could share information over the Internet. The cables, switching

stations, communication towers, and satellites that make up these networks are the hardware over which Internet traffic flows. These large telecom companies are called *network service providers (NSPs)*. Examples include Verizon, Sprint, British Telecom, and AT&T. The combined backbones of these and other NSPs make up the Internet backbone.

NSPs enable Internet users to connect to their networks through utility stations called *points of presence (POPs)*. The POPs act as the hubs, and the connections they provide are the spokes connecting to users around the world. The POPs are connected to each other by the Internet backbone. Individuals, companies, and service providers, such as Comcast, connect to the Internet backbone through POPs. Large telecom companies, such as AT&T and Verizon, have tens of thousands of POPs throughout North America, Europe, and the Pacific Rim that incorporate millions of user connections.

Recently, the Internet backbone has become the target of cybercriminals. Hackers have moved beyond software attacks to literally hacking at fiber-optic cables under the sea. Three scuba divers were caught by Egypt's naval forces while trying to cut an undersea Internet cable in the Mediterranean. When undersea fiber-optic cables are cut, intentionally or by a prop accident, the Internet can become slow or inaccessible in regions of the world.

## **TCP/IP**

The protocols on which the Internet is based are the Transmission Control Protocol (TCP) and Internet Protocol (IP); together referred to as **TCP/IP**.

### **Why This Matters**

It could be argued that TCP/IP is the defining component of the Internet. Although Internet hardware and software are the most visible components, TCP/IP works behind the scenes to allow many different types of networks and devices to join together in an immense global network. TCP/IP is the protocol (actually a family of protocols) that defines how information travels across the Internet.

### **Essential Information**

Data is transported over the Internet in packets. A data *packet* is a small group of bytes that includes the data being sent and a header containing information about the data, such as its destination, origin, size, and identification number. The Internet is a *packet-switching network* ([see figure]). Internet applications divide up information, such as an email message, into small packets to make efficient use of the network. Upon arriving at their destination, the packets are reconstructed into the original message.

The Internet Protocol (the “IP” in “TCP/IP”) defines the format and addressing scheme used for the packets. Routers on the Internet use the information in the packet header to direct the packet to its destination. The Transmission Control Protocol (the “TCP” in “TCP/IP”) enables two hosts to establish a connection and exchange streams of data. TCP guarantees delivery of data and also guarantees that packets are delivered in the same order in which they were sent.

The Internet Protocol requires that all devices connected to the Internet have a unique IP address. An *IP address* is a unique 32-bit identifier for Internet users and hosts. Read as decimal numbers, an IP address consists of four numbers (0 to 255) separated by periods, such as 64.233.161.104. IP addresses can be static (permanently assigned to a particular computer) or dynamic (assigned to computers as needed). Computers that provide services, such as *www.yahoo.com*, use static addresses while computers that connect to the Internet are almost always assigned temporary IP addresses for the time that they are connected.

The current 32-bit IP address system (IPv4) can support  $2^{32}$ , or roughly 4.3 billion, addresses. With a population of 2.2 billion people online and growing, and many using more than one Internet-connected device, IP addresses will soon be in short supply. Some computer scientists envision a future where everyday objects are all connected to the Internet. For example, it is not hard to imagine a time in the near future when vehicles and appliances are Internet connected and assigned their own Internet addresses. For these reasons, the Internet Assigned Numbers Authority (IANA) is in the process of moving Internet hosts to a new IP version, IPv6, that utilizes 128 bits to accommodate  $3.403 \times 10^{38}$  addresses—an astronomical number of addresses, sufficient for the foreseeable future.

## Internet Service Provider (ISP)

A company that provides individuals and organizations with access to the Internet is called an **Internet service provider (ISP)**.

### Why This Matters

There are hundreds of ISPs from local to international levels. ISPs work as liaisons between Internet users and the telecommunications companies that own the Internet backbones. ISPs provide a variety of services at varying monthly rates. ISPs control the flow of data packets over the Internet in an attempt to provide consistent service to users.

### Essential Information

ISPs provide Internet access to meet needs ranging from mobile phone connections to corporate connections that support thousands of users. The largest ISP is Comcast Cable, which had a head start with broadband cables running to many U.S. homes. Comcast and other telecom companies are able to provide television

programming, telephone service, and the web, all through a single Internet connection. Other ISPs, listed by size from largest to smallest, include Road Runner, SBC Internet Services, Verizon International, Cox Communications, Qwest Communications, Bell South, and thousands of smaller ISPs.

ISPs charge a monthly fee to Internet users and provide devices, such as modems, by which the user can connect to the Internet. There are a number of methods used to connect to the Internet, as shown in the following table, beginning with the most popular.

**Table: Types of Internet Connections**

Connection Type Approx. Cost and Speed	Description
<i>Cable modem</i> \$50/month, 6 Mbps \$70/month, 50 Mbps \$200/month, 105 Mbps	Cable modem is an always-on connection that uses a cable TV connection to provide high-speed Internet service. A cable TV receiver receives the frequencies reserved for television, and a cable modem receives the frequencies used for Internet. Another box can be added to include phone service. The cable modem connects to a computer using an Ethernet connection and can be connected to several computers using a router or switch. Cable modem network lines are shared by neighbors, so if many neighbors access the Internet simultaneously, they might experience slower throughput.
<i>Cellular data connection</i> \$20/month, 300 MB 300MB per month \$30/month, 3 GB 3GB (4G) \$50/month, 5GB	Cellular data plans charge by the amount of data you download each month rather than the speed of the connection. A 3G data connection provides speeds under 1 megabit per second (Mbps), 1Mbps while 4G provides speeds of up to 12 Mbps. 4G is growing in its availability and is offered in many mid- to large-sized cities. Subscribers use cellular data connections to access the Internet on their mobile phone or through a computer using a laptop connect card.
<i>Digital subscriber line (DSL)</i> \$40/month, 3 Mbps \$65/month, 24 Mbps	DSL is an always-on connection that uses the customer's phone line, but there is no dialing up and users can use the Internet and talk on the phone simultaneously. This service is similar to cable modem, except that the telephone line is split to carry signals to both a DSL modem and the telephone. As with a cable modem, a DSL

	modem is connected to a computer through an Ethernet card or to a router to share the signal among multiple computers. DSL is slower than cable service, but because it is a dedicated line rather than a shared line, users don't compete with their neighbors for bandwidth.
<i>Dial-up</i> \$10/month, 56 Kbps	Dial-up is a low-speed Internet service that utilizes the customer's existing phone line for Internet access. Customers are typically provided with a local or toll-free phone number along with a username and password. The computer's modem dials the number, establishes a connection to the ISP, and logs on. Dial-up connections tie up the phone line and cannot be used simultaneously with voice communications.
<i>Digital satellite service (DSS)</i> \$40/month, 10 Mbps \$100/month, 15 Mbps	DSS is a wireless high-speed Internet service that utilizes a satellite and satellite dish, provided by companies such as HughesNet. It is faster than dial-up service but typically slower than cable modem or DSL. For this reason, it is used primarily in areas where DSL and cable are unavailable. Satellite is the only service with substantial setup and equipment costs. Although DSS offers an always-on connection, users may lose their signal during stormy weather.
<i>Broadband over power line (BPL)</i> [cost/speed data not yet available]	BPL utilizes existing power lines to carry Internet signals. To connect to BPL, users only have to plug a BPL modem into an electrical outlet. BPL currently has limited availability in the U.S. but is gaining traction in other countries. BPL is viewed as a good technology for delivering Internet to remote areas that may not have phone lines or cable TV, but do have electricity. BPL access speeds will likely rival cable and DSL at comparable cost.

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## Client/Server

**Client/server** is a network architecture in which one computer or program (the client) makes a service request from another computer or program (the server), which provides the service.

## Why This Matters

Most Internet services and applications make use of the client/server architecture. Understanding the client/server relationship helps you understand what occurs behind the scenes of your web browser, email, and other Internet applications.

## Essential Information

The Internet is based on client/server relationships. A web browser such as Internet Explorer, for example, is a *client* that requests a webpage from a web server, such as *www.monster.com*. An email program, such as Outlook, Thunderbird, or Eudora, also acts as a client, but which connects to an email server to retrieve email messages.

*Server* computers are typically powerful computers that can accommodate many simultaneous user requests. They run 24 hours a day, seven days a week to provide Internet services and resources such as webpages and email. The service performed by the server is defined by the type of server software it runs. A server running web server software replies to webpage requests and a server running email server software governs the distribution of email to and from the network.

## Peer-to-Peer (P2P)

**Peer-to-peer (P2P)** is a network architecture that does not utilize a central server but facilitates communication directly between clients with computers acting as both client and server.

## Why This Matters

Peer-to-peer networks are useful in situations where information and/or resources are not distributed from a central source, but are shared directly between multiple sources. P2P networks are used primarily for communication as well as file sharing and distribution.

## Essential Information

Participants running software that utilizes the P2P model allow their computers to act as servers. This may mean making resources on their computers available to other participants to access directly. In this relationship, an Internet user's personal computer acts as both server (as other users access files) and client (as the user accesses other's files). The Gnutella file-sharing system, which is at the heart of music-sharing services like the now defunct LimeWire, makes use of P2P networking. BitTorrent media-sharing networks also make use of P2P networking. The original Napster used a client/server system, which left the company liable for illegal file-sharing activities. Since P2P does not use a central server, it is more difficult to hold the software company liable for what users do with the software, although it ultimately didn't save LimeWire from prosecution. It should be noted that while P2P networks have developed a reputation as a technology for the illegal



distribution of copyrighted music and movies, legitimate and legal companies also use the technology. The popular video phone service Skype, for example, utilizes the P2P model of networking.

*BitTorrent* is a type of P2P protocol that speeds up the download process by dividing files into small units and downloading multiple file units simultaneously from different sources. Rather than waiting hours for a multi-gigabyte file to download from one PC's slow Internet connection, BitTorrent can simultaneously download several megabyte-sized file units from multiple PCs. BitTorrent makes up an increasing amount of Internet traffic.

Bluetooth devices also use P2P technology to connect directly through a wireless connection. Rather than personal devices connecting to each other over a Wi-Fi network utilizing a router, Bluetooth devices are able to connect directly to each other to share files and services. For example, in a conference, Bluetooth-enabled notebook computers can be paired to share data. Similarly, a Bluetooth headset pairs with a mobile phone to provide a wireless connection for talking on the phone while it remains in your pocket.

## Router

A **router** is a network device that manages network traffic by evaluating messages and routing them over the fastest path to their destination.

### Why This Matters

Routers are crucial to Internet communications. Email, webpages, chat conversations, Internet TV, and radio content all travel over the Internet in small data packets. Each packet makes its way across the Internet by traveling from router to router, each router examining incoming data packets and intelligently sending them toward their destination.

### Essential Information

The Internet is a *packet-switched network*. Data that travels over the Internet is broken into small data packets to traverse the Internet more efficiently. Each packet includes a header with information about where the packet is going and where it originated, along with other information necessary to transport the packet to its destination and recreate the original document. Data packets travel over the Internet from router to router until reaching their destinations. Each router examines incoming data packet headers to see where the packet is destined and then uses a routing table to determine the best path for the data packet to take to get closer to its destination.

Routers are typically located where one network is joined to another network. An email sent from New York to Los Angeles passes from router to router until it

reaches its destination. The email might pass through as many as 20 routers along the way, but would reach its destination within a fraction of a second.

Packet switching and the use of routers allow the Internet to operate efficiently and effectively. Because there are many different possible routes across the Internet, if a portion of the Internet is disabled, packets can find an alternate route to their destinations.

Although routers play a crucial role on the Internet backbone, they are also used on smaller networks. Routers are used on business and home networks to allow computers on the network to communicate. Many computer users set up their own wireless routers to provide wireless Internet access at home.

## Domain Name System (DNS)

The **Domain Name System (DNS)** maintains a database of all domain names and IP addresses used on the Internet and acts like a phonebook, supplying information to Internet nodes and routers working to get data packets to their destination.

### Why This Matters

The Internet is a vast and complex system with billions of addresses, names, and servers. Keeping track of all the names and numbers is the responsibility of the DNS.

### Essential Information

Because people are more comfortable dealing with names than numbers, IP addresses are assigned associated names called *domain names*. For example, 74.125.224.244 is also known as *www.google.com*. Domain names and IP addresses are managed by the Internet Corporation for Assigned Names and Numbers (ICANN) and can be purchased from accredited registrars. You can visit a registrar such as *www.name.com* to find out if a particular name is available, and for a small yearly fee you can claim an unregistered name. Registering a domain name does not provide you with your own website, only with ownership of the name. Web hosting companies like *www.dreamhost.com* provide server space on which to store a website. Once a website is hosted, the name server of the hosting company can be used to associate the domain name with the actual site. To bypass this complexity, it is advised that one company be used as both the domain name registrar and the website host.

The Internet uses the DNS to translate domain names into IP addresses. A database of addresses and names is stored on DNS servers. Internet services such as email and the web access DNS servers to translate domain names to numeric IP addresses.

Thirteen root DNS servers, which are mirrored and duplicated around the world, make up the foundation of the DNS. ICANN's Root Server System Advisory Council maintains a website that shows the location of root servers worldwide (see figure)

and provides information on root server operations. Many other servers assist in keeping track of domain details. Should the DNS system fail or become corrupt, all Internet traffic would be affected. For that reason, the root DNS servers have been the target of attacks. Fortunately, redundancy is built into the system so that if and when some of the servers fail, others take up the load. Still, an attack that impacts most of the root DNS servers would be catastrophic.

Some hackers work to corrupt the DNS with false information. A hacking technique sometimes called pharming replaces IP addresses in the DNS with the IP addresses of fraudulent websites designed to spread malware. If such attacks are increasingly successful, legitimate domain names might no longer be trusted and the reliability of the entire Internet could be called into question.

## **Port**

In a computer network context, a **port** is an address used by clients and servers that is associated with a specific service.

### **Why This Matters**

Client/server software, with the assistance of telecommunications software, uses port numbers included in data packets to determine which service the data packet is requesting. Port numbers can be used to track user activity on the Internet. Ports can also be used by hackers to gain access to computer systems.

### **Essential Information**

Port numbers help servers organize the data packets that they manage, sending packets to the correct software for service. For example, a server receives webpage requests on port 80 and Domain-Name-System requests on port 53. BitTorrent, the popular file-sharing application, uses ports 6881-6999. The client application requesting the service includes the correct port number in the outgoing packet headers; therefore, the server software accepting requests on that port number can be assured of the nature of the request.

Some colleges can keep students from using controversial file-sharing software by closing off access to specific ports on the campus network. Likewise, a user's network activity can be tracked by checking the username for an IP address at a given time and the port activity associated with that address. The Recording Industry Association of America has applied pressure to get Internet service providers to supply such information as evidence in file-sharing copyright infringement cases.

A common trick used by hackers involves scanning the Internet for computers that have open ports. Once found, an open port can be used as a back door into a computer system. Good antivirus software will make sure that all ports on a computer are closed except for those being used by services.

## Voice over IP (VoIP)

**Voice over IP (VoIP)** refers to technologies that support voice communications using the Internet Protocol over data networks.

### Why This Matters

Businesses are migrating to VoIP, combining voice and data networks into one easy-to-manage digital network, saving the cost of installing and maintaining two separate networks. Home users are saving money with VoIP by connecting to phone services provided over high-speed Internet connections. Mobile phone users are able to save monthly minutes by talking over Wi-Fi connections.

### Essential Information

VoIP has become popular in many environments, although it sometimes goes by other names. For example, Comcast offers a package called Xfinity Triple Play that offers Internet, cable television, and VoIP phone service. With this service, you can see caller ID on your television when the phone rings, and your phone conversations share the same cable as your television and Internet signals.

Cellular service providers are increasingly supporting VoIP service that allows customers to switch from the voice network to a data network. Many smart phones now provide access to Skype, a popular and free VoIP service. Other handsets allow calls to be made over a nearby Wi-Fi network when available.

Businesses have been investing in VoIP systems for years and saving a lot of money in the process. VoIP eliminates the need for traditional costly phone systems by making use of the corporate data network for voice calls. VoIP also offers additional services like the ability to make phone calls and check voice mail from your computer. Many VoIP systems also support videophone service.

When a system combines voice, video, and data communications into one interface, it is referred to as *unified communications*. Unified communications may also boost productivity. Being able to communicate with colleagues anywhere, anytime, through any form of media can empower professionals to accomplish more in less time.

## Internet2

**Internet2** is a research and development consortium led by more than 200 U.S. universities and supported by partnerships with industry and government to develop and deploy advanced network applications and technologies for tomorrow's Internet.

## Why This Matters

The world depends on the Internet to support financial transactions, communications, and information sharing. Increasingly, we depend on the Internet for entertainment and leisure as well. To support increasing demands on the Internet, it is important for researchers to develop new designs to provide faster data transfer rates and improved reliability. That is the purpose of Internet2.

## Essential Information

Scientists and network engineers are exploring new technologies to develop the next generation Internet to support increasing numbers of users and applications at higher speeds.

Internet2 is not a new Internet, but a group focused on developing new ways to improve the management and performance of the existing Internet. It includes dozens of research groups developing a variety of network applications in health sciences, arts and humanities, science and engineering, and education.

An offshoot of Internet2 that some call Internet3, but which is officially named the *National LambdaRail (NLR)*, is a cross-country, high-speed, fiber-optic network in the U.S. dedicated to research in high-speed networking applications in science, engineering, and medicine.

Internet2 is providing researchers, students, and audiences with access to remote equipment and environments. For example, the Gemini observatories,—twin 8.1-meter astronomical telescopes in Hawaii and Chile—can be accessed and controlled in real time by astronomers around the world over Internet2 (see figure). The high-performance connection also allows scientists to collaborate via videoconferencing and will enable the observatories to share more of their findings with the public through techniques such as virtual observatory tours and live video to museums, planetariums, and classrooms worldwide.

Shared virtual reality provides immersive virtual environments over a network to be shared by participants in different locales. Synthetic worlds may be an inevitable part of our future as people spend increasing amounts of their lives online. It is only natural that efforts would be made to make our online experience more like the real world.

A faster global Internet will provide opportunities to travel without leaving home. The future Internet will forge new professional and personal relationships to increase the interaction and collaboration between people from all walks of life with varying world views and experiences. Such a ramp-up of communications and information sharing is bound to have profound effects on our civilization.

## Web Technologies

**Web technologies** are the hardware, software, and protocols that allow the web to exist. The *web*, short for *World Wide Web*, is an Internet service that provides convenient access to information and services through hyperlinks.

### Why This Matters

The emergence of the web in the early 1990s transformed the Internet from an information and communications tool accessible only to researchers and academics into what it is today: a primary source of information, communication, and entertainment for billions. Before the invention of the web, the Internet was a complicated system that was navigated primarily from a command prompt, using commands that needed to be learned and memorized and accessing a limited set of documents and services. Because of its ingenious and easy-to-use design, the web has become the primary tool for accessing information and services of all kinds.

### Essential Information

The web is not simply another name for the Internet, but is also one of many applications and services available on the Internet. The World Wide Web was developed by Tim Berners-Lee between 1989 and 1991 in his research at CERN, the European Organization for Nuclear Research (in French, La Conseil Européen pour la Recherche Nucléaire) in Geneva and was released to the public in the form of the Mosaic web browser in 1993. What Berners-Lee originally conceived of as an organizational tool to help keep track of his own personal documents has grown into an organizational tool with an easy-to-use graphical interface that helps billions of users share and access information on the Internet—and, in fact, allows you to take this course!

The process of “linking together” documents from diverse sources requires three components:

1. A defined system for linking the documents
2. Protocols that allow different computers to communicate
3. Tools to help create the documents and the links between them

Tim Berners-Lee came up with all three: hyperlinks for linking documents; the Hypertext Transfer Protocol (HTTP); and HTML, a language for creating and linking documents.

The cornerstone of Tim Berners-Lee’s World Wide Web is the hyperlink. A *hyperlink* is an element in an online document—a word, phrase, or image—that when clicked opens a related online document. Relating documents to each other using hyperlinks forms a web of interrelated information that is logically arranged and easy to explore.

The protocol of the web is called HTTP. The *Hypertext Transfer Protocol (HTTP)* controls communication between web clients and servers. A web client, usually called a web browser, takes the form of software such as Internet Explorer, Safari, Firefox, and Chrome and is used to request webpages from web servers. A web server stores and delivers webpages and other web resources such as interactive web content.

Over the past decade, many new technologies have been developed that work with Berners-Lee's original web technologies to deliver richer interactive online experiences, which include animation, video, 3D views of objects and locations, music, and apps. In this section you'll learn about web technologies from basic to state-of-the-art.

## Web Technologies Topics

- Web Browser
- Web Server
- Uniform Resource Locator (URL)
- Hypertext Markup Language (HTML)
- Extensible Markup Language (XML)
- Cascading Style Sheet (CSS)
- Web Development Software
- Cookie
- Plug-in
- Web Programming
- Really Simple Syndication (RSS)

## Web Browser

A **web browser**, or just **browser** (sometimes called a web client), such as Chrome, Internet Explorer, Safari, or Firefox, is used to request webpages from web servers, interpret the HTML code in the webpage that is delivered, and display the content onscreen.

### Why This Matters

Web browsers provide access to the millions of resources available on the Internet. Working with other web technologies, such as browser plug-ins and Ajax, web browsers make it possible to view information in the form of text and images, watch animation and video, listen to music and audio, and even interact with software. During the past decade, web browsers have grown in capabilities and importance to the point where they have become a platform for all types of computing.

### Essential Information

From the user's perspective, a web browser is an easy-to-use application for finding and enjoying content on the Internet. Using hyperlinks, web surfers can easily browse through interrelated documents and media, often wandering from one topic to another. The web browser is a wonderful tool for discovery and learning because, by its nature, it presents relationships between topics that may not otherwise be apparent.

Browsing the web is such an intuitive and fluid activity that web users seldom consider what is actually occurring behind the scenes as they surf. Web browsers

communicate with web servers using the HTTP protocol. When a web user types in a web address or URL or clicks a link on a page, the web browser sends a request to the web server that has the page or resources being requested. The server then provides the webpage and associated files to the browser. The web browser interprets the HTML tags on the webpage and displays the page contents according to the instructions provided by the tags.

Web browsers have been designed for nearly every type of Internet-connected device. Desktop and notebook computers, tablets, and mobile phones all access the web. Internet Explorer, Chrome, and Firefox are the three most popular web browsers. In recent years, Google's Chrome has overtaken IE and Firefox in popularity. Safari is the most popular mobile browser since it is the default browser on iPhones and iPads. Today, users are accessing the web from mobile browsers as much as from PC browsers.

Many people spend most of their computing time on the web. In the near future, the web browser may serve as the primary user interface on a PC, providing access to web-based software, information, media, and file storage. This concept is referred to as cloud computing.

## **Web Server**

The term **web server** refers to software that fulfills webpage requests from web clients and to the computers that run such software.

### **Why This Matters**

The client/server architecture is fundamental to providing Internet-based services. Without servers, Internet users would have little access to information other than their own. Web servers supply every item requested from a web browser, including information, video, music, games, software, and services. Without web servers, your web browser window would always be empty.

### **Essential Information**

Web server software runs on a variety of types of computers. Google, for example, combines tens of thousands of PCs in clusters to act as web servers for its search engines. Facebook utilizes dozens of motherboards combined in large cabinets in an energy-saving design. Facebook makes its server design available for other companies to use through an open source program called the Open Compute Project.

Servers don't necessarily have to be large collections of computers. You can set up your own PC to be a web server; you can even install web server software on a USB thumb drive and have a "server on a stick." The point is that hardware does not



define a web server, but rather the software running on the hardware. A computer running web server software is called a web server.

The most popular web server software today is Apache, followed by Microsoft Internet Information Services (IIS) for Windows Server and others taking less significant amounts of the market. Web server software runs on computers that are typically always powered on and connected to the Internet, with backup power supplies and redundant systems to provide uninterrupted service.

Web servers receive HTTP webpage requests from clients, and retrieve the data being requested from connected file systems, forwarding that data to the web clients. Web servers typically have other software and systems tools installed to support web-related services, such as programming languages and databases.

A *web hosting company* or *web host* is a company that provides web server services to individuals and businesses interested in maintaining an online presence. Web hosting companies typically charge a monthly or yearly fee according to the amount of web traffic anticipated for the site and the amount of storage space required. Rates can be as low as \$5 per month for a personal site, or hundreds of dollars a month for a commercial site. Besides providing basic storage and server services, web hosts, like Hostmonster.com, may also offer Internet and web technologies, such as FTP, SFTP, SSH, SSL, email services, and support for development platforms and languages like PHP, MySQL, Perl, Python, C, C++, Java, Ruby, and WordPress.

## URL (Uniform Resource Locator)

A **Uniform Resource Locator**, more commonly called a **URL**, acts as a webpage address, incorporating the domain name of the web server and the location of the webpage file on the server.

### Why This Matters

The URL makes it possible to attach meaningful names to otherwise technical numeric Internet addresses. Imagine having to remember 72.21.203.1 rather than *www.amazon.com*!

### Essential Information

Webpages are identified and accessed by people using a URL. A URL acts as a webpage address, incorporating the domain name of the web server and the location of the webpage file on the server. The URL

<http://www.techminded.co/kenbaldauf/about/index.php> can be dissected as follows:

**Table: URL Dissection**

http://	www.	techminded.co/	kenbaldauf/about/	index.php
---------	------	----------------	-------------------	-----------

Protocol	Web server	Domain name	Location on server	Requested file
----------	------------	-------------	--------------------	----------------

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The final portion of the domain name—.com, .co, .edu, .biz, and so on—is called the *top-level domain (TLD)*. Top-level domains classify Internet locations by type or, in the case of international websites, by location. There are hundreds of TLDs. The most common are listed in the table at the bottom of this pagebelow.

URLs are translated into a numeric IP address by DNS servers located on the Internet. The Domain Name System was established to support the use of URLs and to translate URLs into IP addresses.

The *Internet Corporation for Assigned Names and Numbers (ICANN)* is responsible for managing URLs and IP addresses. Decisions made by ICANN affect everyone on the Internet. ICANN communicates with the public through its website and Facebook page (see figure). ICANN authorizes businesses known as accredited registrars to register new domain names.

**Table: Top-Level Domain Examples**

TLD	Description
.com .co .biz	Commercial business
.edu	Educational institution
.org	Nonprofit organization
.net	Networking service
.gov	Government agency
.name	Personal website

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## HTML (Hypertext Markup Language)

**Hypertext Markup Language (HTML)** is the primary markup language used to specify the formatting of a webpage.

## Why This Matters

HTML provides a simple language for creating attractive webpages, which is accessible to anyone with a desire to learn it. The fact that HTML is non-proprietary and simple to use, with free tools such as a text editor and a web browser, makes it a perfect tool for anyone in the world who wishes to contribute to the vast pool of information on the web.

## Essential Information

A *markup language* is used to describe how information is to be displayed. It typically combines the information, such as text and images, with instructions for formatting. The primary markup language used to specify the formatting of a webpage is called Hypertext Markup Language (HTML). Webpages are sometimes called HTML documents. HTML uses tags to describe the formatting of a page. An *HTML tag* is a specific command inside angle brackets (< >) that tells a web browser how to display items on a page. Most HTML tags use opening and closing versions. The closing tag is indicated by a forward slash. HTML commands operate on whatever is between the opening and closing tags. Thus, “<strong>HTML</strong>” tells the browser to display the letters “HTML” in a bold font.

Although HTML documents were originally created by typing tags and content into a text editor, today most web developers use software tools that automate much of the production of HTML code. Web-development software such as Adobe Dreamweaver allows designers to more easily create high-quality, attractive webpages. You can also use free online tools like WordPress and weebly.com to create websites without knowing anything about HTML. But, learning HTML empowers users to create webpages that more precisely satisfy their needs.

Today’s commercial webpages use a combination of HTML, CSS, a wide variety of web programming languages, and sometimes database technologies to create webpages and sites. An alternate version of HTML, called *XHTML*, has also been popular but is being replaced by the latest version of HTML, HTML5. *HTML5* provides new support for media and more powerful applications, and it will likely reduce the need for browser plug-ins used to view various forms of media.

## XML (Extensible Markup Language)

**XML (Extensible Markup Language)** provides a method for describing and classifying Internet-delivered data so that it is easier to organize and manage.

## Why This Matters

The web has grown from a repository of scientific information for a handful of academics to a major resource of information for the entire planet. In that time, technology’s ability to organize information and make it easily accessible has been

strained. XML is a technology that enables web developers to more easily catalog, find, and deliver information on the Internet.

### **Essential Information**

A number of newer web markup languages are increasing in popularity. One that has changed the landscape of the web and other aspects of computing is Extensible Markup Language (XML). HTML provides a method of describing the format of a webpage while XML provides a method for describing and classifying the content of data on a webpage.

XML provides advantages to both web content publishers and viewers. Publishers can use XML to separate data from webpage formatting. This is possible because XML web content is implemented using several files: one that defines the structure of the data (such as title, artist, price, and year), another that provides the actual data (*Still Got the Blues*, Gary Moore, \$10.20, and so on), and a third that defines the format of the data's presentation in a web browser—an HTML document. This method of organization offers great convenience to organizations that may change the content of a webpage frequently. For example, a news organization can use the same layout for its webpage but change the data from day to day to reflect the latest news. EBay, which manages millions of database records and distributes them to interested parties, is another example of an organization that utilizes XML to change the content of its webpages frequently.

The structured data approach of XML provides convenience for web browsing as well. Web searches become much easier when website content is classified and defined using XML tags.

The use of XML is leading the way to what researchers have labeled the “semantic web.” The *semantic web* is an extension of the current web that seeks to provide a common framework to support easier and faster access to information. The semantic web will combine and integrate information from many sources and applications, including information about the user and his or her environment, in order to “figure out” what the user is looking for. Rather than sorting through thousands of hits following a web search to find what is needed, users will be supplied information that is needed without even having to ask for it. Although the semantic web is still in the speculative stage, it is assumed that the semantic web will make use of GPS-powered location-based services, always-connected Internet services, personal information, and XML to deliver answers before questions.

### **CSS (Cascading Style Sheets)**

**Cascading Style Sheets** or **CSS** allows easy application of visual styles for fonts, colors, layouts, and other page attributes to create visual themes for webpages and sites.

## Why This Matters

To provide a consistent design and appearance across multiple pages on a website, web designers use a technology called Cascading Style Sheets. CSS uses special HTML tags to globally define font characteristics for a variety of page elements as well as the manner in which those elements are laid out on the webpage. So, rather than having to specify a font for each occurrence of an element throughout a document, formatting can be specified once and applied to all occurrences. CSS styles are often defined in a separate file and applied to many pages on a website.

## Essential Information

Good website design includes a consistent appearance across all pages of a website. Web developers designed CSS technology to save development time, allow for easy changes to a website's design, and allow pages to load quickly.

Before CSS, web developers were required to define the design of each page repeatedly in each HTML file, using HTML tags. When the design of the site needed to be updated, each page in the site would require editing.

CSS allows the style for each page on a website to be stored in one or more files—.css files. Each page on the site links to the .css files. Changes to a css file affect the design of all pages on the site.

CSS supports the customization of specific HTML tags. For instance, a developer can have all links on a site use a red font that turns bold when the mouse pointer hovers over them by styling the <a> HTML tag that identifies links. With CSS, developers can also create new tags that define the visual style of blocks of text. CSS also allows objects to be placed in specified locations on a page and even layered on top of each other. All visual aspects of a page can be specified in CSS, leaving HTML to manage the page content. Adding XML to the mix allows page content to be easily managed.

The latest version of CSS, CSS3, incorporates powerful tools that allow page designs to adjust to the size of the user's display. Using a technique called responsive design, a single website design can adapt to accommodate a notebook display size, a tablet or smartphone display size, or a hi-def TV display size. CSS3 also incorporates other cool features, such as semi-transparent backgrounds, gradient fills, rounded corners, and shadow effects. CSS3, combined with HTML5, provides the necessary tools to produce webpage designs of all types.

## Web Development Software

**Web development software** allows developers to create webpages more easily using a word-processing-style environment and automating complex coding activities.

## Why This Matters

Web development technologies have become involved and complex. Web development software automates the web development process, making it more manageable and accessible.

## Essential Information

When the web was new, creating websites was the domain of techies who took the time to learn HTML and related technologies. Today, anyone who can use a word processor can create professional-quality websites with little time and effort. Web development software enables you to create HTML documents using word-processor-like software. Rather than having to type out HTML tags to create webpage formatting, you define the formatting using standard menu commands in a what-you-see-is-what-you-get (WYSIWYG) editor. *WYSIWYG* (pronounced “wizzie-wig”) implies that the webpage you design with the web development software will look the same when published on the web. When you save your webpage, the software creates an HTML file with the appropriate tags. Adobe Dreamweaver is particularly popular web development software that provides powerful tools for building professional interactive webpages and sites (see video).

Besides supporting fast and convenient webpage development, web development software provides tools for managing entire websites, working with XML and CSS, and managing a web server. Professional-grade web development software includes tools for adding interactive content through the use of more advanced development platforms and higher-level programming languages.

There are also online tools that make building a website as easy as point and click. Sites like [weebly.com](http://weebly.com) and [wordpress.com](http://wordpress.com) provide hundreds of design themes to choose from. Add your own content and images and you have your own personalized, professional website.

## Cookie

A **cookie**, sometimes called an HTTP cookie, is a small text file placed on a user’s computer by a web server in order to identify the user whenever he or she returns to visit a website.

## Why This Matters

Have you ever had a webpage greet you by name? Many of today’s commercial websites are created on the fly—that is, the webpage is custom-created to match a user’s interest. For example, if you have made purchases at [Amazon.com](http://Amazon.com), you may notice that each time you visit the site you are greeted by name and presented with advertisements for products similar to those you have purchased before. Amazon uses a technology called cookies to custom-create a webpage just for you. Cookies can also be used by companies to track a

web user's online habits in order to build a customer profile on which to base behavioral targeting and advertising. Cookies enable a web server to identify visitors to websites—a useful service to those who visit websites and those who provide web content. But this ability can also be seen as a threat to a user's security and privacy.

### Essential Information

HTTP is classified as a *stateless protocol*. Stateless refers to the fact that a web server does not retain information (a particular state) regarding a client, or user, between visits. In other words, each time your web browser requests data from a web server, that web server has no idea who you are, what you are doing, or what you've previously requested of the server. The server treats every request as a new transaction and every visitor as a new visitor; no matter how many times a person has visited the site.

This is a problem to web developers and businesses that want to create relationships with the people who visit their websites. It is also an inconvenience to users who must reestablish their identity every time they visit a website. Cookies were invented to solve this problem.

Today's web browsers allow web servers to store small cookie files on your computer. When you revisit a website, even though your computer may have a different IP address than the last time you visited, the website can recognize you by reading its associated cookie file from your PC. Cookie files can contain data or perhaps a unique identifier that is used to look up your personal profile in a database on the server. Information accessed through cookies can include your name, address, and other personal information, such as credit card numbers, your password, items you've previously purchased at the website, items you've viewed on the website, and the amount of time that you viewed each item. This information is obtained through tracking your activities at the website and from data in forms that you fill out and submit at the site. By collecting this information over time, a detailed customer profile can be developed and used to cater to your individual tastes each time you visit the website.

Some worry that cookies threaten security and privacy. While most companies track a user's activities only within the company's own website, some web advertisers use cookies to track a user across many websites. These types of cookies are called *third-party cookies* because they are not placed on a computer by the company that owns the site, but by a third-party company that provides advertisements on the site. For example, if you're reading The New York Times online edition, the page you're on will often deposit a cookie that comes from both The New York Times as well as from DoubleClick, the ad agency that placed the ads. Tracking a user's activities across many websites can reveal a lot of personal information. Firefox, IE, and Chrome are working to provide users with an option for blocking third-party cookies.

Cookies are also often used by professionals working in computer forensics. Cookies stored on computers confiscated by law enforcement agencies can provide evidence for use in criminal prosecutions.

## Plug-in

A **plug-in**, also called an extension or add-on, works with a web browser to offer extended services such as audio players, video, animation, 3D graphics viewers, and interactive media.

### Why This Matters

When the web was invented, its designers had no idea that it would cause such a sensation and become a platform to deliver all types of digital media and services. HTML was designed to simply show pages that include text and images. Rather than continuously upgrading HTML, web browsers, and web servers to accommodate different types of media and activities, plug-in software was developed by a variety of vendors to extend the capabilities of existing web technologies. Bucking this tradition, HTML5 was developed to support media and has reduced the need for plug-ins.

### Essential Information

The web was originally designed to serve up text and image files. To employ more advanced web content, or what some in the industry call rich content, such as video and interactive media, a helper application called a plug-in may be required. A plug-in works with a web browser to offer extended services to support digital audio, digital video and animation, 3D graphics viewers, and interactive media. Plug-ins are also sometimes called add-ons or extensions. When a webpage contains content that requires a plug-in, you are typically provided with the opportunity to download and install the necessary plug-in at no cost, if you don't already have it (see figure). Adobe Flash is a popular plug-in that enables users to view animations and videos and interact with games and other multimedia content created with the Flash program.

Many plug-ins address the issue of transferring large media files over the web. The traditional method of viewing web content is to request a file from a web server by typing a URL or clicking a link, waiting while the file downloads to your computer, and then viewing the file in the web browser. The large size of audio and video files would leave users waiting for minutes, even hours, after clicking a link before they could view or listen to the file. One solution is content streaming. With *content streaming*—sometimes called streaming media, streaming video, streaming audio, or just streaming—the media begins playing while the file is being delivered. Problems arise with this technique only when the speed of play outpaces the speed of delivery.

Unfortunately, browser plug-ins have become a primary tool for hackers. Security holes in Adobe Flash, Java Runtime Environment, and other plug-ins have provided hackers with direct access to the operating system where they can take control of a computer. This was the primary reason Apple gave for not including support for Adobe Flash on the iPhone and iPad. By using HTML5 rather than plug-ins, Apple and other companies are hoping to provide a more secure computing environment.



**Table: Popular Browser Plug-ins**

Plug-in	Description
Flash Player (Adobe)	Allows Flash movies (which can contain video, animation, games, and other interactive content) to play in the browser window; the most popular plug-in
Microsoft Silverlight	Similar to Flash in purpose; supports media and interactive content
Acrobat Reader (Adobe)	Supports viewing of Adobe PDF documents in the browser window
Java Runtime Environment (Oracle)	Enables the browser to run programs written with the Java programming language
QuickTime (Apple)	Supports viewing and interacting with video, audio, and 3D graphics created with QuickTime
RealPlayer (RealNetworks)	Plays streaming RealAudio and RealVideo
Windows Media Player (Microsoft)	Plays streaming audio, video, animations, and multimedia presentations in the web browser

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## Web Programming

**Web programming** refers to the development of software written to run either in a Web browser or on a web server, using web-based input and output.

### Why This Matters

The web has evolved into a fully interactive computing environment, delivering many of the software services traditionally available through programs installed on local computers. Increasing numbers of software engineers are transitioning from developing software for PCs to developing apps to run in web browsers. Popular web programming languages include Java, JavaScript, jQuery, PHP, and Ajax.

## Essential Information

Software is used on the web to provide a wide range of services. When you use a web search engine, your keywords are used as input for a program that searches a database for related websites. Web-based software processes all kinds of data submitted through web forms, including purchases at online stores, bids on products at eBay, insurance quotes, emails to a friend, updates on Facebook, seat reservations for a concert or ballgame, and stocks purchases and trades.

Web programs and software have become increasingly sophisticated. Today, many web-delivered programs, or web apps, are as powerful as their desktop counterparts. Web apps offer the additional benefits of being available from any Internet-connected device and of serving as a collaborative framework for sharing data and files among multiple Internet users. Companies like Pixlr provide photo editing software that runs in the web browser. Doodle.com produces a popular web app for polling a group to find the best time for a meeting.

*Java* is an object-oriented programming language that enables software engineers to create programs that run on any computer platform. *JavaScript* is similar to Java in that it provides functionality on webpages through programming code that is embedded in an HTML document. However, the two languages are very different. Java is a full-fledged programming language for all computing environments, but JavaScript was developed specifically for the web. *Ajax*, which stands for Asynchronous JavaScript and XML, is a popular and powerful web development platform used to create web apps such as Google Docs and Google Maps. Ajax allows the user to interact with a program without needing to frequently reload webpages. A special set of JavaScript functions called jQuery has become very popular for creating animated webpage effects.

JavaScript and its derivatives create programming code that runs in the browser after being delivered by the server. These are called *client-side programs*. PHP, Perl, C++, and many other programming languages and scripting languages are used to develop software that runs on a web server using the web browser as a user interface. These are called *server-side programs*.

## Really Simple Syndication (RSS)

**Really Simple Syndication**, or **RSS**, is a web technology used to automatically deliver frequently updated web content, such as blogs, podcasts, and news, in a standardized fashion.

### Why This Matters

Many web users have favorite sources of information that they frequent online. A user may have a dozen or so sources of online information that are updated weekly, daily, or even several times a day. Rather than spending a lot of time visiting each

source of information, RSS can be used to subscribe to those sources of information, and access them all from one central RSS reader application.

### **Essential Information**

Using RSS, subscribers can have daily updates of their favorite blogs and news services delivered to their desktop. RSS uses XML to deliver web content that changes on a regular basis. It is ideal for keeping up with blogs and online news. Programs called aggregators or RSS readers can be downloaded from the web and used to subscribe to blogs. Each time an RSS reader is launched, it collects the latest articles from the locations to which you subscribe. Google Reader has been the most popular RSS reader for many years. However, Google recently retired Reader, and its many users have adopted alternatives such as Feedly and NetVibes (see video).

Websites that support RSS feeds are often marked by a small orange rectangular icon showing XML or RSS, like the one shown in the top figure. Websites that support RSS feeds include *The New York Times*, Google News, Quotes of the Day, CNET News, *Scientific American*, and thousands of other popular and obscure sources. *The New York Times*, in particular, provides its readers with RSS feeds to all of its content. Clicking the icon typically provides the user with options for subscribing. Alternatively, you can copy the link from the RSS page into the reader of your choice to subscribe.

Podcasts and video podcasts are also distributed using RSS technology. Software called a *podcast aggregator* or a *podcast manager* uses RSS to allow you to subscribe to your favorite podcasts from one central application. RSS allows programs like *This American Life* to be downloaded automatically to iTunes and your iPod. Apple iTunes is the most popular and easy-to-use podcast manager. Other podcast managers include Juice and Doppler.

## **Cloud Computing**

**Cloud computing** delivers a variety of computing resources from the Internet as a service for free or for a fee, to relieve users from the burden of installing, maintaining, and securing those resources themselves.

### **Why This Matters**

Pervasive and reliable high-speed Internet connections have led to a new generation of computing where computing activities take place on Internet servers accessed through a web browser. Applications like Facebook, Google Docs, Office Web Apps, Gmail, and YouTube, as well as business applications like Salesforce and IBM Cognos, allow individuals and businesses to access powerful applications without needing to install software. Increasingly, computer processing and storage are moving off of PCs and into the cloud.

## Essential Information

The beauty of cloud computing is that users access services from their own computers or mobile devices, but don't have to be concerned with installation, maintenance, or security. Cloud computing derives its name from the depiction of the Internet as a cloud in networking diagrams, a vague structure to or from which data is uploaded or downloaded without the user's having to know the details of the process.

Amazon.com played an important role in developing the cloud computing model. The company found that they typically utilized only 10 percent of their server resources because they had to be prepared for extremely busy periods when demand shot up to 90 percent. The company developed a cloud architecture that accommodated peaks in demand and shifted the load to other activities during slower periods. The company gained huge benefits in efficiency through its new server architecture and started leasing out server resources to outside companies. Today Amazon, an online retailer, is also one of the largest suppliers of cloud services. Another company using the cloud computing model is Salesforce.com, which has created a popular enterprise cloud-computing service that provides customer relationship management (CRM) software in the cloud.

Many people take for granted the wide variety of web apps available and the fact that their data is often stored on servers owned by companies like Facebook and Google. Not many consider the benefits of cloud computing to businesses. Businesses manage huge collections of data utilizing complex information systems that require expensive servers and an army of technicians to support them. Cloud computing offers an opportunity for businesses to outsource all of it and lease the service for a flat monthly fee. Since cloud service providers are dedicated to the business of computing, they are able to invest more in maintenance and development.

There are some drawbacks to cloud computing, mainly in the areas of access, privacy, and security. Many cloud services are only accessible when the user is connected to the Internet. So, business travelers with intermittent Internet access could suffer. However, the amount of time anyone spends without Internet access is becoming less and less. Another issue has to do with lack of control over the data. Some worry that cloud service companies will not adequately secure their data. They may also fear that sensitive information stored in the cloud could be subject to snooping eyes. In fact, government agencies have declined cloud services because they do not meet government regulations for privacy and security. Many cloud companies, including Amazon and Google, are working to become certified for government use.

## Cloud Computing Topics

- Cloud Services
- Cloud Models

## Cloud Services

Cloud services include computing services provided over the Internet in three categories: infrastructure, platform, and application.

### Why This Matters

There are many levels at which cloud computing provides services. There are thousands of cloud applications, many of which are well known. Cloud computing can go deeper than just software; it can also offer an entire computing platform—operating system and all. Even deeper than that, it can offer hardware for storage, security, and networking.

### Essential Information

The application category of cloud computing isn't as new as you might think. It has been around in business environments for over a decade, referred to as Software as a Service or SaaS. It is only recently, since Web 2.0 brought technologies that allow web browsers to act like installed software, that the term cloud computing was coined. SaaS originally required software to be installed on local computers in order to access services on the Internet. With the recent release of powerful web development technologies like JavaScript and Ajax, developers were able to create full-fledged applications to run in the web browser window. This allowed users to access software simply by calling up a web address in the browser. These technologies provided the fuel to launch the cloud computing era. Today, software from basic tools like calendar apps to heavy enterprise tools like business intelligence apps run on web servers and are accessed from browsers.

Increasingly, personal computing is moving to the cloud. Amazon's Cloud Music, Apple's iCloud, and Google's Play services provide ample online storage for music and media that can be accessed from any Internet-connected device. Similarly, cloud services are available for businesses with large amounts of data and enterprise considerations. Amazon Elastic Compute Cloud is a popular cloud service for thousands of businesses.

Some cloud services offer a computing platform to access over the Internet. Platform as a Service (PaaS) provides access to an operating system desktop running in a virtual machine on a server. Using PaaS, a person could run software on a Windows PC from their Linux desktop. This setup is especially useful for developers who develop software for multiple platforms. PaaS is also useful for web hosting. Many hosting companies provide complete virtual servers for hosting customer's websites.

Finally, Infrastructure as a Service (IaaS) provides hardware resources to users over the Internet. This is especially useful for storage. A business can outsource all its data storage with an IaaS provider that encrypts and secures the data behind a

firewall. IaaS relieves a company of having to manage storage media, data backups, and security.

## Cloud Models

There are several **cloud models** that serve various environments, including private clouds, community clouds, public clouds, and hybrid clouds.

### Why This Matters

While most users are familiar with public cloud services like Google Docs or iCloud, they may not be familiar with other models of importance to businesses and organizations. There are four models for cloud computing: public, private, community, and hybrid.

### Essential Information

The public cloud model makes a cloud service available to the general public. This is the model most of us use and are familiar with. The service may be free or require a monthly fee. Businesses, however, may not wish to have their cloud service shared with anyone else. In such a case, a business could set up a private cloud.

A private cloud may be created on-premises or hosted by a service provider. In either case, the cloud is provided for one company alone. Rackspace, for example, offers private cloud services for data center management. The cloud saves a business like Rackspace money by pooling server resources and growing and shrinking as needed. Many businesses are transforming their own data centers and information systems to the private cloud model.

In some cases a private cloud may be expanded to serve multiple businesses or organizations. It then becomes a community cloud. Businesses that have common interests can experience additional savings by pooling their cloud resources. When different types of cloud services are connected, the result is a hybrid cloud.

## Web Resources

**Web resources** are many and varied, assisting individuals, businesses, and organizations with all facets of life, including education, news and information sharing, communication, travel, commerce, employment, and entertainment.

### Why This Matters

Consider the many ways web resources support people in their personal and professional lives. Many web users spend a majority of their online time on Facebook, discovering interesting information about their friends (see figure). While

Facebook may be the most popular web resource, there are millions of others in several categories that are useful in many ways. Knowing more about these resources helps us to make the best use of our online time to lead more efficient, effective, and fulfilling lives.

### **Essential Information**

Businesses rely on web resources to function efficiently and effectively. Professionals rely on web resources to develop skills and advance in their careers. Individuals rely on the web for communication, information, and entertainment. Sometimes, web resources are just a fun way to pass or waste some time (see video). Increasingly, people depend on web resources to enrich all aspects of life. This section covers the most popular categories of web resources.

### **Web Resources Topics**

- Search Engine
- Portal
- Internet Communications
- Online Information
- Online News
- Financial Services
- Online Education
- Online Travel
- Maps & Geolocation
- Online Employment Support
- Online Music
- Online TV and Video
- Online Games
- Social Media

### **Search Engine**

A **search engine** is a valuable software tool that enables users to find information on the web by specifying words that are key to their topics of interest—keywords.

### **Why This Matters**

The fundamental purpose of the web is to make it easier to find related content from diverse Internet sources by following hyperlinks. However, the web has become so large that many complain of *information overload*, or the inability to find the information they need, due to the overabundance of information. To relieve the strain of information overload, web developers have provided web search engines to help organize and index web content.

## Essential Information

Search has become the biggest application on the web. Search giant Google has become one of the world's most profitable companies, with more than \$50 billion in annual revenue. Search has become such a profitable business because it's the one application that everyone uses. Search engine companies make money through advertisements. Because everyone uses search, advertisers are keen to pay to have their ads posted on search pages.

Google has the largest share of the search engine market, with around 67 percent of the U.S. market. Microsoft Bing has captured around 16 percent and Yahoo around 12 percent. Google has leveraged its market dominance to expand into other web-based and mobile product markets.

Most search engines use an automated approach that scours the web with "bots" (automated programs) called spiders that follow all web links in an attempt to catalog every webpage by topic. Each webpage is analyzed and ranked using unique algorithms, and the resulting information is stored in a database. Google maintains billions of indexed webpages on dozens of clusters of up to 2000 computers each.

A keyword search at Yahoo!, Bing, or Google isn't a search of the web, but rather a search of a database that stores information about webpages. The database is continuously checked and refreshed so that it is an accurate reflection of the current status of the web.

Some search companies have experimented with human-powered and human-assisted search. *Human-powered search* provides search results created by human researchers. Because the system is human powered, the search results are typically more accurate, definitive, and complete. With human-powered search, there is no need to examine a long list of search results to find what you are looking for. Each search leads to one page of information on your topic with links to more sources of information. The downside of human-powered search is that it takes a lot of effort. Although an automated search engine can find information on any word in the dictionary (and more), human-powered search provides information only on the most popular topics.

Microsoft has taken a different direction with its Bing search engine. Bing has an innovative design that Microsoft calls a decision engine. Bing provides more than just a long list of links in its search results. It also provides information on related topics and services. The idea is to provide users with all the information needed to act on whatever task is related to the search. Similarly, Wolfram Alpha is an "answer engine" designed to answer factual queries. For example, you can find out the difference between a tortoise and a hare, how many feet are in 120 meters, what the interest is on a 30-year mortgage at 5 percent, and which words end in "alic."

Google is continually adjusting its search algorithm to provide better links and even direct answers to queries. Google hopes to create a "semantic web" that is able to answer any question by more precisely interpreting the meaning, or semantics, of



what the user is seeking. Google's Voice Search is a step in the right direction. Just ask a question to Voice Search on your Android mobile device (or Google Search on iPhone), and Wweb results pop up instantly providing useful information (see video).

Apple is working toward the same goals with its iPhone Siri app. Siri was first released on the iPhone 4S. Users ask Siri a question by speaking into the phone. Siri uses several online information services like Wolfram Alpha and weather.com to provide the user with a voice-delivered answer. Siri may be a step ahead of Google as a meta resource that joins multiple resources to act as a personal assistant.

A *meta search engine* allows you to run keyword searches on several search engines at once. For example, a search run from *www.dogpile.com* returns results from Google, Yahoo!, MSN, Ask, and other search engines.

## Portal

A **web portal** is a webpage that combines useful information and links, and acts as an entry point to the web—the first page you open when you begin browsing the web at home or at work.

### Why This Matters

Portals provide a convenient starting point for web exploration in a general or a specific context. They allow users to have convenient access to their most frequently used web resources.

### Essential Information

Many webpages have been designed to serve as web portals. Web browsers enable users to select a webpage as a home page—the page that loads when the browser is launched, also called a start page. Since many people select a portal as their home page, often the two terms are interchangeable.

A web portal typically includes a search engine, a subject directory, daily headlines, and other items of interest. They can be general or specific in nature. MyYahoo!, AOL, and MSN are examples of *horizontal portals*; “horizontal” refers to the fact that these portals cover a wide range of topics. MyYahoo! allows users to custom design their page, selecting from thousands of *widgets*—small applications that deliver information and services. With the advent of social media, many people are using Facebook, Twitter, Google+, or other social media sites and tools as their portals.

*Vertical portals* are pages that provide information and links for special-interest groups. For example, many colleges use learning management systems such as Blackboard, which provide an opening page that acts as a customizable portal with campus news, weather, and class information.

Many businesses set up corporate portals for their employees. *Corporate portals* (sometimes called dashboards) provide access to work-related resources, such as corporate news and information, along with access to business systems tools and databases and communication tools to support collaboration (see video). Some businesses use a corporate portal to provide employees with work-related online content and limit access to other web content.

## Internet Communications

**Internet communications** include text-based communications like email and instant messaging, voice communications like Voice over IP (VoIP), video communications, and a variety of group and community forums.

### Why This Matters

The digital revolution is ushering in the age of pervasive computing, where anyone can have access to information anywhere, anytime. Equally important and influential is the birth of *pervasive communication*, the ability to communicate with anyone, anytime through a variety of formats. Pervasive communication is the result of advances in wireless and Internet communication technologies. These technologies are fundamentally altering the ways in which personal and professional relationships are created and nurtured.

### Essential Information

Before the Internet, forms of two-way communication were limited to face-to-face, telephone, or printed word (as in mailing a letter). The Internet has broadened our communications options considerably. Today you can phone, email, meet in person, text, update your status, video chat, send a letter, tweet, and otherwise communicate with anyone, anytime, from any location. When determining the most effective and convenient manner in which to communicate, it is useful to consider the importance of what you need to communicate along with the strengths and weaknesses of the various methods of communication.

There are two basic forms of communication: synchronous and asynchronous. In synchronous communication, people communicate in real time, exchanging thoughts in a fluid conversation. Face-to-face conversations, video chat, telephone conversations, online chat, and instant messaging are examples of synchronous communication. Asynchronous communication allows participants to leave messages for each other to be read, heard, or watched and then responded to at the recipient's convenience. Answering machines, voice mail, social network posts, text messages, tweets, and email are examples of asynchronous communication.

Each form of communication should be evaluated in terms of quality, convenience, and time/delay. Typically, the quality and speed of communications compare inversely with the level of convenience. Internet and wireless communication can be categorized as text, voice, or video. With increasing amounts of voice communication traveling over the

Internet, and Internet communication expanding to mobile phones, there is little need to differentiate between Internet communication and mobile phone communication when it comes to evaluating current forms of digital communication.

With all these forms of communication, it would seem that miscommunication or lack of communication would be a thing of the past. Unfortunately, people still miscommunicate and choose ineffective modes of communication. When planning communication, consider the importance of what is being communicated along with the type of person you are communicating with. When communicating with figures of authority, avoid casual language, emoticons—pictures from punctuation like smileys ;- ) —,;-) — texting, slang, and other casual modes of communication. Using less convenient but more effective modes of communication can go a long way in making convincing arguments and showing those you communicate with that you are serious. Remember that no form of remote communication is as powerful or meaningful as in-person, face-to-face communication.

The following table lists current forms of communication in order of convenience and effectiveness. The first listing is the most convenient but least effective, and the last is the least convenient but the most effective in getting a message across. As you read down the table, consider which elements of communication are included and missing from each form. Include subtle components of communication such as eye contact, face expression, voice inflection, body language, and personal space.

**Table: Forms of Electronic Communication**

Text Communication	
Text Messaging (Asynchronous)	Communication through short text messages via cell phone or social network.
Email (Asynchronous)	Communication of text-based messages through transmission over a computer network. Email is only slightly more effective than text messaging because there is no character limit. Email supports file attachments, which makes it a useful method for transferring data.
Messaging via social media. (Synchronous)	Communication through synchronous text messaging between two or more participants utilizing social media such as Facebook, Google+ or Twitter. Also useful for sharing photos, videos, and links.
Voice Communication	
Voice mail (Asynchronous)	Communication by means of voice messages left on phone services or Internet services.

Phone (Synchronous)	Communication through phone conversations allows the use of voice inflection for more effective communication than text-based communications.
Internet voice (Synchronous)	Communication through Internet-based voice through services such as Skype (a free online communication tool that supports text, voice, and video) or online chat services that support voice communications.
Virtual Chat	
Virtual chat (Synchronous)	Communication in an online virtual world where users are represented as avatars (animated characters) and chat via voice or text while interacting with others.
Video Communication	
Video phone and chat (Synchronous)	Communication through synchronous video, typically over the Internet or private data network.
Telepresence (Synchronous)	Communication through high-quality video and audio connections over the Internet, along with large high-definition displays to support meetings between people around the world as if they were gathered at one location.

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## Online Information

**Online information** refers to information of all kinds—business, personal, governmental, factual, opinionated, and even inaccurate—that is delivered over the Internet and web.

### Why This Matters

The web has become a very popular resource for sharing information. In some cultures, it is the primary resource for information, beating out newspapers, books, television, and radio. Material once stored in volumes on library shelves is now available in digital form on library websites, such as the Florida State Libraries site in the figure. Finding information online and being able to distinguish useful and

reliable information from opinionated and inaccurate information has become a valuable skill for those wishing to stay informed.

### **Essential Information**

Finding information on the web can be a challenge. Search engines are a valuable tool in this regard. Choosing search terms to get the desired results is a skill that grows with practice.

Unlike information published through traditional media such as newspapers, magazines, and books, much of what is published on the web has no quality control, editors, or peer review. When judging information provided on the web, always consider the source. Anonymous postings and publications should not be trusted until you identify the provider of the information. If that person or organization is unfamiliar to you, search the web for information on the provider. Providers of valid and trustworthy information on the web typically go out of their way to include references to well-known and highly regarded authorities. For example, Wikipedia encourages all contributors to include links that support research on any topic. Although it may not be appropriate to cite a Wikipedia article as a source, often you can find an acceptable source in the links provided in the Wikipedia article. Encyclopedia Britannica, which is now available online, on your mobile phone, and on your tablet, is an authoritative resource for all kinds of information.

The following table shows the various types of information found on the web.

**Table: Types of Web Information**

Traditional published works	Many publishers and libraries are creating digital forms of past and current published works. Digital libraries offer access, often free, to a wealth of books, research resources, and periodicals. Huge databases of published articles, like the one provided by LexisNexis, are available; unfortunately, many of these require a membership fee.
News	Most newspaper, magazine, radio, and television news sources now have an online presence delivering articles through webpages, blogs, podcasts, and streaming video.
Business	Most businesses have an online presence delivering information on their products and services, and providing a method to purchase their wares.
Financial	Banks and other financial institutions provide information for individuals, investors, and those interested in the economy.

Government, political, and legal	All levels of governments are represented on the web, along with political and legal information from all perspectives.
Opinion	Blogs and social networks provide a platform for anyone on the web to share opinions, solicit feedback, and create discussions on any topic.
Personal	Social media has created a space for anyone to post information on their personal interests and characteristics.
Support	The web is increasingly the first place people turn when they need help with life issues. Information on the web can help you find the perfect mate, prepare for your wedding, get a job, buy a house, and prepare for your first child. All of life's major challenges are addressed on the web.

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## Online News

**Online news** refers to newspapers, magazines, journals, news radio and television, and blogs that deliver news and information about current events on the web.

### Why This Matters

The web is a powerful tool for keeping informed about local, state, national, and global news. It allows the public to actively research issues and become more knowledgeable about current events. Traditional news media deliver the news through television, radio, and newspapers. These media provide only the news that they consider of interest to the general public. Items of special or unique interest may be bumped and replaced with more general stories. In contrast, the web has an abundance of special-interest coverage. It also provides the capacity to drill down deeper into the subject matter.

### Essential Information

All major newspaper, radio, and television news services have expanded to provide online news coverage. This trend has put the various forms of media in direct competition with each other as their online format expands to include text, photos, audio, and video. Text and photos are supported by the HTML standard. Video (sometimes called a webcast) and audio are provided in the web browser through plug-in technology, and in podcasts. Bringing the news to the web is eliminating the

lines of distinction between traditional newspaper, radio, and television news sources.

The leading news agencies have a strong online presence as well. Reuters, the Associated Press, the BBC, and others are sources of global news and information for media companies and the general population. While traditional news sources migrate to the web, new sources of news are emerging from online companies. News websites from Google, Yahoo!, Digg, and Newsvine provide the most popular or interesting news stories from a variety of news sources.

In a trend some refer to as *social journalism* or *citizen journalism*, ordinary citizens are more involved in reporting the news than ever before. Through online tools such as blogs, podcasts, videocasts (vcasts), discussion groups, and social media, the online community is taking journalism into its own hands and reporting the news from each individual's perspective. Although social journalism provides us with important news we would otherwise not get, its sources may not be as reliable as mainstream media sources. As we hear the news from nonprofessional journalists, reporting without the strict guidelines of formal news agencies, it is important to remember that the information may be biased, misrepresented, mistaken, or perhaps even deliberately misleading. Many citizen journalists would be quick to point out that mainstream media may also be biased in its reporting of the news, especially since they are sponsored by commercial enterprises.

Increasingly, social media is used to “spread the news.” Friends are sharing links to interesting news stories on sites like Facebook, Twitter, Google+, and Reddit. Some users of these networks feel they get all the news they need from their social network.

## Financial Services

Online **financial services** support money management, loans, investments, and transactions for individuals, businesses, and organizations.

### Why This Matters

Online services empower Internet users to get a better grip on their finances. Whether you are interested in opening a bank account, balancing your budget, transferring funds, paying bills, borrowing money, lending or investing money, making purchases, paying your taxes, or any number of money-related activities, you'll find the most convenient way of getting it done is online. In fact, in a growing number of cases, the *only* way to get it done is online.

### Essential Information

Online banking has become the default method of banking for both individuals and organizations. In fact, banks are closing their physical locations as the demand for them shrinks. Through a bank's website, a customer can check account balances,

transfer money between accounts, make payments on loans, credit cards, and other bills, and schedule automatic monthly deposits and payments.

Many lenders, government agencies, city utilities, and other service providers expect customers to pay their bills online. Some even charge extra for customers who insist on paying by check through the mail or using cash in person. Processing payments online is much less expensive for a business than processing them through the mail or in person. Payments may be made through a bank account or through the payee's website. Since routine monthly payments typically charge penalties for late payments, it is wise to set up automatic payments so that none are overlooked.

Online services exist for all types of financial activities. Mint.com and quickbooksonline.com are online personal finance services that track your spending and income to advise you on a practical monthly budget. TaxACT.com helps millions of U.S. taxpayers file their federal and state taxes each year by offering several different options of varying expenses for filing your taxes. The software that a company like TaxAct provides for filing taxes has drastically changed the way that people file their taxes; instead of filing through an accountant they can now do it themselves online. Zillow.com helps home seekers discover homes and mortgages that are affordable based on their savings and monthly income. Lendingtree.com and hundreds of other sites assist people with borrowing and refinancing.

The Motley Fool, investmentadvice.org and others are available to assist people for wise financial investments and retirement planning. E\*Trade, Scottrade, Charles Schwab, and others provide tools to make investments online. Kiva provides a method for individuals with a big heart to assist entrepreneurs with small bank accounts in developing countries.

PayPal provides tools for emailing money to others and paying for services and goods online without a credit card. PayPal Here is a PayPal service that allows in-person transactions to be "rung up" on a mobile phone or tablet. Square provides a similar service and provides a credit card reader that attaches to mobile phones and tablets to allow anyone to conduct credit card transactions with a card swipe. The world of ecommerce, where business transactions are carried out by the billions everyday across the Internet, is addressed in a separate unit.

## Online Education

**Online education** refers to websites designed to educate or support education and training.

### Why This Matters

As a tool for sharing information and a primary repository of information on all subjects, the web is ideally suited for education and training. Advances in interactive web technologies further support important educational relationships between



teacher and student, and among students. The web plays a major role in all levels of education. Emerge with Computers—this software you are using—is the ideal example of the power of online education! In today’s highly competitive and rapidly changing professional environments, more professionals are turning to the web to learn skills that will enhance their professional value.

### **Essential Information**

Educational institutions of all types and sizes are seizing the web as a tool to enhance classroom education or extend it to individuals who cannot physically attend.

Primary schools use the web to inform parents of their students’ progress and grades as well as school schedules and activities. Teachers utilize online drills and exercises to reinforce classroom lessons. By high school, students have integrated the web into daily study habits.

Most college-level courses rely on the web to enhance learning. Educational support products, such as Moodle, Blackboard, and Desire2Learn, provide an integrated web environment that includes virtual chat for class members; a discussion group for posting questions and comments; access to the class syllabus and agenda, student grades, and class announcements; and links to class-related material. Some course websites deliver filmed lectures using webcasting technologies provided by companies like Tegrity. Such environments can complement the traditional classroom experience or replace it altogether.

Conducting classes over the web with no physical class meetings is called *distance education*. Many high schools and colleges offer distance education classes, which provide a convenient method for nontraditional students to attend college. Nontraditional students include students who have job or family obligations that might otherwise prohibit them from attending college. Distance education offers them a way of working through class material on a flexible schedule. Some schools offer entire degree programs through distance education.

In a program it calls OpenCourseWare, the Massachusetts Institute of Technology (MIT) offers all of its courses free online. Stanford University offers a free introductory programming course on “Building a Search Engine,” taught by Google cofounder Sebastian Thrun. More than 90,000 students enrolled in the course, marking the beginning of a trend known as Massively Open Online Courses, or MOOCs. Today, three primary MOOC providers,—EdX, Udacity, and Coursera,—offer hundreds of free online courses from dozens of the country’s best universities. Students who take MOOCs do not earn credit toward a degree and have limited access to the instructor, but they benefit from the knowledge gained.

Besides MOOCs, there are a number of other educational opportunities that exist online. Khan Academy offers over 2600 instructional videos on many subjects, especially math and science. Lynda.com offers video lessons on all types of technical and software skills. iTunes U offers full courses online from numerous universities.

YouTube Edu has thousands of lecture videos from professors across around the world.

Beyond traditional education, corporations such as SkillSoft offer professional job-skills training over the web. Job seekers often use these services to acquire specialized business or technical training. Some of the training leads to certification. Certification verifies a person's skill and understanding in a particular area. It has become very important, especially for some technical skill sets, to assure an employer that a job applicant truly has the skills claimed.

Museums, libraries, private businesses, government agencies, and many other types of organizations and individuals offer educational materials online for free or for a fee. Consider eHow, the website that claims to teach you "How to do just about everything!" Certiport offers training and testing for technology certification, such as for Microsoft and Adobe products.

## Online Travel

**Online travel** refers to websites and services that support various travel activities such as preparing for travel, finding your way around new environments, reserving flights and lodging, booking tours and activities, and renting vehicles.

### Why This Matters

The web has had a profound effect on the travel industry and the way people plan and prepare for trips. From getting assistance with short trips across town to planning long holidays abroad, travelers are turning to the web to save time and money and overcome much of the risk involved in visiting unknown places.

### Essential Information

Travel websites such as *www.travelocity.com*, *www.expedia.com*, and *www.priceline.com* act as online travel advisors and help travelers find the best deals on flights, hotels, car rentals, vacation packages, and cruises. Priceline.com offers a slightly different approach. Rather than list existing prices, it allows shoppers to name their own price, and then works to find an airline that can meet that price. Once flights have been reserved, travelers can use these websites to book hotels and a rental car, often at discounted prices. Online businesses like Kayak are helpful in finding good deals on airfare, lodging, and car rentals. Kayak.com can be used to pool the information from numerous sources to more easily find the best deal. One of their best features is their "Explore From" tool, which allows you to enter your departure city into a search box and then produces a map of the world with hundreds of destinations and how much it will cost you to get there from your departure city. If you're on a budget, this might be a good way to see where you can explore! Still others, like Tripadvisor.com, provide user reviews of hotels, flights, restaurants, and accommodations, along with tips on activities and attractions.

There are many special-purpose travel websites that assist individuals with particular needs. Some categories listed at Yahoo! Travel include backpacking, budget travel, disabilities, ecotourism, train travel, traveling alone, traveling with pets, and vegetarian.

There are many travel services offered through smart phones. Many airlines now send text messages notifying passengers of flight delays and gate changes. Smart phones can be used for flight check-in and to check on flight status. Online services from TripIt, TripCase, and others allow you to manage all travel details online, including flights, rental cars, lodging, and agenda information, and then access the information from a mobile app when and where you need it most.

Travel agencies, resorts, airlines, cruise lines, and all businesses associated with travel have a strong online presence. Map websites like Bing Maps and Google Maps are invaluable for finding your way to and around destinations and even for viewing your destination from street view. Today, most travel begins on the web.

## Maps & Geolocation

Online **maps & geolocation** technologies provide geographic services for finding your way around, finding people and places, or finding information related to specific locations.

### Why This Matters

With the increasing use of GPS devices in cars and smart phones, geolocation services have experienced a boom in popularity. We use online maps to view weather and traffic patterns, to find popular hangouts, to plot our journeys from our current locations, to find nearby businesses, and to find our friends. Online maps and geolocation applications allow us to be in the right place at the right time.

### Essential Information

Mapping and geolocation tools are among the most popular and successful web resources. MapQuest, Google Maps, and Bing Maps are examples. Google offers Google Latitude, an app that lets you see where your friends are. By offering free street maps for cities around the world, these tools help travelers find their way. Provide your departure location and your destination, and these online applications produce a map that displays the fastest route. Using GPS technologies, maps automatically detect your current location and let you know how long it will take to walk or drive to your destination.

Google Maps also provides extensive location-specific business information, satellite imagery, up-to-the-minute traffic reports, and Street View. Street View is the result of Google employees' driving the streets of the world's cities in vehicles with high-tech camera gear, taking 360-degree images. These images are integrated into

Google Maps to allow users to get a “street view” of an area that can be manipulated as if they were actually walking down the street looking around. Bing Maps takes it a step further with high-resolution aerial photos and street-level 3D photographs.

Mapping software packages from Google and Microsoft overlay road maps onto high-resolution satellite images of Earth to produce a zoomable view of the planet. You can view the planet from a mile out in space or zoom in to view a country or state and then zoom in further to view roads and buildings.

*Geographic information systems (GIS)* provide geographic information layered over a map. For example, Google Earth provides options for viewing traffic, weather, local photos and videos, underwater features like shipwrecks and marine life, local attractions, businesses, and places of interest. Software such as Google Latitude allows you to find your friends on a map—with their permission—and automatically notify you if a friend is near. Similar software, including FourSquare, Gowalla, and Facebook Places, allows users to “check in” at locations to let friends know where they are and sometimes to access related discount coupons.

*Geo-tagging* is technology that allows for tagging information with an associated location. For example, Flickr.com and other photo software and services allow photos to be tagged with the location where they were taken. Once tagged, it becomes easy to search for photos taken in Florida, for example. Geo-tagging also makes it easy to overlay photos on a map, as Google Maps and Bing Maps have done. Twitter, Facebook, and other social networks have made it possible for users to geo-tag comments, tweets, and posts.

Geolocation information does pose a risk to privacy and information security. Many people prefer for their location to remain unknown, to at least strangers, and often to acquaintances and even friends. Recently, criminals have made use of location information to determine when people are away from their residences so that they can burglarize without fear of interruption.

*Augmented reality* applications take geolocation one step further. Using your phone’s camera, GPS information, compass information, local business information, and sometimes a form of artificial intelligence called pattern recognition, applications like Google Goggles and Layar are able to overlay local information over the image you view from your camera. So, as you pan around an intersection, viewing the image through your camera, you will see information about nearby businesses and points of interest. Location-based advertisements may inform you that that a nearby business will honor a coupon delivered to your phone as a text message. Google Glass utilizes a tiny head-mounted display to provide information accessed with voice commands.

## Online Employment Support

**Online employment support** refers to web-delivered information and services that support researching employment options and finding employment.

### Why This Matters

Websites provide useful tools for people seeking employment and for companies seeking employees. Websites such as [careerbuilder.com](http://careerbuilder.com) and [monster.com](http://monster.com) provide resources for choosing a career and finding a job. Most colleges have career and job placement services that use the web to connect graduating students with employers. The web supports individuals through every step of the process of finding the job that best suits their talents and needs.

### Essential Information

The web provides information, services, and tools to support all stages and strategies in the career-finding and job-hunting process:

- **Select a career.** Use online references to discover your personal strengths and weaknesses and then map them to your ideal job.
- **Discover who the players are in your chosen career.** Search the web for a career or industry title and see which companies are represented. Discover online trade journals and learn as much as you can.
- **Learn about the companies that interest you.** Where better to start than the company's website? Many companies list career opportunities and provide you with information on how to apply.
- **Network with others in the field.** There are many online industry-specific discussion groups and forums. Seek them out to make valuable contacts. Set up an account on professionally focused social media like LinkedIn and connect with others.
- **View job listings at general employment websites.** Websites such as [monster.com](http://monster.com) and [careerbuilder.com](http://careerbuilder.com) have large databases of job openings where you can search by profession or keywords. Monster.com also provides useful career-building and job-finding tools that anyone can use.
- **View job listings at industry-specific employment websites.** There are hundreds of specialized job websites, from employment recruiters of all types to specialized job databank sites, that focus on a specific industry.
- **Create an impressive website to represent yourself.** Consider purchasing your own domain name—for example, [www.janelle\\_johnson.com](http://www.janelle_johnson.com). Include an attractive welcome page with links to your resume and other details regarding your experience and skills. Employers like hard-copy resumes to be brief. At the bottom of your resume, you can add "Please visit [www.janelle\\_johnson.com](http://www.janelle_johnson.com) for more information." Make sure that your website presents a professional appearance and appropriate content. Online tools such as Weebly.com and WordPress.com make creating an online presence a snap!

## Online Music

**Online music** refers to music delivered through Internet-based or web-based services and includes Internet radio, music subscription services, and music download services.

### Why This Matters

The Internet and the web have made music more accessible than ever, with artists distributing their songs through online radio, subscription services, streaming services, and download services. The web has had a dramatic impact on the music industry, causing unprecedented changes in marketing and distribution. Digital music distribution has allowed artists to distribute music directly to fans without the need for record companies. It has also opened the door to music piracy and illegal distribution of music that is legally protected by copyright.

### Essential Information

*Internet radio* is similar to local AM and FM radio except that it is digitally delivered to your computer over the Internet, and there are a lot more choices of stations. For example, Live365 provides access to thousands of radio stations in more than 200 musical genre categories. Some stations charge a subscription fee, but most do not. Local radio stations are streaming online as well. Now fans can listen to their favorite local stations whether they are based in Chicago, New Orleans, or Amsterdam, from any location in the world. Tunein.com is a useful online service that provides access to local radio stations all over the world.

Other web-delivered streaming music services depart from the traditional radio format and create a more personalized service. Pandora and Last.fm online services build radio stations around the listener's tastes by learning what the listener likes and doesn't like. These services base song selections on artists that the listener specifies as favorites and related artists that the service believes play a similar style of music. In this way, the listener gets to hear tracks from the requested artist along with other music in the same vein. Spotify provides free access to full albums of music with occasional commercial interruptions. Paying for Spotify Premium eliminates the commercials and allows you to take your music with you on your mobile devices.

Apple's iTunes was one of the first online music services to find success. Since its release, the iTunes Music Store has become the largest music retailer in the world. Microsoft, Amazon.com, Walmart, and other retailers also sell music online. The going rate for music downloads is 89 cents to \$1.29 per song. Downloaded music may include digital rights management (DRM) technology that prevents or limits the user's ability to make copies and play the music on multiple players.

The latest music services allow fans to upload their music to the cloud for access anywhere, anytime. Apple, Amazon, and Google all have cloud music services that

are reasonably priced, if not free. Amazon's Cloud Player allows customers to store all of their music in the cloud and play it from any device on the Internet, either in a web browser or through an app. GrooveShark offers a similar service, allowing its members to upload their music to the cloud and providing tools for finding new music. Use caution with streaming music to a phone, as it could quickly use up a monthly allocation of bandwidth and could result in data-plan usage penalties.

Music services that make use of a subscription model of distribution include Napster, Rhapsody, Yahoo! Music, and AOL Music. For an annual fee, these music services offer access to a catalog of millions of songs from the Big Five labels—Universal Music, Sony Music, Warner Music, BMG, and EMI—and from independent artists. These services, however, have a hard time competing against free services from Spotify and Pandora.

Podcasts are yet another way to access music on the web. Many independent artists provide samples of their music through podcasts. Podcast Alley features around 8000 music-related podcasts from unsigned artists.

## **Online TV and Video**

**Online TV and video** refers to television programming, motion pictures, movies, and user-generated video available on the web.

### **Why This Matters**

With increasing amounts of Internet bandwidth going to more homes and mobile devices, streaming video and television are becoming commonplace. Once content with small, low-quality YouTube videos, the public now craves professionally produced video delivered to their computers. Some are connecting their computers to high-definition television sets to access television and motion-picture quality programming. The web and TV are rapidly merging into a single integrated system available from home entertainment systems, PCs, tablets, and mobile phones.

### **Essential Information**

Television is expanding to the web in leaps and bounds. Websites like Hulu and Internet-based television platforms like Joost provide television programming from dozens of providers including most mainstream television networks. Many TV networks, like CBS and the BBC offer online full-length streamed episodes of popular programs like CSI Miami, Dr. Who, and season premieres that are released before airing on television. Clicker.com serves as a television guide to most online programming. Apple iTunes offers television programs from ABC, AMC, CBS, CNN, E!, FOX, PBS, MTV, and many other networks—some for free, but most for around \$3 an episode. Once purchased, the program can be downloaded and viewed on a computer, iPod, iPhone, or iPad, or it can be sent wirelessly to a hi-def TV connected to an Apple TV. By no means does Apple have a corner on this market. Television

and movie programming is available for every platform, including PC, smart phone, and tablet.

The Internet is now a popular distribution medium for motion pictures. Subscription services such as Netflix and Amazon Prime allow members to stream movies and TV series over the web to their computers. Apple iTunes, Google Play, and YouTube are also in the motion picture business. Users of the services can rent or purchase movies and download them to a computer.

Television programs and motion pictures are typically distributed online in a controlled manner. Streaming video does not provide access to the entire video file, which makes it difficult to produce copies. Purchased downloaded video is typically protected with digital rights management (DRM) technology. The TV and movie industries are doing all they can to prevent piracy. Still, illegally copied and shared movie and video files are taking up a large percentage of Internet bandwidth. Some Internet service providers have deliberately interfered with movie uploads and downloads over BitTorrent networks in an effort to free up bandwidth for legitimate Internet business.

No discussion of Internet video would be complete without mentioning YouTube. YouTube is the original online video sharing website. Hundreds of thousands of videos are uploaded to YouTube every day and hundreds of millions are viewed every day. While many YouTube videos are relatively short and nonsensical, YouTube has expanded to include college lectures, motion pictures, television shows, and its own video series. YouTube is becoming the online equivalent of HBO and much more.

## Online Games

**Online games** include the many different types of single-user, multiuser, and massively multiuser games played on the Internet and the web.

### Why This Matters

The web offers a multitude of games for all ages. From Nickelodeon's Sponge Bob games to solitaire to *massively multiplayer online role-playing games (MMORPG)*, there are a wide variety of offerings to suit every taste. Of course, the web provides a medium for downloading single-player video games to your desktop, notebook, handheld, or cell phone, but the power of the web is most apparent with multiplayer games.

### Essential Information

Multiplayer games allow you to interact with other users online. There are a variety of types and platforms. Multiplayer games support from two to thousands of players at a time. A multiplayer game could be as simple as an online game of checkers, like



the thousands of people playing backgammon at <http://zone.msn.com> at any given time, or as complex as developing civilizations and defending the galaxy, like the thousands of people that play Ferion.

Multiplayer online games can be categorized into the following genres:

**Table: Multiplayer Online Games**

Type	Description
Action	Fast-paced games requiring accuracy and quick reflexes
Board	Games involving play on a virtual game board
Card	Games involving the use of a virtual deck of cards
Flight Simulation	Games that involve taking on the role of a pilot in a WWI biplane, modern aircraft, or a futuristic starship
MultiUser Dimension or MultiUser Dungeon (MUD)	Text-based games that make up for their lack of graphics with diverse and immersive game play
Role-Playing Games (RPG)	Games in which you take on the persona of a game character
Sims (Simulations)	Games in which you create your own character that lives in a simulated environment
Social	Games that provide social environments in which to interact with friends and complete missions or tasks
Sports	Games involving sports like baseball, football, basketball, or golf
Strategy	Games that feature planning-, tactics-, and diplomacy-dominated game play
Trivia/Puzzle	Games that require a good memory or problem-solving skills

Although most multiplayer games are free, some of the best have fees associated with them. You may need to purchase software, or pay monthly, yearly, or per-play subscription fees.

Game consoles such as Xbox and PlayStation provide multiplayer options for online gaming over the Internet. Subscribers can play with or against others that are logged-on in 3D virtual environments. They can even talk to each other using a microphone headset. Microsoft's Xbox LIVE provides features that allow users to keep track of their buddies online and match up with other players who are of the same skill level.

Mobile games have exposed millions of new users to the joy of games. Simple casual games like Angry Birds have become a favorite activity for passing the time while waiting at the bus stop or in the doctor's office. Social games in Facebook and Google+ provide new ways for friends to play together online.

Although illegal in the U.S., online gambling is a billion-dollar global industry. Online casinos, poker rooms, sports and racing bookies, and bingo halls are found in abundance online. Poker is particularly popular since it pits player against player and allows the more skillful to win. Online gaming companies PartyGaming and Empire Online are so large that they sell shares on the London Stock Exchange. Some worry that the convenience of online gambling increases the possibility of addiction and is a risk to the public good. Changes in U.S. laws have opened the door for legalized online gambling in the states. It's no surprise that Nevada is the first state working to legalize gambling online. Many states are looking to online gambling as a way to bring in extra income to balance their budgets.

## **Social Media**

**Social media** refers to online services that support social interaction and publishing.

### **Why This Matters**

Social media provides more ways to communicate and share information with friends and circles of friends than ever before. The rise of social media has aided in the gradual migration of social interaction to online channels rather than face-to-face. Many people engage in online social networks all day long, checking on their friends periodically from PC, tablet, and phone; maintaining ongoing dialogs; and sharing the nuances of their day.

### **Essential Information**

Web logs or *blogs* are one of the earliest forms of social media. A blog is a website created to express one (or more) individual's views on a given topic. As blogs became more mainstream, tools were developed to assist anyone in creating a blog. Some blogs allow visitors to post feedback and comments. Blogs can function as discussion boards on

a particular topic as interested parties repeatedly check for new comments and leave their own messages in an ongoing dialogue. Bloggers may be famous thinkers and authors, or they may be everyday folks. Blogs exemplify the power of the Internet to level the playing field and give everyone a voice. Blogs exist on nearly every topic and express most points of view.

A *wiki* is a website designed to allow users to add, remove, and edit content. This approach to building web content is called crowdsourcing. *Crowdsourcing* employs the power of online communities to accomplish some task. *Wiki* is Hawaiian for “fast.” The most popular wiki is Wikipedia, the “free encyclopedia that anyone can edit.” For wikis to be most effective, it helps to have professionals reviewing new entries for accuracy. Wikipedia has tens of thousands of contributors—of which, more than 1000 have earned a trustworthy reputation and have volunteered to monitor various subject areas. Wiki software has been used to create thousands of online wikis for as many different purposes. Businesses use wikis for project management and cross-company collaborations.

*Social networking* websites provide web-based tools for users to share information about themselves and to find, meet, and converse with other members. The most popular social networking site is Facebook. Google developed a social network called Google+ to compete with Facebook. Considering Facebook’s over 850 million users, and several years’ head start, Google+ has quite a challenge.

Social networks provide members with their own personal webpages and allow members to post photos and information about themselves. Social networking sites allow members to send messages to each other and post comments on each other’s pages. Members accumulate friends through an invitation process. Special interest groups can be created and joined. Businesses also can create pages and recruit followers.

Facebook provides an application development platform so that developers and tech-savvy members can create applications to run within Facebook. Today there are thousands of Facebook apps available, including family and friends apps, sports enthusiast apps, lifestyle apps, business apps, education apps, gaming apps, and just for fun apps.

Twitter is a social media app that allows members to report on what they are doing and thinking throughout the day. Referred to as a *micro-blogging* service, Twitter allows users to send short text updates (up to 140 characters long) from a cell phone or the Internet to their Twitter page to let followers know what they are up to. Twitter updates can be forwarded to MySpace or Facebook. Many Twitter users prefer to use third-party software designed to add organizational features to Twitter.

*Media sharing* websites like YouTube for video sharing and Instagram or Flickr for photo sharing provide methods for members to store and share digital media files on the web. YouTube allows members to post homemade video content in categories such as Education, Comedy, Entertainment, Film & Animation, Howto &

Style, News & Politics, People & Blogs, Pets & Animals, Sports, and Travel & Events. Flickr allows its members to upload photos to their own personal online photo album and choose photos to share with the community or friends.

Instagram provides mobile apps for members to use to snap and edit photos to share with friends on the Instagram website and social media. Flickr uses a methodology of ranking content that has become popular with many Web 2.0 sites. Formally called a *folksonomy* or *collaborative tagging*, Flickr allows users to associate descriptive tags with photos. A photo of your pet poodle at the beach might be tagged with “Dog,” “Pet,” “Poodle,” and “Beach.” Using associated tags, Flickr can easily group photos together and gather information on what types of photos are most abundant. Flickr uses this information to create a *tag cloud*—a diagram of keyword links with the size of each word representing the amount of photos that use that tag.

Another example of social media is social bookmarking. *Social bookmarking* provides a way for web users to store, classify, share, and search web bookmarks. The main purpose of social bookmarking sites is typically to provide a view of the most popular websites on the web at any given instant. Often social bookmarking sites offer web browser add-ons (extensions) that provide a button on the toolbar for recommending web content. For example, Digg is a social bookmarking website that shows trending news stories. Delicious is a social bookmarking site that allows members to create collections of links called stacks around specific topics like dog shows or the vegetarian lifestyle. When you sign up for delicious, you can install software on your computer that provides a button on your browser toolbar. When you find a page you wish to bookmark, you just click the Tag button on your toolbar and the link is stored in your bookmark list on <http://delicious.com>. A big benefit of social bookmarking is the ability to store your own personal bookmarks on the web so you can access them from any Internet-connected computer.

## Web Research

### Lesson Topics

1. Introduction to Web Research
2. Web Search Engines
3. Web Directories
4. Publications and Academic Resources
5. Crowd-sourced Resources
6. Evaluating and Citing Online Resources

### Overview

Web research skills include knowing how to use search engines and Web directories, as well online publications and academic resources. It is also important to know how to use resources compiled collaboratively (crowd-sourced) and to properly evaluate and cite the Web sources you use.

The Web is a great source of information and it contains a wealth of knowledge, but it is useless if you cannot find what you are looking for. The Web is unregulated and just about anyone can post anything. Because the Web contains a huge amount of information, users must often wade through a lot of “virtual pollution” to find useful information. Knowing how to use search tools and evaluate the information you find is essential to doing research on the Web.

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#### *1. Introduction to Web Research*

##### **Skills Covered**

The World Wide Web consists of billions of interconnected Web pages from a wide variety of sources. When faced with the task of researching a specific topic online, it can be difficult to know where to start.

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#### *2. Web Search Engines*

##### **Skills Covered**

Web search engines like Google are the most powerful tools for finding that “needle in a haystack.” Typing in words related to your topic yields a list of links sorted by relevance, with the most promising links listed first. Getting a search engine to provide search results relevant to your topic requires selecting just the right key terms.

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### *3. Web Directories*

#### **Skills Covered**

If you have a general topic that interests you, but don't know enough about it to form an intelligent search query, a Web directory can be helpful. Web directories are created and maintained by human editors who collect useful Web pages on many topics and organize them into a hierarchical structure.

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### *4. Publications and Academic Resources*

#### **Skills Covered**

The Web provides convenient access to many traditional research tools that have helped researchers for decades prior to the first Web page.

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### *5. Crowd-sourced Resources*

#### **Skills Covered**

The advent of Web 2.0 transformed the Web into a community where everyone was invited to share their knowledge, thoughts, and opinions. The process of Web users cooperating to create or solve something online became known as crowd-sourcing. Wikipedia is an example of a crowd-sourced resource.

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### *6. Evaluating and Citing Online Resources*

#### **Skills Covered**

Now that you have learned how to find information on the Web, it is important to consider evaluating your sources. You need to determine if the Web sites you have discovered are legitimate, unbiased sources of credible information. It is also essential to give credit and properly cite your sources.

## Freedom of Speech

**Freedom of speech** refers to the ability of a person to publicly speak or publish any thought without legal constraints or repercussions.

### Why This Matters

Free speech is a fundamental right in democratic societies. The First Amendment to the U.S. Constitution guarantees citizens the right to free speech. The Internet and web have allowed people to communicate their views to a greater extent and with a broader reach than has ever before been possible, and many are taking full advantage of this freedom. Freedom of speech provides many benefits; however, some people use free speech in a dangerous and hateful fashion, placing individuals, groups, businesses, organizations, governments, countries, and perhaps even the entire human race at risk. When, if ever, does free speech go too far?

### Consider This

Most of us know that employers check social networks as part of their background check for prospective employees. In 2012 some U.S. government agencies and companies started asking for Facebook usernames and passwords as part of the job interview process so they could check the applicant's private profile. With a tough job market, many interviewees felt obliged to go along with the request.

When newspapers reported this new hiring practice, Facebook threatened to sue the companies involved for violating member privacy. The American Civil Liberties Union (ACLU) joined the fight as well, calling the practice an invasion of privacy. Senators Richard Blumenthal and Charles Schumer called for a federal investigation into the new hiring practice. With unemployment at 8 percent in the U.S., Blumenthal and Schumer said that such requests amount to a form of coercion "that could set a dangerous precedent." "In an age where more and more of our personal information—and our private social interactions—are online, it is vital that all individuals be allowed to determine for themselves what personal information they want to make public," Schumer said. "This is especially important during the job-seeking process, when all the power is on one side of the fence." According to Blumenthal, a ban on such hiring practices is necessary to stop unreasonable and unacceptable invasions of privacy. "With few exceptions, employers do not have the need or the right to demand access to applicants' private, password-protected information," he said. Consider both sides of this story. How do employers benefit from reviewing prospective employee Facebook profiles and activity? Why might some prospective employees feel that this practice inhibits their freedom of speech and invades their privacy, even when they don't have anything to hide?

### Essential Information

There are websites, blogs, podcasts, YouTube videos, and social media groups to cover every conceivable topic and point of view. The Internet is used to espouse the views and beliefs of every religious and political group. The Internet has become a

tool for organizing citizens around issues of injustice. In some cases governments have cut off access to the Internet in order to gain control over a population (see video). Governments, including the U.S., are considering the creation of an Internet “kill-switch”—a single shut-off mechanism for all Internet traffic—to use in situations of social unrest or cyber attack. The idea has strong opposition from civil rights groups that consider such an action an inhibition of free speech.

The web has become a platform for anyone and everyone with access to publish information and misinformation. Websites may include points of view that many find offensive and even dangerous, such as those that support or promote suicide, racism, hate, or terrorism. This section examines the social implications of freedom of speech on the Internet and how varying societies deal with controlling what is expressed online.

### **Freedom of Speech Topics**

- Web Empowerment
- Internet Censorship
- Internet Decency
- Computer-Based Violence
- Network Neutrality

### **Web Empowerment**

**Web empowerment** refers to the power that the web provides for individuals to express themselves, influence others, and affect the course of society.

#### **Why This Matters**

Perhaps the largest impact of the web on all cultures is providing ordinary people with the ability to publish their views to the world. Before the web, only large companies, mass media, and governments were able to broadcast messages to the world. The web provides this ability to anyone who can access an Internet-connected computer. People are taking advantage of that power to express dissatisfaction and offer constructive—and sometimes destructive—criticism to those in positions of power. Because of this, businesses and governments are more interested in pleasing their customers and citizens than ever before.

#### **Essential Information**

The Internet has been grasped as a tool to empower those who traditionally have been without a public voice. At websites such as Complaints.com and the Ripoff Report (sponsored by the Bad Business Bureau), customers who feel they have been ripped off by a business can post complaints. Epinions.com provides consumer reviews about most products, which empowers customers to make wise purchasing



decisions. There is no longer reason for consumers to be taken by surprise by the quality of products purchased.

Bloggers have been an important component in online public opinion and journalism. A blog, short for web log, is a website created to express one (or more) individual's views on a given topic. Beyond consumer reviews, blogs extend to cover social editorials and even news journalism. News-reporting bloggers are sometimes referred to as citizen journalists. Mainstream media—the traditional news organizations—originally discredited citizen journalists as amateurs without credentials who operate without proper journalistic mechanisms, such as reliable sources and proper quality control and editing. Others consider citizen journalism a healthy democratic counterbalance to mainstream media, forcing more transparency and honesty in news reporting. Many mainstream media companies now support citizen journalism by providing a portion of their websites for news items submitted by citizen journalists.

The proliferation of digital cameras and camera phones and the ability to easily transfer digital photos have led to many amateur photographers having their photos published. More amateur photos are gracing the front pages of newspapers because a member of the public with a digital camera was at the scene of a breaking story before the press. Sometimes those photos are used in police investigations. The FBI relied on photos submitted by pedestrians to catch the Boston Marathon bombers in early 2013.

Just as the Internet and web have allowed people to stand up to businesses and news media, they have given citizens the power to be heard by the government. Blogs published secretly by citizens living under repressive governments have been instrumental in bringing international attention to their plights and influencing change. The Internet is the perfect tool for gathering people around a cause and organizing rallies and protests. In 2011, young Egyptians used Facebook to rally supporters and organize protests that eventually led Egyptian President Hosni Mubarak to step down. The web can be used to remove leaders from power and also to put new leaders in office. The web has become an important organizational and fundraising tool in U.S. presidential elections.

Perhaps the best example of web empowerment is WikiLeaks. WikiLeaks is a website that publishes confidential documents leaked by employees and others in order to create more transparent business and government practices. In 2011 WikiLeaks released hundreds of thousands of leaked confidential government documents to the public. In reaction to the move, several online banks and financial services blocked WikiLeaks transactions, leaving WikiLeaks financially strapped and struggling. The founder of WikiLeaks, Julian Assange, has inspired many dedicated followers who work to keep WikiLeaks and Assange in business. Others believe WikiLeaks has compromised U.S. national security, and endangered sensitive international relations.

## Internet Censorship

**Internet censorship** refers to the control of speech and other forms of expression over the Internet and web by a government or authority.

### Why This Matters

Censorship may serve a useful purpose when it protects people from serious harm—but who decides what is harmful? What, if anything, should be censored?

Pornography and indecent images and language? Instructions on how to make a nuclear bomb? Terrorist recruitment websites? Neo-Nazi hate messages? Anti-government sentiments and ideas? Who should decide what is censored? Finding the right balance between freedom of speech and censorship can mean the difference between a free democracy and totalitarian rule.

### Essential Information

Although the First Amendment to the U.S. Constitution protects freedom of speech in the United States, there are some restrictions. *Libel* is the deliberate act of defamation of character by making false statements of fact. Libel and direct, specific threats are not protected under the First Amendment. Consider the 15-year-old student who was fined \$4200 for posting an embarrassing video of his schoolteacher on YouTube. Each year, hundreds of similar lawsuits are brought against individuals who post damaging untruths about individuals or companies on the web.

Laws regarding speech vary from country to country. Various forms of censorship exist around the world. Free speech and Internet technologies are most threatening to repressive governments whose citizens lack political and social freedom.

The Chinese government blocks its citizens from many overseas sites and arrests citizens who post obscene or subversive content on the web. Chinese law enforcement officers monitor computer users through a physical presence and through electronic surveillance. Internet cafés in China, where most citizens access the Internet, are equipped with video camera surveillance. Chinese websites like the one shown in the figure may have anime “police officers” to remind people to watch what they read and say online.

In 2010, Google, incensed by Chinese hackers, gave the Chinese government an ultimatum: allow Google to provide uncensored search results, or Google would pull out. After months of negotiations, Google ultimately closed its Chinese search engine. But China isn’t the only one censoring search results. Google has posted an online tool that allows users to see which governments request Google to remove content from search results and YouTube. Among the countries listed are Brazil, Germany, India, and the United States.

If you were under the impression that there is no censorship in the United States and other free democracies, think again. Some information is censored because it is deemed to be dangerous to the public. For example, it is illegal in the United States to make certain encryption technologies available to certain foreign governments. This is in an

effort to keep potentially dangerous foreign governments from using U.S. technologies to decrypt national secrets. After the shootings at Columbine High School in Littleton, Colorado in 1999, the U.S. Congress passed a law mandating 20 years in prison for anyone distributing bomb-making information with the intent to cause violence. Because explosives have numerous industrial uses, many websites continue to contain bomb-making instructions. The Internet is not the only method for obtaining such information, however. Encyclopedia Britannica includes bomb-making instructions, as does a booklet published by the U.S. Department of Agriculture. The same types of explosives used by farmers to remove tree stumps were used in the Oklahoma City bombing in which 168 people lost their lives. This illustrates the difficulty of censoring information that is valuable for both legal and illegal purposes.

Censorship is a hot topic in the scientific research community as an increasing number of scientific publications are being censored on the grounds that they are a threat to national security. The National Academy of Sciences suspended the publication of an article in its journal that described the risk of terrorists poisoning the nation's milk supply using botulinum toxin. The U.S. Department of Health and Human Services considered the information in the article useful to terrorists and prevented it from being published.

Increasingly, private web content companies are taking it upon themselves to censor materials posted through their services. You will notice that YouTube, Facebook, Flickr, and other sites try to avoid videos and photos that might be construed as dangerous or indecent. These businesses have the right to censor content on their sites because their users have signed a terms of use agreement. Apple has purged its App Store of thousands of apps that might be construed by any of its users as indecent.

There is some concern that Internet service providers (ISPs) may soon play a role in censoring the information that flows through their systems to people's homes and businesses. Major U.S. Internet providers agreed to filter Internet and web content in order to find child pornography. Some fear that ISPs may next filter illegally downloaded music and movies, and other content that the government or others convince them should be banned. This fear nearly became a reality when the Stop Online Piracy Act (SOPA) nearly made it to law in 2012. The law would have required ISPs to shut down websites suspected of breaking copyright laws.

These examples illustrate the difficulty of censoring public speech. Censorship typically includes an infringement on an individual's rights in exchange for a perceived greater public good. Because definitions of concepts such as dangerous information and decency differ, any government that attempts to define these terms for its citizenry risks alienating a percentage of the population. Censorship often contradicts the basic tenets of societies that value freedom and individual rights.

## Internet Decency

**Internet decency** refers to efforts by governments and others to rid the Internet and web of content that they consider indecent or to filter indecent content from some users.

## Why This Matters

Most countries support the Internet's ability to empower its citizens but struggle with issues regarding the perceived negative aspects of Internet access. One major concern is keeping indecent content from minors. Because the Internet does not have a rating system like motion pictures and television, theoretically, anyone who can connect to the Internet can view any content there. With increasing numbers of very young children making the Internet a part of their daily lives, it is natural for parents and others to wish to protect them from viewing content that is inappropriate and harmful.

## Essential Information

Several governments have made efforts to protect their citizens from indecent web content. Australia has a commonwealth law that holds Internet service providers and Internet content hosts responsible for deleting content deemed "objectionable" or "unsuitable for minors" from their servers per a take-down notice from the government regulator the Australian Communications and Media Authority. Some Australians feel that the law has failed to reduce the availability of pornography, as it is still readily available from other countries.

The U.S. government has made similar attempts to eliminate indecent content from the web with its 1995 Communications Decency Act. Less than a year after being passed, the law was repealed due to the government's inability to define terms such as "indecent," "obscene," and "lewd," on which the law was based. One person's obscene content may be another person's work of art. During its brief enactment, the law had a serious effect on legitimate and useful websites that may have been considered indecent by terms of the law. Family planning websites, medical websites, and art and literature websites pulled their content in fear of prosecution. For example, it was difficult to find information regarding breast cancer on the web while the law was in effect.

The challenge of censorship is keeping certain content (such as pornography) from a subset of the population (such as minors) without encroaching upon the freedom of adults. One solution is content-filtering software. *Content-filtering software* like NetNanny (see figure) works with the web browser to check each website for indecent materials (defined by the installer of the software) and only allow "decent" webpages to be displayed.

Content-filtering software is ideal for situations where one person is responsible for setting the rules and defining what is allowable. For example, at home, parents may use filtering to block out what they consider inappropriate for their children. In the workplace, management may use such software to filter out non-business-related websites. Such software becomes problematic in larger democratic situations where definitions of decency may vary. For example, the 2000 Children's Internet Protection Act requires schools and libraries that receive federal funding for technology to implement content filtering. The law created a stir in the public library system when it was discovered that filters block access to many valuable nonpornographic websites. Libraries bound by their own Library Bill of Rights, which opposes restrictions based on

age, were forced to find creative strategies to meet the letter of the law while providing the maximum amount of access to adults.

Child pornography goes beyond being indecent and is unlawful in most countries. Many criminals have gone to jail for producing, publishing, and viewing child pornography. British Telecommunications (BT) has applied content-filtering software to the entire British Internet infrastructure to block access to child pornography websites.

## Computer-Based Violence

**Computer-based violence** refers to acts of interactive simulated violence provided by computer games.

### Why This Matters

Never before has it been so easy to commit brutal acts of violence in realistic environments without causing harm to others. Although playing violent video games does no one any physical harm, psychologists, parents, governments, and others wonder how violent role-playing affects the minds of gamers. Are violent gamers more likely to be aggressive in the real world, transferring what they learn in the gaming environment to real life? This is a hotly debated issue that involves many people and governments around the world.

### Essential Information

In efforts to engage teen and older gamers, games have progressively moved to more violent themes. The popular and controversial Grand Theft Auto (GTA) remains a topic of great debate due to its graphic depiction of extreme violence. Some people have become concerned about the effects of prolonged exposure to violence on game users. GTA was banned in Thailand after a disturbed teenager allegedly killed a taxi driver, reenacting a scene from the game. Six teens in New York City were arrested after going on a GTA-inspired crime spree. More recently, the school massacre in Newtown, Connecticut, created more pressure on video-game makers and retailers as Washington and advocacy groups grew even more concerned about possible links between violent games and violent crime. The United States, the United Kingdom, Australia, and other countries have all gone back and forth on banning GTA in response to outcries from concerned parents and other constituents.

GTA isn't the exception, however. There are hundreds of first-person shooter games available. First-person shooter games are those in which the player becomes the game character that does the shooting and killing. They include war games like *Halo*, *Call of Duty*, *Gears of War*, and *Splinter Cell Conviction*. There are also police games like *Crackdown* and *Condemned: Criminal Origins*. There are fantasy games like *Aliens vs. Predators*. In some games the player fights to save the world; in others the player fights as the villain. In all cases, virtual shooting, maiming, and killing become second nature. In an attempt to distance itself from real-life violent acts, game maker Electronic Arts, responsible for first-person shooter games like *Medal of Honor* and *Battlefield*, decided

to end its licensing deals with gun makers whose brand-name hardware it had featured in its games for years.

Studies on the impact of violent games on users have been inconclusive. As video games become increasingly realistic, providing interactive virtual worlds that are less discernable from reality, it seems logical that the violent acts carried out in games will more easily transfer to real life. Also, as individuals spend more time in violent, high-anxiety situations, it is logical that some desensitizing to violence occurs, along with other effects to the psyche. Although these assumptions seem logical, some studies support them and others show them to be untrue.

## **Network Neutrality**

**Network neutrality** refers to a principle applied to high-speed Internet services whereby all data is delivered to all users with equal priority.

### **Why This Matters**

The Internet was designed to be a free and unfettered communications medium. Now that big telecom companies control access to the Internet, many worry that they may begin filtering Internet traffic and giving some traffic precedence. Many scholars, tech professionals, and other members of the public think the Internet should stay free—free as in net neutral. However, the telecom companies complain that their networks cannot support the amount of network traffic generated by the Internet and that bandwidth hogs must be regulated through technologies like traffic shaping. Some feel that it's up to the federal government to decide who is right.

### **Essential Information**

Network neutrality has been a hot topic. Content and application providers, such as Yahoo!, Google, and Vonage, have engaged in legal battles with network providers, such as Comcast and AT&T, over whether the network providers have the right to charge content providers for certain services. The content and application providers are concerned that network providers are planning to prioritize what is sent over their networks, giving preference to some Internet services over others. Content providers fear that network providers will start managing the flow of information, changing the current free-flowing, “neutral” status of the Internet. They want the U.S. government to impose restrictions on the network providers to keep the flow of information unrestricted.

Comcast has been investigated by the FCC for limiting, or throttling, certain types of Internet traffic. The investigation was launched after users complained that video uploads over Comcast's network slowed to a crawl or a standstill. After weeks of FCC hearings, Comcast admitted to limiting certain types of P2P traffic in its efforts to ensure a reliable Internet experience for its customers.

The FCC ordered Comcast to stop throttling BitTorrent video traffic. Comcast complied by implementing a protocol-independent approach to filtering that throttles any user that is hogging the network bandwidth. Later, however, a grand jury determined that the FCC does not have jurisdiction over Internet service providers. So today, Comcast and other ISPs are free to throttle and traffic-shape as they see fit.

The battle over network neutrality has been raging for years and will most likely continue for years to come. Roughly equal numbers of individuals, groups, and corporations are on either side of the issue. Generally, Republicans and ISPs oppose government oversight to provide network neutrality while Democrats and content providers support it. In 2010, the Democrat-led FCC put forward policies that would support network neutrality in a limited scope. In 2011 the Republican-led Congress fought to override the FCC's authority and overturn the policies. A Google search on network neutrality always provides plenty of current news articles.

## Web Publishing

### Lesson Topics

1. Publishing a Blog
2. Publishing Images
3. Publishing Videos
4. Publishing to Social Networks
5. Publishing a Web Site

### Overview

Web publishing involves making your opinions, digital media, and other intellectual property available to the public through Web resources like blogs, social networks, and other Web sites. The Web has made it possible for anyone with an Internet connection to publish information, photos, video, music and ideas for the world to read, view, and listen to. Blogging tools like Blogger and WordPress, and Web sites like Facebook, YouTube, and Flickr have millions of users sharing content online every day.

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#### *1. Publishing a Blog*

##### **Skills Covered**

A blog is a Web site where you regularly post your thoughts. The most recent post is displayed at the top of your blog page, followed by previous posts in reverse chronological order. Visitors to your blog can comment on it, or link to it, or e-mail you a response. And those who enjoy your blog can subscribe to it and be notified whenever something new is posted.

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#### *2. Publishing Images*

##### **Skills Covered**

Sharing images online is one more way the Internet has made the world a little smaller. Web 2.0 technologies provide online services designed specifically for sharing photos, saving you the trouble of setting up a Web site or blog for that purpose.

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### *3. Publishing Videos*

#### **Skills Covered**

First came photos, then came video. As technology allowed us to easily capture video on our video cameras, point-and-shoot cameras, and cell phones, it was only a matter of time before we could post and share videos online. By far the biggest video hosting Web site is YouTube.

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### *4. Publishing to Social Networks*

#### **Skills Covered**

Social networks like MySpace and Facebook give individuals a central location to connect and reconnect with friends and family, and keep track with what is going on in their lives whether they are neighbors or are thousands of miles apart.

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### *5. Publishing a Web Site*

#### **Skills Covered**

There are many online services that make it easy to create a personal Web site, such as Weebly.com. Weebly is a free service. You can choose from hundreds of design themes, you can include photo galleries, maps, Flickr photos, YouTube videos, contact forms, and much more. Weebly even lets you add a blog page to your Web site and handles all the complicated back-end details for you.

## Telecommunications

**Telecommunications** refers to the electronic transmission and reception of signals for voice and data communications.

### Why This Matters

Telecommunications (telecom) networks play a vital role in our daily activities. From the global telecom networks that make up the Internet, to short-range wireless technologies that pass data back and forth between a mobile phone and headset, telecommunications technologies keep people and devices continuously connected.

### Consider This

Today most U.S. mobile phone users own smart phones, phones that have Internet access and can download apps. Smart phones are expected to make up two thirds of all mobile phones by 2017, gradually squeezing plain cell phones out of the market. In developing countries, more people access the Internet via their mobile phones than via computers. Smart phone and tablet popularity, combined with growing cellular and Wi-Fi network availability, is creating an environment where people are no longer bound to desks or any particular location to do work and be productive. Tablet and smart phone sales are skyrocketing while PC sales are tanking. Mobile apps, GPS, and easy access to information further support and even encourage a mobile workforce and lifestyle.

What is gained, in terms of productivity and job satisfaction, by the ability to be mobile? Is anything lost? How does mobility impact professionals in careers that interest you?

### Essential Information

Telecommunications technologies affect our lives in many ways every day. Telecommunications technologies produced the Internet and the many ways of accessing it. These methods include wired connections through Internet service providers, and wireless technologies through Wi-Fi and cellular networks. Telecommunications technologies provide voice, video, text, and other forms of communications to a wide variety of clients worldwide, from individuals to corporate offices. From small home networks to large private global networks, telecommunications technologies give us access to public and private information, communication, and services wherever we may be, whenever we need them. This section begins by presenting the fundamental technologies that support all types of telecommunications networks. It then progresses to focus on cellular network technologies and wireless data communications. The section concludes with a look at a wide variety of computer network technologies.

## Ethical Dilemmas

Today nearly all of our communication and information access is accomplished through telecommunication systems: cellular networks, Wi-Fi networks, corporate networks, and of course, the Internet. The companies that control these networks have tremendous responsibility and power. They control who can access the networks. They also control what information can travel over their networks. Issues of censorship and privacy have arisen when network providers have filtered data that flows over their networks. Internet Service Providers can block users who download movies from illegal sources, and cellular providers can collect confidential user information from mobile phones, including location information. Ethical issues arise when network providers offer services only to densely populated areas in order to maximize profits, creating a digital divide.

Today, more than ever before, information is power. In order to provide information access equally to all people, governments often step in to provide incentives and regulate how telecom companies behave. Do you think this is wise? Should the market alone drive what telecom companies do? How much, if any, government intervention is required, and in what form? In their efforts to fight crime and terrorism, governments and law enforcement agencies have been known to ask telecom companies for confidential information about customers. Should government access to network information be regulated?

## Telecommunications Topics

- Infrastructure
- Cellular Network
- Wireless Data Communications
- Computer Network

## Infrastructure

In telecommunications, **infrastructure** refers to the hardware, software, and protocols that support telecommunications.

### Why This Matters

Both voice and data communications have become an important part of our daily lives. Understanding the hardware, software, and protocols that support this useful technology can help you select telecommunications services that are best suited to your needs.

## Essential Information

As with all forms of communications, telecommunications requires a sender, a receiver, a signal that contains information, and a medium over which the signal

travels. For telecommunications to function as intended, both the sending device and the receiving device need to speak the same language. The language of telecommunications is governed by protocols. Telecommunications media such as cables and the air carry the mostly digital signals that represent the information being sent. Telecommunications devices such as routers, network adapters, Wi-Fi access points, cellular towers, and satellites send and receive the signals, employing telecommunications software that governs their operations. Various combinations of devices, media, software, and protocols can provide varying qualities of service. This section looks at the most important components of telecommunications infrastructure and the effects they have on the quality of communications.

### Infrastructure Topics

- Telecommunications Signals
- Telecommunications Media
- Radio Spectrum
- Telecommunications Devices
- Telecommunications Software

## Telecommunications Signals

**Telecommunications signals** are analog or digital electronic transmissions for the purpose of communication.

### Why This Matters

Companies go to great lengths to send telecommunications signals to every corner of the globe (see video). The signals used to send information over voice and data networks can vary in speed and strength. Understanding how the speed and strength of signals impact a network's performance can help you when choosing and using network services.

### Essential Information

If you were to measure the voltage on a traditional home telephone wire during a phone conversation, you would see fluctuations in voltages similar to the signal shown on the left (a) in the first figure. This type of signal is called an *analog signal*, and it fluctuates continuously, creating a curved waveform. Originally, many types of telecommunication, such as phones and radios, were based on analog systems because they were designed to carry the sound of a voice, and sound waves are analog signals. Today, even signals like voice that traditionally were analog are increasingly sent using *digital* technology, the same technology that computers use to communicate.

In contrast to analog systems, if you measure the voltage on cables used to connect PCs, you will probably see something comparable to the signal on the right (b) in the

first figure. This signal, at any given time, is either high or low. This type of discrete voltage state—either high or low—is called a *digital signal* and has a box-like waveform. The two states are used to represent the state of a bit: high for 1, and low for 0. Digital signals are designed to carry computer data, which is digitally represented as bits.

The speed at which an electronic communications signal can change from high to low is called the signal *frequency*, illustrated in the second figure. A faster frequency means a faster data transmission rate. Signal frequency is measured in *hertz (Hz)*, or cycles per second. In computer networks, the data transmission rate is also referred to as the *bandwidth* and is measured in *bits per second (bps)*. Today's bandwidth options fall into one of two categories: narrowband or broadband.

Broadband media are those advertised by Internet service providers as “high-speed.” In home use, the terms *broadband* and *high-speed Internet* refer to a connection that is *always on* or active, such as cable or DSL. These connections are significantly faster than old-fashioned dial-up telephone connections. DSL and cable claim maximum download speeds of 6 Mbps (megabits per second) and 50 Mbps, respectively. New 4G cellular technologies are bringing similar speeds to cellular networks. *Narrowband* is considered any medium with a speed less than 200 Kbps (kilobits per second). With the efforts of governments to bring high-speed networking to all, narrowband connections are a shrinking minority.

## Telecommunications Media

**Telecommunications media** include anything that carries a signal and creates an interface between a sending device and a receiving device.

### Why This Matters

Various types of media are used for telecommunications networks. Each medium has its own characteristics, including transmission capacity, speed, convenience, and security. When developing a network, the selection of media depends on the environment and use of the network. Media should support the needs of the network users in a given environment at the least cost, taking into account possible future needs of the network. Using the wrong type of media can reduce productivity, or waste money.

### Essential Information

Different communications media connect systems in different ways. Some media send signals with low voltage or light along physical connections such as cables, but others send signals through the air using radio waves.

Different physical cables offer a bandwidth range from narrowband to broadband. Cables have an advantage over wireless options because some cables support much

higher data transfer rates than wireless technologies and are considered by some to be more secure. The disadvantage of cables is their physical presence. Cables need to be installed, typically in an inconspicuous manner: They are run underground, undersea, and through utility tunnels; strung from pole to pole, through attics and basements and above ceiling tiles; pulled down inside walls, through walls, and around the interior of a room. Depending on the environment, laying cable can take a considerable amount of time and effort. Three types of transmission cables are typically used to connect data communications devices: twisted pair copper cable, coaxial cable, and fiber-optic cable (see table below).

Telecommunications signals can also travel through air using radio waves. A radio wave is an electromagnetic wave transmitted through an antenna. All wireless telecommunications—cell phones, wireless Internet, AM and FM radio—make use of radio waves designated to certain frequencies. The radio spectrum is divided up for various uses on various frequencies by government agencies. In the United States, the FCC (Federal Communications Commission) oversees the radio spectrum.

**Table: Types of Cable**

Cable	Description
Twisted pair	Pairs of twisted wires covered with an insulating layer, used for telephone and computer networks. Available in varying categories (“cats”) to support a wide range of bandwidths.
Coaxial	An inner conductor wire surrounded by insulation, a conductive shield, and a cover used for cable TV and other applications. Supports faster data speeds but is more expensive than twisted pair.
Fiber-optic	Consists of thousands of extremely thin strands of glass or plastic bound together in a sheathing (a jacket); transmits signals with light beams. Much faster than coaxial and twisted pair, but also much more expensive. Used for backbones of telecom networks and in some local area networks.

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## Radio Spectrum

**Radio spectrum**, part of the electromagnetic spectrum, refers to all of the frequencies available for radio waves from about 10 KHz to 300 GHz and their assigned uses.

### Why This Matters

The U.S. Federal Communications Commission (FCC) assigns different frequencies of the electromagnetic spectrum for different uses in the United States. For example, FM radio, cell phones, baby monitors, and garage door openers all operate at

different frequencies. If these devices were on the same frequency, they would cause interference for each other, and your cell phone conversation might trigger your garage door to open. The figure, courtesy of NASA, illustrates some attributes of the seven types of waves and rays in the electromagnetic spectrum. To show all frequency assignments would take a chart several feet tall. Such a chart is available in the On the Web links below. The radio spectrum allows for many different uses of radio signals and attempts to safeguard those uses from interference.

### **Essential Information**

Thousands of radio waves are passing through the air and your body as you read this. AM and FM radio waves, television, wireless phones, wireless computer networks, Global Positioning Systems, ham radios, CB radios, police and emergency communications, satellite communications, and wireless clock systems all make use of radio waves. All it takes to receive the information being transmitted on a specific frequency is a device with an antenna that allows you to tune in to that frequency. For example, when you tune your car radio to 98.9 FM, you are selecting the signal being broadcast at 98.9 MHz, and your receiver translates the fluctuations of the radio waves it receives into sound.

Some wireless applications require very little bandwidth. For example, AM radio requires a relatively low bandwidth to carry its low-quality mono audio signal in the low KHz range. FM radio provides a higher quality, stereo audio signal in the low MHz range. The mid MHz range is ideal for high-speed wireless Internet and cell phone use.

Waves sent at the high end of the radio spectrum, between 1 and 300 GHz, are called *microwaves*. These high-frequency waves have numerous uses. As you may have guessed, microwave ovens use microwaves (2.45 GHz) to cook food. Microwave signals are also used for high-speed, high-capacity communication links and satellite communications.

Above microwaves in the spectrum comes infrared light, used to send signals from television remote controls, and then visible light, ultraviolet light, x-rays, and gamma rays, none of which are commonly used to carry telecommunications signals.

### **Telecommunications Devices**

**Telecommunications devices** include the wide variety of computer hardware designed to support telecommunications activities for individuals and businesses.

## Why This Matters

Not long ago, networking devices were of interest only to network technicians. Today, the increase in home networking and wireless networks has provided a reason for everyone to acquire a basic understanding of the most common networking devices such as modems, network adapters, access points, and others.

## Essential Information

Telecommunications devices range in size and purpose from small Mi-Fi wireless adapters that fit in the palm of your hand and share a cellular connection with a computer, to satellites that manage data communications for thousands of users. A *modem* is a device that modulates and demodulates signals from one form to another, typically for the purpose of connecting to the Internet. The following table shows the various devices that enable computers to connect to networks and the Internet.

**Table: Network Connection Devices**

Device	Description
dial-up modem	Provides narrowband Internet connections over phone lines
cable modem	Provides Internet access to PCs and computer networks over a cable television network
DSL modem	Similar to a cable modem but provides high-speed Internet service over telephone lines
network adapter	A computer circuit board, PC card, or USB device installed in a computer so that the computer can be connected to a network
network interface card (NIC)	A circuit board or PC card that, when installed, provides a port for the device to connect to a wired network with traditional network cables
wireless adapter	A circuit board, PC card, or an external device that connects through an antenna-equipped USB port that is able to send and receive network radio signals
cellular devices	Cellular network carriers provide several options for connecting computers to the Internet. Cellular connect cards are USB devices that connect a notebook to the Internet through a cellular data plan. Some carriers allow users to “tether” or wirelessly connect computers to mobile phones to access the Internet. Mi-Fi routers are palm-size devices that wirelessly connect computers to the Internet through a mobile phone’s data service using Wi-Fi technology.

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For multiple computers to communicate over a computer network, special devices are required to control the flow of bits over the telecommunications medium and to



ensure that information that is sent reaches its destination quickly and securely. A number of different network control devices handle this responsibility. The table below provides brief descriptions of those that are most commonly used.

**Table: Network Control Devices**

Device	Description
hub	A small electronic box used as a central point for connecting a series of computers; sends the signal from each computer to all the other computers on the network. Hubs have largely been replaced by switches in today's networks.
switch	A fundamental part of most networks; a switch makes it possible for several users to send information over a network at the same time. Switches direct signals to the intended recipient only.
repeater	Connects multiple network segments; listens to each segment and repeats the signal heard on one segment onto every other segment connected to the repeater. Repeaters are helpful in situations where a weak signal requires a boost to continue on the medium.
bridge	Connects two or more network segments, as a repeater does; a bridge also helps to regulate network traffic.
gateway	A network point that acts as an entrance to another network.
router	Determines the best path for passing a data packet between networks to its destination.
wireless access point	Typically a Wi-Fi device, connected to a wired or cellular network to send and receive data to wireless adapters installed in computers and other devices; it allows devices to connect to a network wirelessly.
firewall	Device or software that filters the information coming onto a network; it protects the network computers from hackers, viruses, and other unwanted network traffic. Many routers include firewall capabilities.

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Large corporations and telecommunications companies require expensive, heavy-duty devices to manage large amounts of network data, often using microwave or satellite transmission.

Microwave transmission, also called terrestrial microwave, is a *line-of-sight* medium, which means that a straight line between the transmitter and receiver must be unobstructed. Microwave transmissions can be sent through the air up to distances of approximately 31 miles (50 kilometers). Microwave towers are placed along interstate highways and other unobstructed stretches to carry thousands of simultaneous communications channels.

In areas where microwave towers are impractical, or in order to send data long distances, communications satellites are employed. A *communications satellite* is basically a microwave station placed in outer space. Satellites receive a signal from one point on earth and then rebroadcast it at a different frequency to a different

location. Most of today's satellites are owned by telecommunications companies that rent or lease them to other companies. However, several large companies have their own satellites.

Television news organizations make use of small mobile satellite systems mounted on trucks that allow them to broadcast from remote locations. Some companies lease dedicated lines from telecommunications companies to maintain long-distance connections. A *T1 line* supports high data transmission rates by carrying 24 signals (64 Kbps) on one line. *T3 lines* carry 672 signals on one line and are used by telecommunications companies; some act as the Internet backbone.

## Telecommunications Software

**Telecommunications software** is software based on telecommunications protocols used to control, monitor, and troubleshoot data traveling over a telecommunications network.

### Why This Matters

As you have no doubt learned, hardware is useless without the software necessary to drive it—and so it is with telecommunications and computer networks. Networking software performs a number of important functions in a computer network. It monitors the load, or amount of traffic, on the network to ensure that users' needs are being met. It provides error checking and message formatting. In some cases, when there is a problem, the software can indicate what is wrong and suggest possible solutions. Networking software can also provide data information security and privacy.

### Essential Information

Telecommunications companies have many custom-designed software utilities that they use to manage the flow of data over their networks. These industrial-strength applications are the domain of the professionals that use them. This section focuses on software used in private computer networks, and leaves the industrial systems to the professionals.

Servers that manage the data flowing over networks and the Internet use operating systems created specifically for the task, sometimes called *network operating systems (NOS)*. Network operating systems are responsible for creating data packets to send over a network, sending those packets, and receiving packets sent from other computers, or nodes, on the network. Today's PC and mobile operating systems include networking features that allow them to carry out networking tasks.

Network management software allows system administrators to monitor the use of individual computers and shared hardware (such as printers), scan for viruses, and ensure compliance with software licenses. Network management software also

simplifies the process of updating files and programs on network computers. Changes can be made through a communications server instead of on each individual computer. Some of the many benefits of network management software include fewer hours spent on routine tasks (such as installing new software), faster responses to problems, and greater overall network control.

Network management software isn't only for administrators. Many smart phones also have the capability to provide diagnostics. Android phones, for example, provide data usage information and allow the user to set an alarm to sound when the phone is nearing its monthly data limit. This helps users avoid penalties for going over their limit.

Routers, switches, firewalls, modems, and other telecommunications devices include software interfaces that allow you to change device settings. Once the device is connected to the network, its software interface can be accessed from a network computer, typically through a web browser. A wireless access point's software can be accessed to change security settings so that unauthorized users cannot access the network. The image on this page shows a Linksys setup page; this is where users can configure a host of settings. A router's software can be used to divide a physical network into multiple virtual networks. A firewall's software can be used to specify which data packets to allow in and which to keep out. Software for a dial-up modem might allow you to enable or disable call waiting.

A *protocol* is an agreed-upon format for transmitting data between two devices. A *standard* is an agreed-upon way of doing something within an industry. In the world of networking, protocols and standards are essential for enabling devices to communicate with each other. Protocols define the format of the communications between devices, and standards provide the physical specifications of devices and how they interconnect. The Internet uses the TCP/IP family of protocols. They have become the default protocols for most private networks as well.

*Ethernet* is the most widely used network standard for private networks. This standard defines the types of network interface cards, control devices, cables, and software required to create an Ethernet network. Other network standards, such as token ring, use unique hardware and software that are not compatible with Ethernet. Special devices such as routers or gateways are required to connect networks that use different standards.

## Cellular Network

A **cellular network** is a radio network in which a geographic area is divided into cells with a transceiver antenna (tower) and station at the center of each cell, to support wireless mobile communications.

## Why This Matters

Cellular network technologies have altered the way people live. The ability to communicate with friends, family, and business colleagues anywhere and at any time provides great benefits and perhaps some drawbacks. People can work more efficiently and flexibly. Cell phones have become a necessity in many cultures. To gain the most benefits from cellular technology, it helps to understand how the technology works and what services it provides.

## Essential Information

A cellular network is composed of many different technologies and devices. The challenge in supporting ubiquitous mobile communications is to find a method of sending and receiving telecommunications signals from devices that have a limited signal range. The solution that cellular networks provide is to cover a geographic area with many cellular towers dispersed in a honeycomb of cells, each roughly 7 miles (11 kilometers) across, so that wherever a device is within the area, it can connect with a tower. If a cell phone user travels from one cell to another, the system judges the cell phone's location based on its signal strength and passes the phone connection from one cell tower to the next. The signals from the cells are transmitted to a receiver and integrated into the regular phone system.

Each cell tower has a transmitting and receiving range of 3–15 miles (about 5–24 kilometers) depending on geography and environment. Because it is not economically feasible to cover the entire planet with towers, cell phone usage is limited to a network's coverage areas (see figure), which often focus on metropolitan areas and major highways. The inability to provide 100% coverage, combined with the limitations of working with wireless signals that are prone to interference, results in less-than-perfect quality of service for cell phone users. Cell phone technologies have progressed through three generations and are currently in 4G.

**Table: Cell Phone Generations**

Generation	Defining Characteristics
1 <sup>st</sup>	The original analog cell phone network
2 <sup>nd</sup>	Digital cell phone service
3 <sup>rd</sup>	Internet services over cellular networks
4 <sup>th</sup>	High-speed Internet service over cellular networks

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Selecting a cell phone service is no small task. The variables involved in the decision are many and complex. When you choose a cell phone service, there are three primary decisions to make:

- Choosing a carrier
- Choosing a plan
- Choosing the device, features, and services that you want

These decisions are interdependent. Each carrier offers different mobile phones and devices, and cellular services are related to device capabilities. There are two different strategies for selecting a cellular carrier. You can choose a phone or tablet first and then find out which carriers support it, or you can choose a carrier first and then choose one of the devices that the carrier supports. If you know of a phone or tablet that you simply must have, then the first strategy is for you. If you have a strong inclination for a specific carrier—for example, the carrier that *Consumer Reports* rates number one, or that your family and friends all use, or that you know has excellent coverage where you will be using the service—then the second strategy is for you. This section covers topics that will assist you in selecting a cellular carrier, plan, and device.

### Cellular Network Topics

- Cellular Carrier
- Cellular Plans
- Cellular Services
- Mobile Phone

### Cellular Carrier

A **cellular carrier** is a company that builds and maintains a cellular network and provides cell phone service to the public.

#### Why This Matters

Choosing a carrier is an important step in the process of acquiring cell phone service. Since many carriers require a two-year contract, it becomes difficult and costly to switch if you find you've made a bad choice.

#### Essential Information

Many carriers provide cell phone service worldwide. The most popular U.S. carriers are Verizon, T-Mobile, AT&T, and Sprint. Different carriers offer different cell phones, features, coverage areas, and services. It is important to take your time when selecting a carrier as your choice will define your cell phone experience. It is typically costly and inconvenient to change your carrier once you've signed a contract.

Today's cell phone networks are all digital. The last analog cell phone networks were closed in 2008. The predominant digital networking standards for cell phone networks are GSM and CDMA. Global System for Mobile Communications (*GSM*) is the most popular international standard for mobile phones, used by over a billion people across more than 200 countries. AT&T, T-Mobile, and most international

carriers use GSM. The Code Division Multiple Access (*CDMA*) networking standard is used in the United States, where it is in equal competition with GSM. Sprint and other smaller U.S. carriers use CDMA. Verizon is moving from CDMA to GSM with its adoption of 4G LTE technology. LTE is the evolution of GSM to a faster wireless network standard. Carriers around the world are embracing LTE as the 4G standard of choice.

Mobile phones are designed to work on either a GSM or a CDMA network, but not both. Some popular phones offer both GSM and CDMA models. Often handset manufacturers will contract with one carrier for the initial release of a handset. Since AT&T and Verizon have the largest market share, they typically get the cool new phones. For example, the first iPhone and the Nokia Lumia 920 Windows phone were both first released on AT&T's network.

When choosing a carrier, it is useful to consult user survey data, such as that provided by *Consumer Reports*, as well as the opinions of friends. Check the coverage maps provided by the carrier's website to make sure that it offers the network speed you require (3G or 4G) in the areas where you live and work. Finally, compare the carriers' network standards (GSM, CDMA, LTE), phones, rates, and plans to find out which best suit your needs in your location. If you plan to travel abroad with your cell phone, you will probably want to use GSM or LTE.

## Cellular Plans

A **cellular plan** defines the terms of service provided by a cellular carrier to which a cellular user subscribes.

### Why This Matters

Cellular carriers offer service plans for every type of phone and cell-network-enabled tablet user. The trick is determining your usage habits and needs. Do you plan to use your cell phone locally, regionally, nationally, or internationally? During what time of day and on which days of the week will you use your phone or tablet? Will you use your phone for data (Internet access) as well as voice communications? The plan you select defines your terms of service for cell phone or tablet usage.

### Essential Information

Most carriers provide a choice of a prepaid plan without a contract, or a two-year subscription plan with a contract. Prepaid is a system in which you buy minutes up front that must be used in a given time frame, such as \$25 for 130 minutes that must be used in 90 days. Most users, however, opt to sign a two-year contract because it is more convenient and provides a significant discount on a mobile phone. Two-year service plans typically specify the terms of use according to where you can use your phone and how many minutes you can use it the phone per month, and where you can use your phone. T-Mobile offers plans without a contract that require customers

to pay the full price for a new phone. If two plans from different carriers seem roughly comparable in terms of features, you should view the coverage maps of both carriers and examine their phones and services. You should also find out which carrier your friends and family use, as phoning within the network could save you money.

**Table: Cellular Plan Terminology**

<b>Service option/specification</b>	<b>Description</b>
Whenever, or anytime, minutes	The number of minutes per month, at any time of the day, that can be used for phone calls
Weeknight minutes	Typically Monday through Friday, 9:00 p.m. to 5:59 a.m. or 6:59 a.m.
Weekend minutes	Typically Saturday 12:00 a.m. to Sunday 11:59 p.m.
Rollover minutes	Unused minutes from one month that “roll over” to the next month, sometimes enabling users to avoid extra charges for exceeding monthly allotments of minutes
Mobile to mobile, IN (in-network) calling	Phone calls to other users of the same carrier, typically provided for free or at a steep discount
Additional minutes fees	Penalty for exceeding your allotted minutes for the month, typically charged by the minute
Roaming fees	Incurred when you use your phone outside of your carrier’s coverage area

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## Cellular Services

**Cellular services** include specific features of a cell phone plan beyond voice communication, such as text messaging, high-speed Internet, and streamed media.

### Why This Matters

Mobile phones provide more than voice communications. Today’s mobile phone and smart phone users can access thousands of communications, information, and entertainment apps. Tablets extend what smart phones provide to a larger display. On older generation cell phones, services like ring tones, games, music, movies, navigation, and other mobile services were provided by the cellular provider. Over the past few years, many of those services have migrated to the handset manufacturer as mobile apps. For example, iPhone users get their apps from Apple, Windows Phone users get apps from Microsoft, and Android users get apps from Google, Amazon, and others. While the list of cellular services from cellular carriers has shrunk in recent years, there are still some useful services available as add-ons to cellular plans.

## Essential Information

Mobile phones and tablets typically come with many applications preinstalled. Mobile devices provide access to thousands of other apps, many often for free. Cellular carriers offer some extra features that can be added on to monthly service plans at an additional cost. The most popular add-on service is text messaging. Messages can be sent to and from cell phones or between cell phones and Internet e-mail addresses. The table below lists cell phone add-on services that provide additional communication power, entertaining media, access to information, and even safety.

**Table: Cellular Service Options**

Service option/specification	Description
Data plan	Access the web and Internet-based services content at roughly 2–6 Mbps from phone, tablet, or connected PC
Text messaging	Send text between phones or email addresses
Picture and video messaging	Send images and videos from phone to phone, or from phone to email
Push to talk	Connect using a walkie-talkie-style interface
Maps and navigation	Access turn-by-turn directions, or track your location and the locations of friends and family

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Mobile apps have become the most powerful and popular services for mobile device users. Apple and Google provide tens of thousands of apps in categories including Books, Business, Education, Entertainment, Finance, Games, Health & Fitness, Lifestyle, Medical, Music, Navigation, News, Photo & Video, Productivity, Reference, Social Networking, Sports, Travel, Utilities, Weather, and more. The mobile device app industry has become one of the largest industries in technology. The industry is dominated by apps provided by the mobile OS companies Apple, Android, Microsoft, and Blackberry. However, handset manufacturers may include their own custom apps. For example, many Android-based phones provide a combination of handset apps and Android apps. Apps have spread from mobile devices to PCs. Apps can even be shared across all of a person's devices.

## Mobile Phone

**Mobile phone** refers to the handset used by the subscriber to communicate on the cellular network.



## Why This Matters

Advances in mobile phones have been fast and furious in recent years, with manufacturers such as Nokia, Samsung, Motorola, Pantech, Kyocera, LG, Sony, HTC, and Apple competing intensely to gain an edge in the largest technology market. Cell phone handsets range in price from free (with service subscription) to more than \$500 for the latest and greatest smart phones. Determining which phone best suits your needs requires some time and consideration.

## Essential Information

A mobile phone can be designed primarily for voice communication, in which case it is referred to simply as a cell phone; or it may be designed to support voice and Internet, in which case it is referred to as a smart phone.

There are a few options for keyboards in handsets, such as:

- A numeric keypad that includes a typical phone keypad with roughly four alphanumeric characters per key
- A SureType QWERTY keypad that includes more keys and roughly three alphanumeric characters per key
- A full QWERTY keypad, typically with one character per key
- No physical keypad, but instead a soft keyboard displayed on a touch-sensitive screen

Many mobile phones use predictive text technology to assist with typing text. As you type, the phone guesses what word you are typing and offers to complete the word for you or to correct your spelling. Larger keypads make for bulkier phones but easier texting. Soft keyboards provide the most flexible design but lack the tactile feel of a physical keypad.

There are a number of form factors that have been used for mobile phones over the years (see table). Today, the most popular form factor is the bar phone, used on the iPhone and most Android and Windows phones.

**Table: Mobile Phone Form Factors**

Form factor	Description
Bar	A solid thin rectangular block with no hinges; keyboard and display are left exposed.
Clamshell	Hinged phone with the keypad on one panel and the display on the other. Components are protected when clamshell is closed.
Flip	Like the clamshell, except keyboard and display share one panel.
Slide	Provides keyboard that slides out either vertically or horizontally.
Swivel	Provides a component that swivels out rather than slides.

Besides form factor and keyboard type, phones are selected by display size, network type (GSM, CDMA, 3G, 4G/LTE), processor type, features, and storage size. Today more than two-thirds of mobile phone shoppers in the U.S. buy smart phones. While smart phones are coming down in price, the real cost is in the data plan required to provide Internet access to the handset. Adding a data plan to a standard voice plan can increase subscription costs by 50 to 100%. Most shoppers find the extra fees worth it for having continuous access to the Internet and thousands of apps.

After selecting a carrier, plan, phone, and add-on services, you can also select cell phone accessories, such as a case or car charger, or a headset or earbuds for hands-free phoning. Some U.S. states are making hands-free headsets a requirement for using cell phones while driving. Phones and headsets that contain Bluetooth chips can connect wirelessly to other Bluetooth devices. These are especially useful for phones that support voice commands. If your cell phone plays digital music or other media, you may wish to purchase stereo headphones and an additional storage module for storing music and movies. Tiny solid-state storage modules called miniSD or microSD cards—based on a format developed by SanDisk (SD)—can add several gigabytes of storage to your mobile phone.

## **Wireless Data Communications**

**Wireless data communications** refers to telecommunications that take place over the air to provide data and Internet access.

### **Why This Matters**

Access to information anywhere, anytime has been a dream for many technology enthusiasts—a dream that has become a reality. Many wireless technologies are available for accessing data and information from various locations. Those who understand those technologies can lead more productive lives.

### **Essential Information**

Many wireless technologies are used to access different types of data and information from various environments. Some, like GPS, have very specific functions. Others, such as Wi-Fi and Bluetooth, have become standards used by many every day. Still others, like Long Term Evolution (LTE), are becoming standards for global high-speed wireless Internet access. Combined, these wireless technologies are transforming our lives by making communication and access to information effortless from any place at any time. This section covers the most useful and promising wireless data technologies available today.

### **Wireless Data Communications Topics**

- Wi-Fi
- WiMAX
- Long Term Evolution (LTE)

- Bluetooth
- Radio Frequency Identification (RFID)
- Global Positioning System (GPS)

## Wi-Fi

**Wi-Fi** (short for wireless fidelity) is wireless networking technology that uses access points to wirelessly connect users to networks within a range of 250–1000 feet (75–300 meters).

### Why This Matters

Wi-Fi is the dominant technology that provides wireless Internet access in households and businesses. It provides certain benefits, such as high-speed Internet access, and suffers from some limitations, such as its relatively short range and its inability to support large numbers of users. Understanding Wi-Fi enables users to make the best use of the technology and make wise decisions when choosing an Internet service provider.

### Essential Information

The Wi-Fi standards, also known as the *802.11* family of standards, were developed by the Institute of Electrical and Electronics Engineers (IEEE) to support wireless computer networking within a limited range at broadband speeds. There have been several versions of Wi-Fi, each increasingly more powerful. 802.11b provides 11 Mbps, while 802.11g increases to 54 Mbps, and the most recent, 802.11n, is up to 248 Mbps. Each is backward compatible with the previous version, but needs to be connected to devices of the same version to enjoy the faster speed. Newer versions of 802.11 (ac and ad) are in the works to provide even faster wireless connections for short- and long-range data networks.

Wi-Fi technology uses wireless *access points* that send and receive data using radio frequencies to and from computers and other digital devices equipped with Wi-Fi cards or adapters. Access points are connected to networks (via network cable) that are typically connected to the Internet. So, when connecting to an access point, a wireless user also connects to a local area network and the Internet. Wi-Fi has a maximum range of about 1000 feet (300 meters) in open areas, and 250 to 400 feet (75 to 125 meters) in closed areas. Areas around access points where users can connect to the Internet are sometimes called *hotspots*. By positioning wireless access points at strategic locations throughout a building, campus, or city, Wi-Fi users can be continuously connected to the network and Internet, no matter where they roam on the premises. Wi-Fi is popular for businesses like Starbucks and McDonald's as well as for home networks. Wi-Fi is even available in aircraft for connecting to the Internet while in flight. While free public Wi-Fi is a great convenience, there are also increased risks from hackers (see video).

An increasing number of digital devices are incorporating Wi-Fi technology into their design. Most new notebook and desktop computers include Wi-Fi capability. Smart phones and tablets also include Wi-Fi, providing a less expensive way to connect to the Internet than through the cellular data plan. Some printers have built-in Wi-Fi so that you can print to them from any PC on the network. Wi-Fi capabilities can be easily added to a printer or computer by connecting a Wi-Fi adapter to the device's USB port. Video game consoles such as the Xbox 360 and Sony PlayStation, as well as media devices such as TiVo, Roku, and Apple TV use Wi-Fi to connect home entertainment systems to home PCs and the Internet. Wi-Fi technology is even moving to automobiles.

Some cellular carriers allow customers to use their cellular data plan to connect their computer to the Internet. Tethering is the process of connecting a notebook or tablet computer to a mobile phone through Wi-Fi to access the Internet. Multiple computers can be connected to the Internet using Mi-Fi technology. Mi-Fi uses a small pocket-size access point is connected to the cellular network to function as a mobile hotspot. Several users can connect to the router to share the cellular data service.

## **WiMAX**

**WiMAX**, which stands for Worldwide Interoperability for Microwave Access, also known as IEEE 802.16, is a fourth-generation wireless broadband technology that evolved from Wi-Fi to provide faster Internet access at a longer range.

### **Why This Matters**

The race to get wireless broadband Internet connections to mobile users over large areas is in full swing. Wi-Fi satisfies the need in small areas, but it requires hundreds, if not thousands, of access points to cover a city. 3G cellular network technologies cover cities and large areas but only support bandwidth of up to roughly 2 Mbps. WiMAX emerged as a 4G wireless technology that covers large areas with high-speed Internet that rivals cable modems and DSL. Imagine receiving high-speed Internet at home, at work, in your car, on the street, in any restaurant or business, and everywhere you travel over one wireless network.

### **Essential Information**

WiMAX is built on Wi-Fi standards and can interoperate with Wi-Fi networks. A WiMAX access point has a 31-mile (50-kilometer) range; therefore, WiMAX is a perfect technology for providing citywide high-speed Internet access. Such networks are referred to as *municipal wireless* networks or *muniwireless*. Some cities, including Chicago, San Francisco, and St. Louis, have found that the costs of installing citywide Wi-Fi outweigh the benefits. WiMAX can provide a better cost-benefit balance and bring muniwireless to many more cities. In fact, Seattle's famous

Space Needle has become home to a WiMAX antenna that provides high-speed Internet access to local subscribers that is double and triple the speeds provided over cable modem.

Sprint Nextel was the first and only cellular provider to offer 4G WiMAX in select cities through a service called CLEAR from Clearwire. Sprint recently switched its 4G strategy from WiMAX to Long Term Evolution (LTE), a similar technology used by the other cellular carriers. While investors in WiMAX hoped it would become the global standard for 4G cellular networks, LTE technology has outpaced WiMAX in the market. WiMAX is still a valuable technology, however, providing high-speed Internet access for some cities and on the back end of some telecommunications networks.

## Long Term Evolution (LTE)

**Long Term Evolution (LTE)** is a fourth-generation wireless broadband technology that was developed to allow GSM cellular technology to evolve to provide very high-speed Internet access.

### Why This Matters

Technology is advancing toward very high-speed wireless Internet access being available essentially everywhere, delivering digital data, information, entertainment, and communications. LTE has become the technology to take us there. LTE is being promoted by all of the popular cellular carriers, both on GSM networks such as AT&T and T-Mobile, and on CDMA networks such as Verizon and Sprint, as the next generation—4G—of wireless data communications. LTE appears to have beaten out WiMAX, a similar technology that was used by Sprint.

### Essential Information

LTE is promoted by the 3rd Generation Partnership Project (3GPP), which is composed of GSM cellular providers and affiliates. LTE promises to bring wireless Internet connection speeds that are as fast or faster than today's home connections. LTE is an extension of GSM, so only GSM carriers will be able to use it. Verizon and Sprint have decided that they will be pursuing LTE, indicating that their networks will be gradually moving from CDMA to GSM. Hundreds of U.S. cities now have access to 4G LTE from one or more carriers.

LTE is being proposed as a solution to the “last mile” problem. The *last mile* refers to the part of a telecommunications network that connects to residences and businesses—the part of the network other than the backbone. The problem with this portion of the network is that there are many residences and businesses; and it is too expensive to deploy the fastest network components, such as fiber-optic cables, to so many endpoints on the network. LTE provides a solution with its high-speed, inexpensive technology.

## Bluetooth

**Bluetooth** (named after a 10th-century Danish king) enables a wide assortment of digital devices to communicate directly with each other wirelessly over short distances.

### Why This Matters

Bluetooth technology is becoming quite well known. Go shopping for a new cell phone, handheld, or notebook computer, and there is a good chance that you will find Bluetooth listed among the specifications. Bluetooth is useful for passing data wirelessly over a short distance. The data might be a conversation on a cell phone passed to a headset, music from a media player passed to stereo headphones, files passed between computers, or characters passed from a keyboard to a computer. Bluetooth has many, many uses.

### Essential Information

The Bluetooth specification was developed by the Bluetooth Special Interest Group (BSIG), a trade organization composed of leaders of the telecommunications, computing, and network industries, such as 3Com, Agere, Ericsson, IBM, Intel, Microsoft, Motorola, Nokia, and Toshiba.

Bluetooth-enabled devices communicate directly with each other in pairs. Up to seven devices can be paired simultaneously. The pairings can be created automatically or manually. For example, you might use a wireless headset to chat on a cell phone stored in your backpack. Many auto manufacturers offer some form of Bluetooth connectivity in at least some of their cars. In a Bluetooth-enabled Toyota Prius, for example, when you start the car, the car automatically connects with your cell phone and displays your call info on an LCD display in the dashboard. You can scroll through your address book, make calls, and check messages, by using the LCD touch screen on the dashboard, by using controls on the steering wheel, or by speaking voice commands.

Bluetooth communicates at speeds of up to 1 Mbps within a range of up to 33 feet (10 meters). Bluetooth can also be used to connect devices to a computer network. Bluetooth and Wi-Fi compete in some areas but have unique qualities. Manufacturers are installing Bluetooth chips in a wide variety of communications and computer appliances to allow device-to-device connections. For example, six participants sitting around a conference table could exchange notes or business cards among their notebooks, tablets, or smart phones. In contrast, Wi-Fi is generally used to connect devices to a computer network and the Internet.

Bluetooth is also used as a method for hackers to illegally gain access to devices. A number of cell phone viruses have spread through Bluetooth. Also, an open Bluetooth connection on a computer can be used by a hacker to access files on the

computer. For these reasons, it is good to keep Bluetooth turned off when not using it; and when it is on, set it so that it is not “discoverable” by other devices.

**Table: Some Bluetooth Devices**

Computing	Digital Media	Appliances
<ul style="list-style-type: none"> <li>• Personal computers</li> <li>• Printers</li> <li>• Keyboards and mice</li> </ul>	<ul style="list-style-type: none"> <li>• Mobile phones</li> <li>• Digital cameras</li> <li>• Portable MP3 players</li> <li>• Headphones and headsets</li> <li>• Speakers</li> </ul>	<ul style="list-style-type: none"> <li>• Microwave ovens</li> <li>• Refrigerators</li> <li>• Washers and dryers</li> </ul>

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## RFID

**RFID**, or **radio frequency identification**, uses tiny transponders in tags that can be attached to merchandise or other objects and read wirelessly using an RFID reader, typically for inventory and supply chain management or to facilitate commercial transactions.

### Why This Matters

There are two important uses for RFID technology today: It's used to identify and track products, and is embedded in credit cards, cell phones, and other devices to enable wireless transactions at checkout counters and vending machines.

### Essential Information

For tracking merchandise, RFID tags are attached to products and/or crates and pallets so inventory can be tracked from the manufacturer to the retail store checkout counter. RFID tags consist of a transponder as small as a grain of sand, with an antenna, embedded on a paper tag. RFID readers may take the form of handheld devices or devices mounted in the doorways of loading docks or in conveyor belt systems. RFID may eventually replace the bar code as the primary identification system for merchandise because it is much more convenient and can relay more information. RFID systems are typically connected to central databases where inventory information is stored. As a tagged item progresses from manufacturing to warehouse to retail vendor to checkout counter, its database record is updated, providing up-to-the-minute information. This enables companies to gain better control over inventory, getting products to locations where they are needed just in time. Wal-Mart has required its suppliers to include RFID tags on all shipping crates and pallets.

*Contactless payment systems* make use of an RFID chip embedded in a credit card, ID card, or other device to wirelessly send data to an RFID reader installed in a cash register, vending machine, toll booth, or other transaction location. Users can pay for merchandise by simply waving the credit card over the reader, like the MasterCard PayPass system shown in the figure. This form of telecommunications is referred to as *near field communications (NFC)*, which is defined as wireless telecommunications that take place at a distance of about 8 inches (20 cm) or less. With lighter rules and restrictions governing credit card transactions, which no longer require signatures and receipts for small purchases, contactless payment will likely soon become widespread.

Nokia and mobile telecom carriers are using RFID to embed credit card information in a cell phone. The goal is to create a cashless and walletless culture where all you need to carry is your mobile phone. You simply wave your phone over a cash register pad to pay. More expensive purchases might require keying in a four-digit authentication code. Google's Nexus handset includes RFID capabilities to support Google Wallet, an e-wallet application from Google. Many believe that iPhone will soon adopt NFC technology as well.

An obvious concern with contactless payment systems is wireless security. If your credit card or cell phone transmits private information through the air using radio signals, what's to stop a thief with a card reader from stealing that information? The credit card companies assure those concerned that they have a system in place to protect private information, but some security experts remain skeptical.

Besides its use in retail inventory control and contactless payment systems, RFID is used in a number of other areas where automatic identification is useful:

- Systems that allow vehicles to autopay at highway toll booths use an RFID device mounted on the dashboard or windshield.
- Hospitals employ RFID patient wristbands to enhance patient care and staff working conditions, and to save on money and prevent mistakes.
- Airlines are integrating RFID into their baggage-handling systems to more efficiently track the location of passenger baggage.
- RFID devices are used in parking lots to track how long cars are parked and send reminders to drivers while automatically deducting parking fees from drivers' bank accounts.
- RFID is used to track prescription medications through the supply chain and curb drug counterfeiting and theft.
- RFID tags are being used to assist blind individuals in recognizing objects.

Other uses of RFID are more controversial. RFID chips have been embedded in the passports of international travelers. There is talk of embedding RFID tags in all automobile license plates, driver's licenses, and even currency. RFID tags injected under the skin are used to track ex-convicts and employees in high-security facilities. Privacy advocates are concerned that RFID could be used by governments



and law enforcement agencies in ways that infringe on people's privacy and civil liberties.

## GPS

A **GPS**, or **global positioning system**, uses satellites to pinpoint the location of objects on earth.

### Why This Matters

GPS technology provides useful navigation assistance in many environments for many purposes. Available in mobile phones, cars, aircraft, ships, and elsewhere, GPS provides a range of uses from necessary functions, such as staying on course at sea, to fun utilities, such as keeping track of where your friends are. GPS has become an important part of most people's daily lives.

### Essential Information

Using a GPS receiver and a network of 24 satellites, a GPS can tell you the exact location of the receiver on the earth's surface. GPS satellites orbit the earth in such a way that at any given time and location on earth, at least four satellites are visible to a GPS receiver. By measuring the distance from the receiver to each satellite and calculating those distances with the known position of each satellite, the receiver can determine its location on earth. Like the Internet, GPSs were originally developed for national security and later extended for public use.

Early GPS receivers were expensive and used only in environments where determining your location was a matter of life and death, such as in far-traveling ships. Now they are available as inexpensive, small handheld devices, as in-dashboard or on-dash devices for automobiles, and are embedded in smart phones and accessed through mobile apps. GPS receivers are primarily used to assist travelers in getting from one place to another. GPS software can display a traveler's location on a city map and give suggestions for the shortest routes to destinations. Many GPS devices also integrate information about local businesses and services, such as restaurants, retailers, and hospitals. Car rental companies provide GPS units to assist customers with navigating in an unfamiliar city. GPS has also been used to map the planet's surface.

GPS is also playing a role in social media. *Geotagging* is the process of adding geographic identification metadata to digital media and messages. GPSs in cell phones enable this to occur automatically if the user so chooses. On the iPhone, photos posted to Facebook, Twitter, or Flickr can automatically be tagged with the location where they were taken. Posts on Facebook and other messaging systems can also include geotags. Software such as Google Latitude and FourSquare allows users to automatically find friends or make friends in nearby locations, using GPS

data. Using a variety of GPS software, users can quickly find nearby restaurants, hotels, or other businesses.

GPSs provide convenience and safety; however, as with all technology that accesses personal data (such as a person's location at a given time), its use may infringe on an individual's privacy. Consider, for instance, the possibility of someone stashing a GPS device in your car or backpack in order to track your movements. Also consider the common practice of cellular carriers collecting location data automatically from users.

## Computer Network

A **computer network** is a collection of computing devices connected together to share resources such as files, software, processors, storage, printers, and Internet connections.

### Why This Matters

Most people are familiar with the benefits of sharing information among computers from their experience with the Internet and web. Information sharing is only one benefit of networking. Computer networks have become an essential component around which people manage and organize many facets of their professional and personal lives.

### Essential Information

Within a private network or intranet, computing resources are shared in order to maximize computing power and organizational effectiveness. You have learned that a computer includes devices for input, processing, storage, and output. These components can be distributed throughout a computer network. This is referred to as a *distributed network*. For instance, you may connect to your corporate network through a Wi-Fi connection and work on a server shared by all employees in the organization. In such a scenario, your computer provides the input and output devices, but the processing and storage may be handled at some other location. You may store your files on a network drive that exists on a file server and send your print jobs to a printer in a shared area of your office. A computing system may be distributed over components in one small business building or around the world on a network operated by a global corporation.

Devices attached to a network are called *nodes*. Desktop computers attached to a network are sometimes called *workstations*. Workstations typically have access to two types of resources: local and network resources. *Local resources* are the files, drives, and perhaps a printer or other peripheral device that are connected directly to the workstation and are accessible on or off the network. *Network resources*, also called *remote resources*, are resources that the workstation accesses over the network.

A *network administrator*, sometimes called a *system administrator*, is a person responsible for setting up and maintaining the network, implementing network policies, and assigning user access permissions. A large organization might employ dozens of network administrators. In a small business, the business owner may take the role of network administrator. Even home networks have a network administrator, usually a family member that takes responsibility for setting up and maintaining the network.

Networks are classified by size in terms of the number of users they serve and the geographic area they cover. From a network that links two personal devices that serve an individual user, to international enterprise networks that serve large corporations, to the Internet, which serves the entire world, different types of networks are uniquely designed to accommodate specific needs. Types of networks include personal area networks, home networks, local area networks, virtual private networks, metropolitan area networks, wide area networks, and global networks. This section presents all of these popular types of networks and how they are used.

### **Computer Networks Topics**

- Personal Area Network (PAN)
- Home Network
- Local Area Network (LAN)
- Wide Area Network (WAN)

### **Personal Area Network (PAN)**

A **personal area network (PAN)** is the interconnection of personal information technology devices, typically wirelessly, within the range of an individual.

#### **Why This Matters**

As people have begun to use multiple mobile computing devices rather than one desktop PC, the ability for those devices to communicate has become important. Personal area network technologies allow personal devices to communicate with or without wires, sharing data, media streams, phone conversations, and all types of information.

#### **Essential Information**

A personal area network (PAN) typically covers a range of around 33 feet or 10 meters. A PAN is typically implemented with Bluetooth. Using a PAN, you might be able to use one set of wireless headphones for both your digital music player and your mobile phone. A PAN allows your notebook computer to automatically communicate with your cell phone to connect to the Internet. Your PAN could interact with other PANs to transfer meeting notes to others at a committee meeting

or to allow your friends to listen to music from your digital music player on their headphones.

## Home Network

A **home network** is a local area network designed for personal or business use in the home.

### Why This Matters

With most homes having multiple PCs, and with the popularity of wireless networking, home computer networks have become common. Home networks are used to share Internet access, media, files, printers, and other computing and media resources.

### Essential Information

Like televisions, telephones, and automobiles, personal computers have become an integral part of many people's lives, and many households have multiple PCs, which may include desktop and notebook PCs, tablets, and smart phones. Home networks enable residents to do the following:

- Share a single Internet connection
- Share a single printer
- Share files such as images, music, and programs
- Back up copies of important files to another PC for safekeeping
- Participate in multiplayer computer games
- Share output from devices such as a DVD player or webcam
- Stream music and movies from a computer to devices around the house

Most home users take advantage of the convenience and power of Wi-Fi wireless technology for their home network. A typical wireless home network uses a wireless access point/router to connect the network to an ISP. Wireless adapters connected to each computer communicate with the access point. Wi-Fi home networks can be connected to the Internet using a router provided by an ISP. Desktop and notebook PCs typically connect to the Internet through a Wi-Fi connection. People use Wi-Fi to connect their smart phones and tablets to the Internet as well. It's often cheaper than accessing the Internet through a cellular data plan.

Besides connecting to the Internet, two of the most popular uses of wireless home networks are for data storage and access and for wireless digital media distribution. Digital photos and other files that household members would like to catalog and share can be stored on a file server and accessed by all network PCs. Data could also be backed up over the home network.

Home networking technologies can also be used to distribute media files throughout your home. Many companies offer Wi-Fi devices that play either audio files or both

audio and video files, sometimes streaming media from the Internet. Other technology enables you to send television signals from TV to TV in order to share a cable or satellite connection without wires.

A number of storage devices are available for connecting to a home network in order to back up important data files. Some also enable users to store media and stream it between networked devices.

Other technologies are also applicable to home networks. Technically inclined people may opt to run twisted-pair copper cable through the walls and attic space of their homes to set up a business-quality network. Some new homes include built-in Ethernet wiring for a computer network. Other options take advantage of existing wires in the home. Phone-line networking, also called *HomePNA*, links computers through a home's phone wires; and power-line networking, or *Home PLC*, links computers through the power lines in the house.

## Local Area Network (LAN)

A **local area network (LAN)** is a privately owned computer network that connects computers and devices within the same building or local geographic area.

### Why This Matters

Local area networks are used in most businesses and organizations to provide network and Internet connectivity. Corporations distribute various business systems among servers located across buildings and campuses; and in larger networks such as MANs and WANs, across cities and around the world. Employees of businesses retrieve files, data, software, and other services from local area networks. Increasingly, users are connecting to LANs through wireless connections.

### Essential Information

Local area networks can include personal computers, servers, printers, and other network-capable devices. Devices connect to LANs through network interface cards or wireless network adapters. Larger networks use servers to store databases, files, and software. When a person on the network uses software or data stored on the server, the server transfers the necessary programs or data to the user's computer. Although servers typically are large multiuser computers, a server can be a computer of any size—even a personal computer. Any computer that serves up information or services to others on the network can be a server.

Many LANs incorporate familiar Internet technologies to create intranets. An *intranet* uses the protocols of the Internet and the web—TCP/IP and HTTP, along with Internet services such as web browsers—within the confines of a private network. In an intranet, employees might access confidential documents using a web browser, while those same documents remain secure from the outside world.

Enterprises typically allow users within their intranet to access the public Internet through firewalls that screen messages to maintain network security. An intranet may be extended beyond the confines of the LAN over the Internet to connect with other networks and create a virtual private network. A *virtual private network (VPN)* uses a technique called *tunneling* to securely send private network data over the Internet. A VPN may be used to connect an organization's networks dispersed around the world into one large intranet.

Intranet content can be extended to specific individuals outside the network, such as customers, partners, or suppliers, in an arrangement called an *extranet*. Extranets are sometimes implemented through a simple login procedure on a web server. For example, Wal-Mart provides key suppliers with access to its intranet so that they can see what products are selling fastest and ramp up production to meet the demand.

VPNs can also be used to allow employees to access the corporate intranet from home and while on the road. A large business or organization might hire an *enterprise service provider (ESP)* to set up a *network access server (NAS)*. Users are provided with software that connects to the NAS, VPN, and ultimately the corporate intranet. Some services are set up so that if you have access to the Internet, then you also have secure access to your private intranet.

LANs that are designed to serve an entire city are called *metropolitan area networks*, or *MANs*. Sometimes they are referred to as municipal or muni networks. Many cities supply local businesses with access to a MAN to improve local commerce and communications. Often a MAN acts as a stepping stone to larger networks, such as the Internet.

## Wide Area Network (WAN)

A **wide area network (WAN)** connects LANs and MANs between cities, across countries, and around the world, using microwave and satellite transmission or telephone lines.

### Why This Matters

A LAN becomes a WAN when it extends beyond one geographic location to another geographic location. When you make a long-distance phone call, you are using a wide area network. AT&T, Verizon, Sprint, and other telecommunications companies are examples of companies that offer WAN services. Companies, organizations, and government agencies also design and implement WANs for private use.

## Essential Information

WANs usually consist of privately owned LANs connected over a dedicated line provided by a telecommunications company. For example, your school may maintain a LAN that covers the campus. The school network engineers may have laid fiber-optic cable across campus and connected it to networks in each building to provide high-speed networking to students, faculty, and staff. This LAN is owned and controlled by the school. If your school should decide to open a branch campus across the state, administrators may decide to join the LAN of the main campus with the LAN of the branch campus. Using a dedicated line leased from the phone company, your school could create a WAN by joining the two LANs.

WANs are often used in business systems to connect multiple businesses in a supply chain. Connecting corporate computer systems among organizations is the idea behind *electronic data interchange* (EDI). *EDI* uses network systems and follows standards and procedures that enable output from one system to be processed directly as input to other systems, without human participation. For example, as the cashier scans the barcode of the new jeans that you are purchasing, the inventory count of that item is decreased by one. The effect of the decrease may bring the total inventory amount for that item below a set threshold, indicating that more jeans need to be ordered. Because the retail store's computer system is connected to the supplier's computer system, the order for more jeans can be made automatically. For many industries, EDI is becoming a necessity to stay competitive.

A WAN that crosses an international border is considered a global or international network. The Internet is the most obvious global network, but as an increasing number of businesses enter global markets, private global networks are becoming more prevalent.

The process of creating and maintaining a global network has its challenges. In addition to requiring sophisticated equipment and software, global networks must meet national and international laws regulating the electronic flow of data across international boundaries. Some countries have strict laws restricting the use of telecommunications and databases, making normal business transactions costly, slow, or even impossible. Other countries have few laws restricting the use of telecommunications or databases. Some governments and companies can avoid their own country's laws by processing data in other countries, sometimes called *data havens*, that have few restrictions on telecommunications or databases.

## Privacy

**Privacy** refers to being free from intrusion—the right to be left alone, to be free from surveillance, and to have control over the information collected and stored about yourself.

### Why This Matters

With the digitization of all forms of information and the increasing use of the Internet for all types of activities, it has become easy to collect detailed information about individuals. This has helped businesses to locate customers for their products; allowed government and law enforcement to monitor individuals' behavior; and enabled criminals to find victims.

Loss of privacy is so widespread and is occurring so quickly that some believe that it is too late to do anything about it. Others are interested in maintaining some forms of privacy. Still others are embracing a transparent lifestyle, broadcasting their every action to the world.

### Consider This

The concept of Big Data emerged from the vast and exponentially-growing amount of data generated by social media, mobile devices, apps, and all the other digital tools wielded by the global population every day. Corporations, and others, are driven to collect all of that data and analyze it to gain useful insights that can be used to make better business decisions. Companies like Google, Facebook, AT&T, and many others have gotten good at collecting the data. Developing software to analyze the massive amount of data being collected is the primary challenge of the Big Data industry. In coming years, that challenge will become much more complex. Today, the average Internet user owns two Internet connected devices, typically a smart phone and computer. Over the next couple of years, that number is expected to jump to seven, more than tripling the number of devices on the Internet. The bulk of new Internet devices will represent things rather than people—thermostats, security systems, televisions, electric meters, cars, refrigerators, and other appliances. These devices will increase the amount of Big Data by adding information like the temperature in every home at every second, the energy usage of each residence and business, eating habits, laundry habits, water usage, waste production, and more. Add this information up and the Internet becomes a source of real-time information about the state of the planet at any given moment in time.

In an *EETimes* article titled "The Intangible Assets of the Internet of Things," IBM researchers view the Internet as becoming a "global electronic nervous system, with trillions of individual sensors monitoring the status of everything of interest to humans." IBM wants to stream all of those exabytes of data to its cloud-based cluster supercomputers to extract the "ultimate value from the data using Analytics software modeled on the human mind." With so much data being collected from



each person's life, what data, if any, should remain private? Is it worthwhile to sacrifice privacy to provide valuable insight for improving life on Earth?

### **Essential Information**

Computer technology gives us the ability to collect, maintain, process, and transfer more information than ever before. This power has given rise to a seemingly endless number of public and private databases that include details about many individuals. Combined, these databases could tell a person's life story in terms of daily activities, personal interests, and financial matters. This massive data collection, combined with surveillance technologies that include the increasing use of cameras in public places, has given rise to legitimate concerns over the invasion of privacy in the digital era. For example, Google's Street View technology has caused a stir over privacy issues because of its 360-degree street-level imagery which uses satellite technology to take real-time pictures of private and public locations.

Privacy issues include being free from intrusion—the right to be left alone, to be free from surveillance, and to control the information collected and stored about yourself. Information security often comes at the cost of some level of convenience and privacy. This section looks at the extent to which your privacy might be sacrificed in order to provide conveniences offered by the digital world and to increase your personal safety and national security.

### **Privacy Topics**

- U.S. Privacy-Protective Laws
- U.S. Privacy-Invasive Laws
- Electronic Surveillance
- Behavioral Targeting
- Traffic Shaping
- Transparency

## **U.S. Privacy-Protective Laws**

**U. S. privacy-protective laws** refer to legislation designed to protect the private information of U.S. citizens.

### **Why This Matters**

The right to privacy has been a hotly debated topic in countries around the world for generations. Generally, free and democratic governments include laws that protect citizens' privacy to some extent. At a minimum, in a free society, a citizen would expect to have privacy within his or her home. The level of privacy a person enjoys can vary greatly, depending on social circumstance and the political and legal position of the government on privacy issues. Digital technologies have made

protecting private information more difficult than ever. Many recent privacy laws focus on digital technology issues.

### **Essential Information**

You might be surprised to learn that the U.S. Constitution itself contains no express right to privacy. However, the Bill of Rights (the first 10 amendments to the Constitution) refers to privacy issues. The First Amendment protects the privacy of belief; the Third Amendment protects the privacy of the home against demands that it be used to house soldiers; the Fourth Amendment protects the privacy of the person and possessions against unreasonable searches; and the Fifth Amendment protects a person from self-incrimination.

A later amendment has also been important for privacy issues. Over the years, the Supreme Court has interpreted the word “liberty” in the Fourteenth Amendment to include issues of privacy—particularly in terms of issues such as marriage, procreation, childrearing, and termination of medical treatment. Polls indicate that most Americans support this interpretation of the word “liberty.”

The free flow of digital information has created the need for a number of laws to protect the private information of individuals. When it comes to information privacy, government agencies in the United States and many other democratic countries are regulated more stringently than businesses and health care professionals. However, with the exponential growth of digital information, the government is stepping in to regulate the use of information across many industries.

The Privacy Act of 1974 is the primary law controlling what many U.S. government agencies can and cannot do with the information they hold. The primary tenets of the law include the rights of citizens to know what information certain government agencies store about them and to exercise control over the accuracy of that information and how it is used. Laws that control the handling of information by the government, businesses, and the health care industry are listed below. As technology advances provide additional means of invading individuals’ privacy, new laws will need to be enacted. For example, as unmanned drone aircraft begin entering commercial markets, media companies and others may begin using them to gather video and photographs of private property. Some states have already banned the use of unmanned drones in expectation of just such abuses. Privacy advocates are up in arms in states where drones are being considered for use by police (see video).

**Table: U.S. Privacy-Protective Laws**

<b>Law</b>	<b>Explanation</b>
Identity Theft Protection Act of 2005	Requires businesses to secure sensitive data physically and technologically and to notify consumers nationwide when data is compromised
Information Protection and Security Act of 2005	Gives the Federal Trade Commission (FTC) the ability to regulate the sale of personal information
Notification of Risk to Personal Data Act of 2003	Requires businesses to notify individuals when their personal information is stolen
Education Privacy Act of 2003	Restricts the collection of data by federally funded schools
Sarbanes-Oxley Act ("Sarbox") of 2002	Fights corporate corruption by imposing stringent reporting requirements and internal controls on electronic financial records and transactions
Children's Online Privacy Protection Act of 2000	Gives parents control over what information is collected from their children online, and how such information may be used
Gramm-Leach-Bliley Act (GLBA) of 1999	Requires banks and financial institutions to alert customers of their policies and practices for disclosing customer information
Consumer Internet Privacy Protection Act of 1997	Requires data collectors to alert people that their personal information is being shared with other organizations
Health Insurance Portability and Accountability Act (HIPAA) of 1996	Requires those in the health industry to protect the privacy of health information, and provides policies and procedures for doing so
Computer Matching and Privacy Protection Act of 1988	Regulates cross-references of data between federal agencies

Tax Reform Act of 1979	Controls the collection and use of certain information collected by the IRS
Right to Financial Privacy Act of 1978	Restricts the government's access to certain financial records maintained by financial institutions
Privacy Act of 1974	Controls what many government agencies can and cannot do with the information they hold
Freedom of Information Act of 1966	Gives citizens the right to view their own personal records maintained by federal agencies

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## U.S. Privacy-Invasive Laws

**U.S. privacy-invasive laws** refer to legislation that is invasive to individual privacy for a perceived greater good of the country.

### Why This Matters

In the history of the United States and other developed and democratic societies, there have been times when individual privacy and civil liberties have been sacrificed for the sake of national security. These times typically strain the relationship between a government and its citizens, which is sometimes expressed through protests, violence, and arrests. It is at times such as these that citizens must be aware of government action, understand what sacrifices may be required on their part for the sake of the country, and express concern over any civil liberties and privacy that might be sacrificed unnecessarily.

### Essential Information

In times of war, U.S. law allows the government to restrict privacy in an effort to capture or defeat an enemy. Such has been the case since the attacks of September 11, 2001. The USA PATRIOT Act of 2002 gave the federal government greater access to private information and wider latitude in the treatment of suspected terrorists. It was designed to “deter and punish terrorist acts in the United States and around the world, to enhance law enforcement investigatory tools, and for other purposes.” It includes measures to “enhance surveillance procedures.”

The easing of privacy regulation in time of war causes concern for privacy advocates. They fear that in a state of panic, the government may overreact and needlessly sacrifice civil liberties and rights.

When the Information Awareness Office of the Defense Advanced Research Projects Agency (DARPA) proposed a new tracking information system called Total Information Awareness (TIA) in 2002, privacy advocates complained loudly. Total Information Awareness was designed to capture the “information signature” of people so that the government could track potential terrorists and criminals. An information signature is any unique information stored about an individual, such as information about property, address history, utility connections, bankruptcies, liens, and business filings, as well as a host of other information. Data mining techniques were to be applied to the database developed by the TIA system in order to “connect the dots” and detect potential terrorist activity.

What outraged privacy advocates was that this system could be used to track all citizens, not just those suspected of crimes. It was essentially a form of the “Big Brother” concept introduced by George Orwell in his book *1984*. In his story, the government (Big Brother) watched over everyone in society by using information gathering and video surveillance. In this Orwellian society, there was little in the way of crime, nor was there any privacy or freedom. It was like living in a prison.

In the case of Total Information Awareness, the privacy advocates won. The name of the program was changed to Terrorism Information Awareness. Shortly after that, Congress cut off funding for the program.

Following the fiasco with Total Information Awareness, in 2002 the U.S. government developed a system called MATRIX (Multistate Anti-Terrorism Information Exchange). MATRIX combined state records and data culled by Seisint, a database and information service provider, to give investigators fast access to information on crime and terrorism suspects. Seisint developed a scoring technology that evaluated each citizen and assigned a number used to rate that individual’s “terrorist factor.” Because the system included information on innocent people as well as known criminals, MATRIX drew objections from liberal and conservative privacy groups. Many of the states participating in MATRIX pulled out due to the controversy, and the system was abandoned at the federal level in 2005. However, a few states still use MATRIX-like technologies on the state level to help identify criminals.

In 2012, the FBI solicited social networks to access all user posts. The FBI believes that social media data can be mined for information about terrorist plans and other global events. As has been the case across history, privacy and security are once again at odds with each other.

## Surveillance

**Surveillance** is the close monitoring of behavior through electronic technologies such as wiretapping, data mining, remote video and audio monitoring, GPS, and RFID.

## **Why This Matters**

Computer-controlled surveillance technologies, combined with ubiquitous telecommunications networks and powerful information processing systems, have made it possible to gather huge quantities of video, audio, and telecommunications signals and process them to reveal personal information. Although this is mostly done in an effort to curb crime and catch criminals, some people are concerned with the lack of oversight. Who is monitoring those individuals doing the monitoring? Will the information gathered in electronic surveillance be used to invade our privacy?

## **Essential Information**

There are many forms of electronic surveillance, including wiretapping, data mining, video and audio surveillance, Internet monitoring, and GPS and RFID surveillance.

### ***Wiretapping***

*Wiretapping* involves secretly listening in on conversations taking place over telecommunications networks, including telephone, email, instant messaging, VoIP, and other Internet communications. Wiretapping has been around as long as there have been wires to tap and now extends to wireless communications. With increased dependence on electronic communications, wiretapping has grown to be an important tool for law enforcement and a major concern for those interested in personal privacy.

The Federal Wiretap Act, enacted in 1968 and expanded in 1986, sometimes referred to as Title III, sets procedures for court authorization of real-time surveillance of all kinds of electronic communications in criminal investigations. The Foreign Intelligence Surveillance Act of 1978 allows wiretapping based on a finding of probable cause to believe that the target is a member of a foreign terrorist group or an agent of a foreign power. Both laws allow the government to carry out wiretaps without a court order in emergency situations involving risk of death or serious bodily injury and in national security cases.

With cooperation from Internet service providers, an FBI surveillance system called Carnivore has been used to monitor email correspondence. The system has alarmed privacy advocates and some members of Congress because of the manner in which it surveys all email on the system, not just email of suspected criminals. To avoid public criticism, the FBI switched from Carnivore to its own proprietary system, of which little is known.

### ***Data Mining***

A lot can be learned about a person from the information and data he or she creates. *Data mining* refers to the process of extracting information from large databases. Businesses, governments, and other organizations invest heavily in amassing data generated by consumers and citizens and in mining that data for information that is useful in meeting their goals.

Data is generated through financial transactions in which people participate, including sales and purchases, investments, and loans. Medical data is generated by our interactions with physicians, dentists, hospitals, medical imaging services, insurance companies, and other medical services. Communications data is generated with each phone call, text message, chat posting, and email message. Entertainment data is generated through cable TV viewing, movie rentals, and other transactions. Personal and legal data is generated by our interactions with government agencies and law enforcement, including police reports, driver's license information, voting registration, tax information, birth certificates, and marriage licenses. Internet and web activities can be tracked through the use of cookies, IP addresses, and other technologies.

By combining the above types of information, an interested party could learn more about a person than through any other form of surveillance.

### ***Video and Audio Surveillance***

Increasingly, cities are turning to networked video surveillance to monitor their streets. Video cameras in public places are assisting in capturing criminals who might otherwise escape. For example, video surveillance cameras in London's King's Cross train station were used to identify suspects in the July 2005 train bombings. Surveillance video was also critical in the investigation to find the Boston Marathon bombers in early 2013.

In Chicago, a multimillion-dollar system dubbed Operation Disruption includes over 300 street-surveillance cameras. The cameras include microphones that can detect gunshots, even when a silencer is being used. City officials credit the video system for a 12-year low in violent crime rates and a reduction in the number of homicides. Many other cities have installed or are planning to install similar surveillance technology.

The increasing number of surveillance cameras used by both cities and private businesses leave very few public spaces unmonitored in most cities. The recent addition of audio recording devices with cameras has some concerned about eavesdropping on private conversations. Once again citizens are asking, "Who is monitoring the people doing the monitoring?"

In addition to living with permanent mounted cameras, we are now entering the era of flying cameras. Unmanned drone aircraft have become a necessity to the military for scoping out the enemy without risking life. Small drones the size of hummingbirds have been developed to travel among a population to spy and collect incriminating evidence. As technology continues to shrink, there may be camera-toting drones the size of mosquitoes.

High-resolution cameras attached to satellites and pointed at the earth are providing amazing new mapping technologies, as demonstrated through software such as Google Earth (see figure). Google's high-resolution satellite cameras can capture images of objects as small as 41 cm. Government-owned satellites can get

even finer resolution. Satellite imagery is used by law enforcement to track criminals, and by governments to monitor their own territories and territories of other countries. China is working to launch more than 100 satellites before 2020 in order to monitor its country and citizens. Satellite images are not only useful to law enforcement and government; criminals are finding them useful as well. The terrorist attacks and bombings in Jaipur, India, in 2008 were carried out with the use of Google Earth.

### ***GPS and RFID Surveillance***

Global positioning system (GPS) and radio frequency identification (RFID) technologies are very useful, but they can also be used to invade privacy. Consider the case of a man who attached a GPS tracking device to the undercarriage of his ex-girlfriend's car to monitor her movements. The man was picked up by police after his ex found him under her car, changing the battery on the device. He's serving time in a California prison.

GPS devices are being considered by some states for tracking ex-cons. Some in law enforcement believe that GPS microchips should be implanted in former convicts on parole and probation so that they can be monitored remotely. Although this may prevent some ex-cons from backsliding, it also infringes on their privacy rights after they have paid their debt to society.

Malaysia, the United Kingdom, Japan, South Africa, and even some U.S. states plan to tag cars with RFID-embedded license plates. Privacy advocates fear that monitoring vehicles electronically could lead to a database of information that can pinpoint the location of any vehicle at any time.

The combination of data mining, consumer and government databases, listening in on electronic communications, video and audio surveillance, satellite surveillance, and GPS and RFID location monitoring adds up to the possibility of serious invasion and abuse of basic privacy rights. Currently, at least in the United States, privacy laws and advocates work to keep government agencies in check. A second deterrent to abuse of surveillance technologies by government is a lack of funding and personnel. It takes a considerable investment to monitor video from thousands of cameras. As technology improves and surveillance becomes increasingly automated, funding and personnel will become a non-issue. We may soon be able to entrust the monitoring of surveillance data to a powerful AI (artificial intelligence) computer system. Once again this matter becomes a case of trust: Can those monitoring society be trusted to use surveillance only in the best interest of the public without invading the privacy of law-abiding citizens?



## Behavioral Targeting

**Behavioral targeting** uses information about a person's behavior to inform businesses and marketers so that they can offer products that are likely to be of interest to that person.

### Why This Matters

Much of the information gathered about individuals is collected without their knowledge. For example, a person might join a discount club at a local grocery store to enjoy special deals on products and to facilitate a faster checkout process. That person might not be aware that the club membership card also allows the store to digitally track his or her buying patterns. The customer may receive special mailings providing information on products that he or she typically buys. Some customers find this to be a valuable service, while others consider it an invasion of privacy. With commerce moving to the web, the tracking of consumer information has become much easier.

### Essential Information

Traditional marketing uses a technique known as market segmentation, where ads target customers based on their race, gender, income, education, age, and other general characteristics. Although this is often more effective than mass marketing, which advertises to everyone regardless of their social characteristics, it still can miss the mark.

The Internet allows market segmentation to take place at the level of each individual consumer. By studying a user's web behavior, businesses can learn and even predict what the person may be interested in purchasing. This is referred to as personalized or one-to-one marketing.

The Internet acts as a supercharged tool for invisible information gathering and behavioral targeting. Through the use of cookies, companies can accumulate immense amounts of information about customers visiting their websites. *Onsite behavioral targeting* involves a company tracking a user's activities on its own site. The information the company collects allows the company to custom-design a website that caters to the individual's interests. Amazon.com uses this approach to custom-design its opening page for each visitor for whom it has data. For example, if you purchase romance novels and kitchen appliances at Amazon, the next time you visit the site, you will see promotions for other romance novels and home appliances.

Many users find onsite behavioral targeting useful, while others find it a bit invasive. Even more invasive is network behavioral targeting. In *network behavioral targeting*, user behavior is tracked over multiple websites. Web advertising companies that provide ads to many websites, such as DoubleClick by Google, have the power to collect cross-site data about a user through the use of third-party cookies. Such information can be used to create a detailed consumer profile that can

be very valuable to businesses. Some browsers now offer the ability to block third-party cookies.

Facebook uses “Like” icons on over a billion websites so that its users can share with their friends the products, services, and content they like. Facebook and its partners collect this information, developing a detailed user profile for use in targeted advertising. Google+ uses a similar system. Google+ and Facebook’s Like icons are often found side-by-side on websites.

The ultimate network behavioral targeting exists at the Internet service provider level. An ISP is capable of collecting information on what every user is doing over its connections—and for ISPs like Comcast and AT&T, that can include Internet, television, and phone data. ISPs have come under fire for collecting such data. It is useful to read the privacy policy of your ISP to find out what it does with that information. Such information would be a goldmine to marketers, and there isn’t much standing in the way of ISPs mining that gold.

Network behavioral targeting is the tip of the iceberg for data aggregation companies such as LexisNexis Risk Solutions, formerly ChoicePoint. LexisNexis Risk Solutions collects and combines information from the three big credit bureaus; public records of numerous local, state, and federal government agencies; telephone records; liens; deeds; and other sources in order to develop detailed information about individuals, companies, and organizations. Over the years, the company has purchased many other personal information services, increasing its database to include drug test records, physician backgrounds, insurance fraud information, and a host of other specialized pieces of valuable personal information. Businesses and organizations contract LexisNexis for data mining to provide information on specific individuals for a variety of uses.

LexisNexis has more information about U.S. citizens than the government does. As a matter of fact, it has a multimillion-dollar contract with the Department of Justice and the IRS. FBI agents use information supplied by LexisNexis Risk Solutions in their criminal investigations. In this way, federal agencies can sidestep privacy laws that restrict the government from collecting and mining such information itself.

## **Traffic Shaping**

**Traffic shaping** refers to controlling the flow of network traffic in order to optimize performance by delaying some data packets in favor of others.

### **Why This Matters**

The practice of traffic shaping impacts users in different ways. Users who upload and download large data files like video may find their service disrupted during prime network usage time. Users not impacting the Internet with large data files might find their service rates unaffected or improved. All users should be concerned

about how traffic shaping is implemented and if any private information is being gathered in the process.

### **Essential Information**

Traffic shaping is implemented by most Internet service providers in an effort to provide a high level of service to most customers. ISPs have claimed that 10% of broadband Internet subscribers consume 80% of Internet bandwidth. That being the case, it makes sense that if the other 90% of Internet users are suffering Internet delays, the 10% hogging the bandwidth should be reined in. Reining in those bandwidth hogs is what traffic shaping is all about.

It turns out that those 10% are mainly eating up the bandwidth with video downloads and uploads. Comcast made headline news when it was discovered throttling—cutting back or cutting off—BitTorrent users. BitTorrent is a popular tool for (mostly illegal) movie sharing. The FCC ordered Comcast to stop application-specific filtering. Comcast now uses a filtering approach that reins in any service that is hogging the bandwidth, not just BitTorrent traffic. Unfortunately, such filtering could inadvertently affect customers who are legitimately downloading video.

Most ISPs have switched to a tiered subscription model, where customers pay extra for additional bandwidth. For example, at present Comcast offers four tiers priced at roughly \$29.99/month for 3 Mbps, \$42.95/month for 25 Mbps, \$69.99/month for 45 Mbps, and \$72.95/month for 50 Mbps depending on various options. When users reach their limit, they are cut off or throttled. This allows those labeled “bandwidth hogs” to pay for the privilege of massive downloads without impacting others who simply want to check email.

There is concern that traffic shaping could lead to censorship or unfair business practices that thwart healthy competition. For example, an Internet service provider like Comcast could filter out packets from a competitor like Skype or Vonage so that its customers would have to purchase Comcast phone and television service. The concept of network neutrality is supported by those who wish to keep the ISPs honest, keep packets unfiltered, and maintain an open Internet.

The privacy concern over traffic shaping arises from the methods that ISPs use to decide which packets to throttle. If an ISP is using deep packet inspection to examine the contents of all data packets traveling over its network, user privacy may be an issue. Network neutrality favors a hands-off approach in which every packet is treated equally and anonymously. It is feared that, through traffic shaping, ISPs may claim too much power over the Internet and the flow of packets over the Internet, which is contrary to the original intent of its designers.

## Transparency

**Transparency** is when a person, business, organization, or government keeps little or nothing secret from the world—an approach that is supported by technologies such as livestreaming, geo-location, and microblogging.

### Why This Matters

So what is the danger in having other people know about your life, the intricacies of your day-to-day dealings, and your secret thoughts? Perhaps the solution to privacy issues is to abandon the concept of privacy altogether. If you aren't doing anything illegal, why should you care what other people know about you? Some individuals subscribe to this philosophy, have abandoned concerns over privacy, and are leading a transparent lifestyle. Businesses, organizations, and governments may support a transparent approach in order to win the trust of the public.

### Essential Information

Some experts in the area of privacy believe that there are three scenarios regarding the relationship of technology, privacy, and society:

- Full privacy: Citizens should be assured of 100% privacy. They should have absolute control over what personal information is maintained in public and private databases, and there should be no surveillance of any kind for any purpose.
- Full trust: Citizens should trust governments to provide surveillance in a safe and secure manner that respects privacy rights.
- Full transparency: All surveillance and information should be accessible to every law-abiding citizen. Governments and law enforcement should not maintain exclusive control over surveillance. Citizens should have the ability to turn the cameras onto authority to ensure that power is not being abused.

It may be too late for full privacy. Technology and its use have progressed past the point of regaining previous levels of privacy. If full privacy is not attainable, some feel it would be a mistake to fully trust those in power to manage privacy responsibly. Power corrupts, and being responsible for all private information of a population would imply absolute power. Such a scenario, some fear, could lead to an Orwellian society.

Full transparency is an intriguing notion. How would society change if everyone was openly honest and had equal access to all information and surveillance? No group would hold an advantage over others because of the information it controlled. Any person could view surveillance data from any location. Everyone would hold all the cards. Although there would be little privacy, except perhaps in one's own home, there would also be little opportunity for abuse of power, except for by those who cheat.

The advent of Web 2.0 technologies and social media has provided tools for Internet users to lead a transparent life. Some individuals like Justin Kan are strapping on video cameras and broadcasting their every waking moment. Justin's website justin.tv also provides other people with the tools necessary to *lifestream* on the Internet. Justin.tv's iPhone and Android apps provide access to 2500 live channels produced by users. In a less extreme and more popular form of transparency, people are broadcasting their daily events, using microblogging sites such as Twitter, Tumblr, and Facebook updates. Web 2.0 sites make it possible to share your thoughts, your interests, your photos, your location, your friends, your personal information (like your birthday and love interests), your web activities, and your favorite organizations. Just about everything about yourself can be presented for the world to see.

One possible danger in leading a transparent lifestyle is that it gives others power over you. When people know everything about you, but you know nothing about them, they could take advantage of you. You become more susceptible to identity theft. Someone could break into your residence when they know you are out. There are many ways that the personal information people provide to others over social networks can be used, and is being used, to take advantage of those individuals.

There are also issues surrounding the division of a person's professional life and personal life. Most people are not eager to have their boss and work colleagues analyzing their party photos on Facebook. Nor do most people want their personal friends and business colleagues intermixed in their social networks. People typically behave differently at home than they do at work. A totally transparent lifestyle would not support any division of home life and work life.

Nonetheless, there is a certain feeling of freedom that results from casting away concern for privacy and broadcasting yourself to the world: "Like me or not, I am who I am." It is a trend that may spread voluntarily or out of necessity as privacy becomes increasingly difficult to maintain.

## Information Security

**Information security** refers to the protection of information systems and the information they manage against unauthorized access, use, manipulation, or destruction, and against the denial of service to authorized users.

### Why This Matters

Information security is a growing concern as increasing amounts of important and private information are stored digitally on systems connected to public networks and wireless private networks. From bank account and credit account access codes, to personal medical records, to secret business strategies, to national defense initiatives, to email sent to a friend, people trust information systems to keep their most valuable and secret information safe and secure. But can information systems be trusted?

### Consider This

2012 went down as a record year for hacker activity with attacks spreading from primarily large businesses and government agencies to small and medium-size businesses. Security firm Symantec reported that in 2012, “the number of attacks on small businesses rose threefold amid a 42 percent rise in overall targeted attacks.” Roughly 240 million people had their identities stolen in 2012. Research by Verizon found that 75 percent of cyberattacks are financially motivated, while another 20 percent are state-affiliated espionage campaigns.

The Internet can also be used to spread misinformation. The Associated Press' Twitter account was hacked, and the hackers used it to tweet breaking news that there were “Two Explosions in the White House and Barack Obama is injured.” Within seconds, Wall Street went into panic mode, sending the Dow Jones industrial average into free fall, erasing nearly \$200 billion off the broader market's value. The confusion was eventually cleared up and the market recovered. An organization calling itself the Syrian Electronic Army claimed responsibility for the attack.

Cyberattacks of one kind or another are occurring on the Internet, continuously causing concern over information at every level: personal, business, and government. Consider the information of concern to you that is stored on your computer, on web servers, and in the systems of every business and organization with which you have interacted. What damage could be inflicted on you if that information fell into the wrong hands or was destroyed? What types of businesses are at the biggest risk of cyberattack? Why? How do cyberattacks against businesses impact you and the country? What should the government do to protect its citizens from cyberattacks? Should the government force businesses to adopt tighter security measures? Who should incur the costs of increased national cybersecurity?

## Essential Information

Corporate and government networks and home computers are under attack, and the Internet is the battlefield. Automated criminal systems probe Internet-connected computers owned by individuals, businesses, and governments, continuously seeking security holes that might allow a hacker to infiltrate the system. The casualties of this war include your privacy, information, property, and money. Crimes that take place online, called cyber crimes, can impact personal information, corporate information, and governmental information. Valuable information and many forms of intellectual property can be compromised or stolen. Computer systems, automated industrial systems, and critical national infrastructure, such as the power grid, can be attacked and derailed. An increasing percentage of criminal activity now takes place online.

Cyber crime takes place on many levels. Pirates illegally download copyright-protected music, movies, and software. Plagiarists copy portions of online articles and claim ownership of others' ideas. Criminal hackers illegally access computer systems to steal information, to cause problems or embarrassment for a business or organization, or to utilize hacked network resources for criminal activity. Cyber spies take part in cyber warfare to steal government secrets. These represent examples of intentional crimes. Others may be unintentional. Sometimes damage to computer systems and information occur through negligence. For example, a user may unintentionally delete files, enter incorrect and misleading data, lose archived data stored on removable media, or fail to take safety precautions like backing up data.

*Total information security* refers to securing all components of the global digital information infrastructure from mobile phones to PCs, to drone aircraft, to business and government networks, to Internet routers and wireless networks. The figure shows the layers of information security and illustrates how you, the computer user, are at the heart of information security. Your recognition of security risks and the actions you take to secure the systems with which you interact are the most important component of total information security. As a computer user, you must learn about security risks at three levels: the machine level, the network level (including wireless networks), and the Internet level. As you move from the machine level toward the Internet level, you face increasing exposure and risk.

## Ethical Dilemmas

When it comes to state-affiliated cyber -espionage, China has been blamed for many attacks against the U.S., but denies all charges. The nature of cyberattacks makes it difficult to trace an attack to its exact origin. President Obama has signed a cybersecurity executive order to protect the country's critical and vulnerable infrastructure. A new branch of the Pentagon was created to focus on cyber warfare. A legal review on the use of America's growing arsenal of cyber weapons concluded that the president has the power to order a pre-emptive cyber strike if the United

States detects credible evidence of a major digital attack looming from abroad. Clearly things are heating up in what has been called a cyber cold war with China.

Meanwhile the international community is working to create rules for cyber warfare engagement similar to the Geneva Convention, which governs traditional warfare. The NATO Cooperative Cyber Defense Center of Excellence has created a set of rules named the Tallinn Manual to protect civilian targets such as hospitals, dams, and nuclear power stations from state-sponsored cyberattacks.

What steps do you think world powers should take to rein in damaging cyberattacks and prevent global cyber warfare? How can the U.S. better protect its critical infrastructure?

### **Information Security Topics**

- Machine-Level Security
- Network Security
- Internet Security

## **Machine-Level Security**

**Machine-level security** refers to actions taken to protect information on a computer that may or may not be connected to a computer network or the Internet.

### **Why This Matters**

Information security is implemented at multiple levels: the individual machine level, the computer network level, and the Internet level. This section examines security from the perspective of the individual machine and discusses security precautions for personal computers that may or may not be connected to a network or the Internet. While it may not be practical to lock your computer in a vault to protect your data, there are methods available to provide nearly the same level of protection. By learning how to protect stand-alone PCs, you also learn about the first line of defense for the networks to which those PCs may be connected.

### **Essential Information**

The greatest threat to information on a computer is through network connections. However, information on computers not connected to a network is also at risk from people who might access that computer physically rather than remotely. The only way to fully protect a computer is to eliminate access to the machine by anyone other than the owner. Many businesses take this approach by keeping important computer systems behind locked doors, accessible only to authorized users granted access with a card swipe. Other methods of protecting data on a machine include the use of passwords and encryption. Keeping backups is essential for protecting data in case all defenses fail.



## Machine-Level Security Topics

- Authentication
- Encryption
- Data Backup

## Authentication

**Authentication** is a security process in which the identity of a person is verified.

### Why This Matters

Deciding who should have access to information and who should not is the foundation of information security. There must also be a method of determining that persons attempting to access the data are who they claim to be. That is the purpose of authentication. There are several forms of authentication, some stronger than others. Implementing authentication properly is important in protecting computers and mobile devices.

### Essential Information

Access to today's PCs is typically guarded with a username and password. In security terms, this is called *authentication*, which confirms the identity of a user. The table below shows the three common forms of authentication:

**Table: Forms of Authentication**

Form of Authentication	Description
Something you know	Information such as a password or personal identification number (PIN)
Something you have	An item such as an ID card, smart card, badge, keychain fob, and other items designed to be used to authorize access to secure areas and systems
Something about you	Unique physical characteristics such as fingerprints, retinal patterns, and facial features that can be scanned and used for authentication

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A *username* identifies a user to the computer system. Varying levels of computer access and environmental preferences are associated with a username. Although usernames can act as a form of “something you know” authentication, they are not very strong because they are typically not kept secret. Usernames can often be

accessed from email addresses. A *password* is a combination of characters known only to the user that is used for authentication when gaining access to systems. Passwords can be an effective form of authentication if they are difficult to guess, kept confidential, and changed regularly. However, passwords are considered a weak form of authentication because they can be guessed by others to access systems without your knowledge. It is important to create passwords that are strong—that is, difficult, if not impossible to guess. For example, *johnnyb* and *nycjohnny* would be weak passwords for John Baily from New York City. The password *92Tpo5#cCw* is very strong but nearly impossible to remember. The password *nyK00LB@Y* might make a good password for John, since it is strong and is also easy to remember.

It is equally important to use different passwords for different accounts and to change your passwords regularly, at least twice a year. This will thwart hackers who may be accessing your account without your knowledge.

A number of physical devices are used in corporations and organizations to identify users and provide access to restricted areas and computer systems. These technologies make use of the “something you have” form of authentication. Sometimes they are combined with a password to increase the security level. The most popular of these devices are ID cards and tokens that sometimes take the form of a keychain fob. ID cards may contain forms of identification in a magnetic strip or in a microchip, as is found in a smart card. A *token* is an object like a smart card or key fob that contains a microchip that stores ID information. The user holds the token against a reader device to gain access to a location or information systems.

A token can also take electronic form on a computer. For example, a bank may require its members to install a special bookmark in their browsers to use when logging into their online bank accounts. The bookmark is used as a token to identify the computer as an approved device for a member’s account. If the account is accessed from a different computer, the user is required to enter more detailed information to authenticate his or her identity.

Facebook, Google, and other online services offer a higher level of security using 2-step verification. Two-step verification requires a combination of a password with a verification code sent to the user’s phone. Typically the 2-step verification is only required if the account is accessed from an unrecognized computer. These systems also use digital tokens to identify and recognize approved computers. They may notify a user by email when someone attempts to access the user’s account from an unrecognized computer.

*Biometrics* is the science and technology of authentication by scanning and measuring a person’s unique physical features (“something about you”). Fingerprints, facial characteristics, retinal patterns, and voice patterns are commonly used in biometrics. A *fingerprint scan* uses the pattern of a fingerprint to authenticate a user. Fingerprint scans are an increasingly common method of

authentication for access to secure areas, for validating credit card purchases, and for logging on to computers.

*Facial pattern recognition* is a form of biometrics that uses a mathematical technique to measure the distances between points on the face. Taking a weighted sum of these measurements, software can quickly scan a database of known faces and come up with a match if one exists. Law enforcement agencies and airport security agents use facial pattern recognition software in efforts to catch criminals and terrorists. Facial pattern recognition is also being used to secure PCs and mobile devices that include cameras (see video). Another form of biometrics, *retinal scanning*, analyzes the pattern of blood vessels at the back of the eye (see figure). As the field of biometrics expands, other physical characteristics, such as speaking patterns, are also being explored for use in authentication.

## Encryption

**Encryption** is a security technique that uses high-level mathematical functions and computer algorithms to encode data so that it is unintelligible to all but the sender and recipient.

### Why This Matters

With the increase in mobile computing, the possibility of losing a computer or having it stolen is very real. Data can also be stolen from computers by hackers who break through network security. Sometimes, the data stored on a mobile device is more valuable than the device itself. If that data is encrypted, it will be unintelligible to hackers and thieves that have stolen it. Data can also be stolen while it is in transit over a computer network. Encryption techniques help safeguard data that is stored or traveling over a network.

### Essential Information

Today's PCs include security tools that can encrypt files stored on disks and flash drives. This is useful in situations where the information you are storing is confidential or valuable, and there is a possibility that your computer can be accessed by others, lost, or stolen.

Files can be encrypted "on the fly" as they are being saved, and decrypted as they are opened. To open encrypted files, you must enter a password. Encryption and *decryption* (the process of decoding encrypted data so it can be comprehended) tends to slow down a computer slightly when opening and saving files, so encryption is not typically turned on by default. Instead, the user manually selects the files or folders that contain confidential information and marks them for encryption.

Mac OS X uses the FileVault system for file encryption. FileVault uses the latest U.S. government security standard, AES-128 encryption, to safeguard confidential documents. Microsoft Windows uses BitLocker Drive Encryption, which is machine-level data encryption that can secure the entire hard drive and protect the data even if the PC is stolen. Some Windows PCs include an embedded security subsystem that stores passwords and encryption keys on a dedicated security chip on the motherboard. Storing security information in a dedicated chip rather than in a file on the hard drive offers perhaps the strongest method of personal computer security.

Besides protecting data on storage media, encryption is used to protect data that travels over a network. By sharing an encryption key, the sender and receiver can send encrypted data over a network and the Internet. Encryption is particularly important for wireless networks, where data can be easily intercepted. Several wireless encryption protocols exist. *Wired Equivalent Privacy (WEP)* and *Wi-Fi Protected Access (WPA)* are the two most popular. *WPA2* is the most recent version. WPA is far more difficult to crack than WEP. Even with encryption, it is dangerous to send passwords and other private information over public wireless networks.

When sending confidential data over the web, users are wise to make sure the browser is using a secure connection, which can be indicated by `https://` in the address bar, a green color in the address bar, and a closed lock icon in the address bar or at the bottom of the browser screen. HTTPS is a secure form of HTTP that encrypts the data submitted by users, such as passwords, credit card numbers, and other data submitted using forms on webpages. Also, other software that is used to send sensitive data over the Internet should apply encryption. For example, traditional FTP (File Transfer Protocol) software does not use encryption, but newer SFTP (secure FTP) software does. Email servers and client software can also be set to encrypt email and to use digital certificates to prove the user's identity in electronic transactions.

Encryption and other forms of information security, used alone, do not safeguard data 100 percent, as is illustrated in the video. Maximum information security is accomplished through the implementation of all computer security tools combined with safe computing practices.

## Data Backup

**Data backup** is a process in which copies of important computer files are stored in a safe place to guard against data loss.

### Why This Matters

Data may be lost due to hardware failure, human error, software corruption, hackers, malware, or natural disasters. The only method that provides protection for data against all of these disasters is to back it up! Still, many computer users do

not have a regular backup procedure in place. Today's backup technologies make backing up important data and system files easier than ever.

### Essential Information

When you purchase a new computer, it typically comes with a system recovery disk. If operating system files become corrupted, either due to failure of the hard drive or a virus, your computer may simply not start. A *system recovery disk*, sometimes called a *rescue disk*, is used to regain access to a computer that has lost its ability to boot normally. The disk includes utility software that can be used to attempt to repair the damaged system files, recover data files, or prepare the computer for a reinstall of the operating system. Operating systems typically provide a way for users to create a system recovery disk if one is not provided by the manufacturer.

Windows PC users who find their system damaged but can start the computer can benefit from the System Restore utility. Periodically, Windows creates backups of the state of the operating system at what it calls "restore points." If the computer contracts a virus or newly installed software causes system problems, the system can be taken back in time to when the computer was without problems. Data files are left intact, but software and the operating system are reconfigured to match the state they were in at the restore point. Apple Mac OS X provides a similar tool called Time Machine (see video), which backs up not only system files but also data files.

In addition to backing up important system files, it is important for computer users to back up data files. Businesses typically have regular backup procedures to back up corporate data to disk drives, tape, or online storage media. Individuals typically back up their personal data files to DVD, USB drive, a network drive located on another computer, or remote online storage.

Operating systems usually provide a backup utility for data files. Typical backup software collects the files you wish to back up into a compressed file called an archive. Some backup software provides the ability to encrypt the archive and password-protect it. Backup software typically provides the following options:

- Select the files and folders you wish to back up.
- Choose the location to store the archive file.
- Choose whether to back up all files (a *full backup*), or just those that have changed since the last backup (an *incremental backup*).

Most backup utilities also provide a scheduling option that allows you to automatically run backup routines at specified dates and times.

Rather than creating an archive, some users prefer to create an exact copy of their data files, using a technique called *mirroring*. Some software provides real-time mirroring for home users. As the user saves a file, a second copy is saved to a drive connected to the home network. Businesses sometime use a technology called *Redundant Array of Independent Disks (RAID)* to keep a mirror copy of all data on the

system. Should the primary system fail, the RAID kicks in, allowing uninterrupted operations.

Internet-based backup services are becoming popular as more users have high-speed Internet connections. Services like Remote Data Backups, Dropbox, Mozy, SugarSync, and Carbonite provide automated backup of data continuously or periodically over an Internet connection for a monthly or yearly fee. Files that are backed up to the cloud may be accessed from any computer by the owner or by individuals the owner chooses to share the files with. SugarSync allows its users to make folders or files accessible to the general public—a useful feature for sharing photos on the web. An important feature of an online backup service is that it allows you to back up your data off-site in a different location from your computer. It is smart to keep backups off-site, as keeping them on-site may expose them to the same destructive forces that wipe out the original data: fire, flood, a power surge, and so on.

With the advent of cloud computing, users are storing increasing amounts of data on Internet servers. Email, calendars, documents, photos, and other data are being saved in services provided by Google, Amazon, Microsoft, Flickr, Facebook, and other cloud apps. Both Microsoft and Apple offer remote data storage for backing up files, sharing files, and accessing data from any Internet-connected computer. Microsoft offers free online storage and sharing of Microsoft Office documents with Windows Live OneDrive, while Apple's iCloud provides backup options and the ability to share apps and data across Apple devices.

As data moves to the cloud, the responsibility for backing it up falls on the shoulders of the service providers. But before trusting a service provider to back up your data, make sure to read the disclaimers. The providers do not typically ensure against data loss. Ultimately, it is up to the users to keep backup copies of everything.

## **Network Security**

**Network security** is concerned with addressing vulnerabilities and threats in computer networks that may or may not be connected to the Internet.

### **Why This Matters**

When a computer becomes connected to a network, security risks increase a hundredfold. If the network happens to be a wireless network, it is all the more vulnerable. If the network is connected to the Internet, risks increase a million times that of a stand-alone computer. In fact, for information of highest security, government agencies use computers that are not connected to agency networks or the Internet. As long as there is a network connection, there is an increased risk of unauthorized access. The primary challenge in securing a computer network is keeping user data private and accessible only by authorized persons.

## Essential Information

This section discusses threats, considerations, and security for computers connected to wired and wireless networks. A later section on Internet Security deals specifically with security measures for computers connected to the Internet.

Networked computers may be in a government agency; a large, medium-sized, or small business; a college campus or campus housing; an apartment building; or a home. Whenever many people share computing resources remotely over a network, a system administrator assumes the responsibility of establishing which resources should be accessible to each user. A *system administrator* may be a person or persons hired by a corporation to manage a large computer network, or it could be a person like you managing your own home network. The topics in this section discuss the threats posed to computer networks—both wired and wireless—and the tools available to system administrators to protect the network.

## Network Security Topics

- Permissions
- Interior Threats
- Network Usage Policy
- Wireless Security

## Permissions

**Permissions**, or **file system permissions**, refers to the specific access privileges afforded to each network user and each system resource in terms of which files, folders, and drives each user can read, write, and execute.

## Why This Matters

A *multiuser system* is a computer system, such as a computer network, where multiple users share access to resources. When sharing resources, users are naturally concerned about the privacy and protection of their data files. System administrators are concerned with protecting the system from intentional and unintentional damage. If a corporation owns the network, corporate management is concerned about the security and privacy of corporate information. The network administrator can control which network resources—files, folders, drives, network connections, systems, and software—each user can access and edit, by defining specific permissions for each resource and user on the network.

## Essential Information

Operating systems such as Microsoft Windows, Mac OS X, and Linux provide methods for associating permissions with each user account and each system resource. As each user logs on to a computer connected to the network, the permission policies are applied, and the user can access only the resources defined by those policies.

To control user access to system resources such as files, folders, and disk drives, access policies must be defined for both the resources and the users. For example, a user may be restricted to accessing only files that he or she created. Files and folders on the system must carry information that identifies their creator. This is referred to as file ownership. Users are the owners of the files they create.

The system administrator is responsible for setting the access rights of users and for setting the permissions on system resources. The system administrator can also assign permissions to groups of users. Users have the power to set permissions for the files they own. The system administrator is typically the only user who has full access to the system.

The system administrator can also define the type of access allowed. Access to files and folders can be classified as read, write, and execute. Execute permission can be applied to programs (.exe) and folders, in order to control access to folders. Data files make use of read and write permissions. The following table illustrates settings for a system resource, such as a file stored on a web server accessible from the web.

**Table: File Permissions Example**

	Read	Write	Execute
<b>Owner</b>	X	X	X
<b>Group</b>	X		
<b>World</b>	X		

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The ability to carry out system commands can also be restricted through *user permissions*. For example, Windows uses three classifications for user accounts: Administrator, Standard, and Guest. Those with Standard access can only change their own account password and associated icon. A Guest account is for someone who does not have a permanent account and needs to temporarily access computer or network resources. Guests can't change settings, install hardware or software, or create passwords. An Administrator has full access to system commands and resources.

Home users can set permissions on their own files so that others on the network can access them or not. By default, the personal files and folders on Windows and Mac OS X computers are off limits to others on a network. You can adjust file permissions for a specific file or folder by accessing its properties. On a Windows PC, you right-click and choose Properties; on a Mac, select Get Info from the File menu (see figure).



User permissions provide a second layer of security for computer networks. Usernames and passwords and the login process are the primary way of keeping unregistered users out of the system. User permissions provide registered users with access to the files they need while restricting access to private resources. User permissions become even more important for files accessible on the Internet. Webpage files, for example, exist on a web server with permissions set to allow the World to read but not write.

## Interior Threats

**Interior threats** are network security threats that originate from within a network, typically from registered users.

### Why This Matters

Interior threats can be intentional or unintentional. Unintentional threats can occur when users make mistakes or exceed their authorization. Intentional threats come from registered users who desire to do the system harm or steal information. Interior threats can be as troublesome for corporations and organizations as hackers, malware, and other exterior threats.

### Essential Information

Network users can become security threats through intentional or accidental behavior.

There are many situations where innocent human mistakes result in monumental problems. Take, for example, the Taiwan stock trader who mistakenly bought \$251 million worth of shares due to a typing error, causing her company a paper loss of more than \$12 million. In another error, the U.S. Defense Department, Internal Revenue Service (IRS), and Justice Department have misplaced hundreds of government notebook computers, many of which contain classified government documents. In a more common act of negligence, many users provide hackers with easy access to computer systems by visiting websites designed to spread malware, downloading infected files, using passwords that are easy to guess, or storing passwords and other private information where others can access them.

People's mistakes can lead to problems with security, accuracy, or reliability of computer systems and information. The major types of human errors include those shown in the following table.

**Table: User Mistakes That Threaten Computer Security**

Type of mistake	Example
Data-entry errors	A military commander might enter into the computer the wrong GPS position for enemy

	troops into the computer. This data-entry error might cause friendly troops to be killed.
Errors in computer programming	A payroll program might multiply a person's pay rate by 1.5 instead of 2 for overtime. This programming error results in a lower paycheck than the employee should receive for overtime work.
Improper installation and setup of computer systems	A person may neglect to properly set the necessary security settings to secure a wireless network.
Mishandling of computer output	A medical office might send lab results to the wrong person, so the person receiving the results has access to another person's private medical information.
Uninformed dangerous computer activity	An employee might write down his or her password for others in the office to find, download an infected file, visit an infected website, or use an infected USB drive.
Inadequate planning for and control of equipment malfunctions	An individual's hard drive might fail. If the person has not backed up important files recently, he or she will lose important information and have to redo work.
Inadequate planning for and control of electrical problems, humidity problems, and other environmental difficulties	A power outage could shut down an organization's computer system. Without a backup power supply and protection from electrical surges, information and data might be lost, and equipment might be ruined.

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Individuals and organizations can take a number of actions to prevent computer-related mistakes. Smart businesses and organizations automate data entry whenever possible to cut down on typing errors. For example, scanning RFID chips or bar codes rather than typing in item numbers during inventory is more accurate. Database management systems and spreadsheets can be programmed to validate data entry. Businesses typically have data backup policies and procedures, as well as backup power supplies and surge protection. Businesses also employ technology experts to set up and maintain computer systems so that both the hardware and the software are safe and secure.

It is not uncommon for a business to include policies that outline how employees are to use information systems and handle data in soft and hard copy. For example,

a business may have a policy that calls for employees to shred all documents that contain private information. To avoid viruses, most organizations do not allow users to install software on their corporate PC. To keep corporate data secure, some businesses don't allow removable storage devices like USB drives. Just as today's best businesses employ smart and thorough information security practices, individuals should do the same when managing their own personal computers and information.

Besides accidents and careless mistakes, inside threats can be intentional. Disgruntled employees pose a serious threat to computer systems and information. There have been many cases where employees expecting layoffs have taken malicious revenge on data. Those with technical expertise might create software time bombs that destroy data after they have left the organization.

Financial gain is often the goal of internal system attacks. Employees may know of ways to transfer funds within a system or find other illegal means to benefit financially based on their knowledge of the system. Other employees might be bribed by outsiders to provide corporate secrets or database records.

## **Network Usage Policy**

A **network usage policy** is a document, agreement, or contract that defines acceptable and unacceptable uses of computer and network resources for a business or organization.

### **Why This Matters**

Network usage policies are important for network owners in that they define what is permitted on the computer network and can provide legal protection for the network owner when a user breaks the law using the network. Network usage policies are important for users as they can prevent the user from accidentally using the network in a way that was unintended by the network owner. It is important that network users and owners have a clear understanding of acceptable network behavior. This is particularly important in corporate networks, where using the network in inappropriate ways can be used as a basis for a user's dismissal.

### **Essential Information**

To safeguard against threats to a network's health and stability and to prevent information theft, businesses and organizations often implement network usage policies. New users are often asked to agree to the conditions of the policy before receiving a network account. Users are held liable for upholding the policies and can lose their network account or job if they violate the rules.

Employers are not legally responsible for notifying employees of network usage policies. If policies are not provided at the time of receiving network privileges, it is wise for the new user to ask what is and isn't allowed on the network. Corporate

network administrators have the right to listen in on network communications, read employee email, and electronically monitor employees' web activities without giving notice to the employee. Employees enjoy very little legal protection with regard to privacy when using employer-owned networks. People have lost their jobs over activities that they thought were okay but that their employer thought were wrong.

Network usage policies typically warn against using the network for illegal activities. They also cover issues that may not be as obvious. For example, most college networks do not allow students to use their network account to run a business. Some businesses do not allow employees to use their business email account for personal correspondence. The following table lists some common corporate security and usage policies and examples.

**Table: Network Usage Policy Examples**

Policy type	Examples taken from actual company policies
Network and computer use	<ul style="list-style-type: none"> <li>• Users are responsible for maintaining the security of their password.</li> <li>• Users are responsible for using the network facilities in a manner that is ethical, legal, and not to the detriment of others.</li> <li>• It is against federal law and corporate policy to violate the license on computer software.</li> <li>• Users must request permission of system administration for the installation of software and provide proof of ownership of the software license.</li> </ul>
Email use	<ul style="list-style-type: none"> <li>• Employees shall use corporate email systems only for corporate business purposes.</li> <li>• Email systems shall not be used for transmission or storage of information that promotes discrimination.</li> <li>• Employees must use judgment on the type of information sent through email.</li> <li>• The use of network systems to send and forward chain letters and other inappropriate messages is prohibited.</li> <li>• The office may access an employee's email media.</li> </ul>
Internet use	<ul style="list-style-type: none"> <li>• The use of Internet access and the web should be restricted to corporate business purposes.</li> <li>• Users shall request the permission of system administration before installing web plug-in applications.</li> <li>• The use of peer-to-peer networks and file-sharing software is strictly forbidden.</li> </ul>

## Wireless Security

**Wireless security** refers to the unique threats and defenses associated with wireless computer networks.

### Why This Matters

Wireless networks provide wonderful convenience; but, as is usually the case, with convenience comes security risks. With wireless technologies, an attacker no longer has to establish a wired connection to a network. Attackers located within the range of the wireless signal, perhaps on the floor above or in a car parked outside, can attack a wireless network to gain access.

### Essential Information

Wi-Fi networks are centered on a telecommunications device called an access point. Access points are essentially routers with the capability of wirelessly connecting to Wi-Fi equipped devices. The access point sends and receives signals to and from computers on the wireless local area network or WLAN (pronounced W-lan). By default, access points are set to broadcast their presence. So, for instance, if you open up your notebook computer in a coffee shop, a message may pop up on your display, letting you know that the Starnet wireless network is within range and asking you if you would like to connect. Starnet is the SSID (service set identifier) of the wireless network. Clicking the Connect icon establishes your wireless connection with the access point. In the case of a commercial provider, you may then be asked for a credit card number to pay for the service. If an access point has no security enabled, clicking the Connect icon puts you on the network, no questions asked. By viewing the Connect to a Network dialogue box in Windows, (see second figure) a user can view all wireless networks available and select one to connect to.

Consider the user in a small apartment who decides to set up a Wi-Fi network. Once the access point is set up, a dialog box appears on the owner's computer with the message, "Network available, would you like to connect?" Easy, right? At the same time, the wireless-enabled computers of neighbors on either side of the user, as well as those upstairs and downstairs from the user, get a similar message. Now there are five users connected to the "private" home Wi-Fi network without the owner's knowledge. This is a fundamental problem of Wi-Fi networks.

Neighbors may find it hard to resist free wireless network access when a pop-up message offers it. But there are other intruders who go out looking for open wireless networks. *War driving* is the act of driving through neighborhoods with a wireless notebook or handheld computer looking for unsecured Wi-Fi networks. Homemade war-driving kits include high-powered antennae attached to the vehicle roof, a long-lasting power supply for the computer, software such as NetStumbler that probes and scans for networks, and sometimes a GPS receiver to mark coordinates that can be shared with others over services on the web. The legality of war driving is questionable. While accessing unprotected wireless networks that owners have

left open may be regarded as legal, (but perhaps unethical), working to gain unauthorized access to a secured wireless network is definitely against the law.

Another common hacker trick is to set up a computer to masquerade as a free Wi-Fi network in a public space. When nearby users connect to the “network,” all of the data they send and receive can be accessed by the hacker, including passwords.

So, how can Wi-Fi network owners keep neighbors and war drivers off their private networks? Access points provide several settings that can all but bulletproof a wireless network. The access point configuration settings are accessed using a web browser on a network-connected computer. The web address and the password are provided in the access point’s owner’s manual. The following steps combine to offer sufficient protection for most wireless home networks:

- Change the default password for your access point to something unique
- Add encryption to your network communications through settings on your router, preferably WPA2 encryption (see the Linksys settings screen in the third figure)
- Set your router to connect to only the MAC addresses of your devices
- Set your access point so it does not automatically broadcast its existence

When away from home, protect your wireless devices and the information they hold by following these tips:

- Avoid sending private information like passwords and credit card numbers over public Wi-Fi networks.
- Do not connect to unknown access points in public places.
- Turn off any “auto-connect” option for connecting to wireless networks.
- Make sure that the data on your PC is not set to be readable to others on the network and that all sharing services are disabled.
- Do not accept network connection requests from users who may attempt to access your PC.
- Make sure that Bluetooth is set so that it is not “Discoverable” or “Visible” to others. Bluetooth can be used to hack onto smart phones and computers.

## Internet Security

**Internet security** refers to the unique threats and defenses associated with computers connected to the Internet.

## **Why This Matters**

The Internet is the most popular resource for information, communication, and digital services, and it is also the most dangerous. Criminals long ago discovered that it is much easier and safer to commit crimes in cyberspace than it is in physical space, and they have devised a wide array of traps, scams, and attacks. Internet threats and defenses become more advanced and complex every day. Internet users must learn how to protect themselves online for their own security, the security of the businesses they work for, and that of the countries in which they reside. It is likely that an unprotected PC, when connected to the Internet, will be attacked and infected within minutes.

## **Essential Information**

Expanding a connection from a local area network to the Internet is akin to moving from a small town in South Dakota to downtown Manhattan. While your access to information is dramatically increased, so is your exposure to risk. When a computer is connected to the Internet, it becomes visible to billions of Internet users and a target to millions of attacks.

Internet connections are not a one-way street. Just as you can request information and services from servers, so too can intruders attempt to access information and services from your computer. On the Internet, everyone is just a number—an Internet (IP) address. An address such as 128.186.88.100 could be a web server, an email server, or your PC. Although you may be anonymous, your computer's IP address is registered and known to others.

Attacks against Internet-connected computers can come in the form of direct attacks by hackers (system penetration), through malware like viruses and worms, or via spyware obtained through email, the web, or downloaded files. Internet users are also at risk of being manipulated through scams.

Keeping a computer and the information it holds safe and secure requires a two-pronged approach: applying software security tools and maintaining safe, vigilant behavior. This section provides information on threats and defenses.

The checklists below can be used as a quick reference to the material in this section.

### **Applying Software Security Tools Checklist**

- Set your operating system to update automatically.
- Install and use antivirus and antispyware software.
- Install and use firewall software.
- Make sure that all security, antivirus, firewall, and antispyware software is set to update automatically.
- Use backup software to back up important data files automatically on a regular schedule.

- Use a security suite, such as McAfee Security Center or Norton Security Suite, to manage all of the above.
- Install web browser security updates as soon as they are released.
- Use encryption to protect private files stored on your computer, to secure web transactions, and to secure wireless networks.
- When connected to a network, make sure that user permissions are set to share only the files you wish to share.
- If you use a home wireless network, disable SSID broadcasting on the access point, change passwords on the access point, and set it to connect with only specific MAC addresses.
- Windows users can consider using Windows cleaner software to maintain the Windows Registry.
- Use spam filters on your email.

### **Maintaining Safe and Vigilant Behaviors Checklist**

- Don't type private information when connected to a public wireless network.
- Select strong passwords carefully and change them regularly.
- Do not open attachments unless expected and scanned for viruses.
- Do not click links received in emails, text messages, or social network messages unless you are certain they are authentic and safe.
- Examine web addresses closely to make sure that they are legitimate and include *https://* for forms.
- Avoid P2P file-sharing networks.
- Avoid websites set up for unethical, immoral, or indecent purposes.
- Do not allow websites to install software on your computer, unless you are certain the website is legitimate.
- Keep your computer system well organized and up to date using the housecleaning tips provided in this section.

### **Internet Security Topics**

- Hacker
- Firewall
- Software Patch
- Malware
- Antivirus Software
- Botnet
- Cyber Warfare
- Identity Theft
- Internet Fraud
- Digital Certificate
- Phishing Scam
- Laws



## Hacker

A **hacker** is an individual who subverts computer security without authorization.

### Why This Matters

In the battle between Internet users and those who attack them, it is valuable to understand the motivation of the enemy. Learning about criminal hackers, why they hack, and what tools they use enables Internet users to defend against attacks more effectively.

### Essential Information

A hacker subverts computer security without authorization. Security professionals refer to this as *system penetration*. In reality, there are many names used to label those who unlawfully hack into secure computers and networks. The news media generally uses the term hacker. Hackers and others who wish to differentiate between law breakers and innocent techies use the term *cracker*, for criminal hacker, claiming that hackers do not necessarily break laws. Those in the information security industry tend to prefer the labels *attacker* and *intruder*.

There are several labels associated with different forms of hacking. Some of the most common include:

- Black-hat hacker: A hacker who takes advantage of security vulnerabilities to gain unlawful access to private networks for unethical purposes
- White-hat hacker: An individual who considers himself/herself to be working for the common good by hacking into networks in order to call attention to flaws in security so that they can be fixed
- Gray-hat hacker: A hacker of questionable ethics
- Script kid or kiddie: A person with little technical knowledge who follows the instructions of others to hack networks
- Hacktivist: A hacker who hacks networks for a social cause or perceived greater good

Notice that there are ranges of ethics embraced by varying types of hackers. Not all hackers are considered unethical. Many hackers simply enjoy re-engineering, technologies and gadgets so that they perform differently than originally intended. *Make* magazine (see figure) is a publication geared toward this type of hacking. Other hackers, experiment with cyber attacks and hacks so that they can better protect computer systems. This is the philosophy behind the popular hacking/security podcast HAK5. Often the line between hacking as an exploratory hobby and breaking the law is difficult to define. Some hackers are drawn over that line and face serious consequences for their crimes.

Over the past decade, hacking migrated from a hobby to a money-making profession. Hackers have increasingly gained access to systems for the purpose of taking control and selling access to hacked computers for illegal activities, such as

sending illegal spam or launching denial of service attacks. In 2011 that trend took a dramatic turn towards hacktivism. Hacker collectives like Anonymous began hacking systems for perceived righteous causes. They targeted businesses and government organizations perceived by the hackers as evil. They exposed large numbers of confidential records online through websites like WikiLeaks. They did not profit financially from their exploits, but instead embarrassed companies and proved that no network is safe from hackers. In 2012 and 2013, global attention was turned to cyber warfare and espionage, where one-fifth of all cyberattacks became associated with various governments' ambitions.

Hackers have many tools at their disposal for finding vulnerable computers and gaining access to them. Attacks may also be automated in the form of malware viruses, worms, and spyware. These methods of attack can achieve many of the goals of common attacks without the need for directly manipulating a system. The following table describes some tools in the hacker's arsenal.

**Table: Hacking Tools**

Tool	Description
<i>key-logging software</i>	Software installed on a computer to record all keystrokes and commands. The recording is later collected from a remote computer over the Internet and played back in order to spy on the user's actions and sometimes to steal usernames and passwords.
<i>packet-sniffing software</i>	Software that captures and analyzes all packets flowing over a network or the Internet. It can be programmed to look for personal information such as passwords and credit card numbers.
<i>wireless network scanning software</i>	Software used to locate unprotected wireless networks. Once found, a hacker will try to connect to it. If unable to connect to it, <i>wireless sniffing software</i> can be used to capture the information being sent over the network. Encryption hacking software can be used to break common forms of encryption used on wireless networks.
<i>port-scanning software</i>	Software that searches random IP addresses for open ports. Port-scanning software is allowed to run for several hours, after which the attacker can collect a list of IP addresses waiting to be hacked.

<i>social engineering</i>	A technique that uses social interactions to manipulate individuals to give up personal information. For example, a social engineer might phone a person, pretending to be a system administrator in order to get that person to provide a password. A social engineer may even go <i>dumpster diving</i> , that is, rummaging through trash to steal credit card numbers or other personal information.
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## Firewall

A **firewall** is network hardware or software that examines data packets flowing in and sometimes out of a network or computer in order to filter out packets that are potentially dangerous.

### Why This Matters

Hackers attempt to access your computer dozens of times every day. Hacker tools allow them to continuously cruise the Internet, checking computers for an open port that can be used to gain access. A firewall slams the door in hackers' faces, turning away probes and hack attempts. A firewall can also prevent infected computers from operating under the control of a hacker. Using a firewall is one of the four pillars of information security, the others being installing software patches, using security software, and practicing safe, cautious online behavior. Firewalls are also used by some governments, Internet service providers, and businesses to censor data that may not be dangerous but may be undesirable.

### Essential Information

A firewall is implemented either through the software running on a computer or through hardware such as a network router. For personal computers, firewall software is typically used. Networks typically use software as well, but some larger networks employ a hardware firewall—a network device connected to the network at the point it joins the Internet. Whether implemented through software or hardware, a firewall protects all the ports of a network or PC from intruders and guards against known methods of attack.

A standard firewall checks all incoming data packets and rejects packets that are defined as dangerous or undesirable. Microsoft Windows, Mac OS X, and some Linux distributions include a firewall utility. Users not using a firewall should enable the firewall as soon as possible.

Users looking for a more powerful firewall can find plenty to choose from online. Some firewalls include the ability to check outgoing as well as incoming packets. The purpose of checking outgoing packets is to keep zombie computers from carrying out the will of hackers. Zombie computers are infected computers that are being used in a botnet to attack other computers or send spam. There are millions of zombie computers on the Internet today. Using firewalls that check outgoing packets reduces online infections and spam considerably.

It is even more important to use firewalls on networks than on PCs. A firewall is installed at the point that the network connects to the Internet to protect the entire network from infection and attacks. It is a good idea to use a firewall that checks both incoming and outgoing packets because infected computers are hard to identify on a network. Network firewalls also provide settings that allow the administrator to filter particular types of network activities. For example, a campus network administrator might use a firewall to block access to P2P networks.

## Software Patch

A **software patch**, sometimes called a security patch, fixes software bugs and flaws and is typically distributed to software users through online software updates.

### Why This Matters

Although software vendors do their best to develop secure and bug-free software, the high degree of complexity in today's software makes it very difficult to achieve perfection. As flaws are discovered, software vendors provide updates to users that include patches to correct the bugs and flaws.

### Essential Information

Software bugs in operating systems, web browsers, and other Internet software can create security holes that hackers may exploit to gain full control of a computer. These are called *critical software flaws* and should be patched as soon as possible to keep computers and data safe. Software updates are one of the four pillars of information security, the others being using a firewall, using security software, and practicing safe, cautious online behavior.

Most software companies offer free and regular *software updates* for their products. Software updates are distributed to customers over the Internet, and the process of applying them is typically automatic. Many programs use the Internet to check periodically to see if an update is available. When an update is discovered, the patch may be downloaded automatically or the user may be prompted to download it. In either case, the user is then asked to click to install the update. The figure shows the prompts for updates provided by Microsoft Windows and Apple OS X.

One of the great benefits of cloud computing is that it removed the burden of software updates from users. For online software like Google Docs, and Microsoft Office Web Apps, the software company—Google or Microsoft in these cases—fixes software bugs as they are discovered, often without users ever noticing the bug.

Microsoft provides security patches for its Windows operating systems the second Tuesday of every month—“Patch Tuesday.” Often, problems that are patched are classified as critical. Windows users are wise to set Windows to update automatically, whenever updates become available. It takes hackers less than 24 hours after a Windows patch is released to design a method of exploiting the security hole that the update patches. When an update is released, it becomes a race between users applying patches and hackers seeking to exploit the vulnerability.

Apple Macs have become targets of malware and hackers as well. The Flashback malware attacked over a half million Macs in 2012 and acted as a wake-up call for many users. Due to Mac’s small market share, it hasn’t attracted as many hackers or viruses. Now that Macs have become a more prominent player in the market, and many Mac users do not use security software, the platform is becoming a bigger target.

Mobile devices including iPhones, iPads, Windows phones, and Android devices are also targets for hackers. Many Android phones have been infected with malware from free apps in the Android Marketplace. It’s important to keep mobile device software updated to protect the devices from attacks.

It is particularly important to patch operating systems, web browsers, and other network and Internet software as soon as updates are available. The vast majority of hacker exploits take advantage of the security holes in Internet software. Keeping this software up to date and using firewall software are two of the most important steps to take to ensure information security.

## Malware

**Malware** is short for “malicious software” and includes any software designed to damage, corrupt, or illegally manipulate computer resources. Common forms include viruses, worms, and spyware.

### Why This Matters

Cyberattacks can take the form of software that is distributed and executed on a computer without the user’s knowledge, for the purpose of corrupting or disrupting systems, stealing information, or using the system to launch further attacks. The most common of these malware programs are viruses, worms, and spyware.

## Essential Information

A *virus* is a program that attaches itself to a file, spreads to other files, and delivers a destructive action called a payload. The payload could be the corruption of computer data files or system files, resulting in the loss of data or a malfunctioning computer. There are many different types of viruses. A worst-case scenario for damage would be the total loss of data and software. Viruses do not harm computer hardware or cause users to have to buy a new computer. Recovery might involve wiping the hard drive of all files to remove all infection, reinstalling the operating system and all software, and restoring data files from backup.

Viruses are sometimes delivered through a technique called a *Trojan horse*, or just a *Trojan*. Like the Trojan horse in Greek mythology, these Trojan horses appear to be harmless programs; but when they run, they install other programs on the computer that can be harmful. A *backdoor Trojan* opens up ports (back doors) on the computer to allow access to intruders.

You've probably received emails warning that your computer may be infected with a virus. However, chances are that the email itself is a form of malware. A *virus hoax* is an email or pop-up window that warns of a virus that doesn't exist in order to confuse users or to get them to take actions that harm their own computers. Virus hoaxes are typically forwarded by well-meaning but inexperienced users. Don't take action on such emails; check websites like [snopes.com](http://snopes.com) or [mcafee.com](http://mcafee.com) to see if the message is identified as a hoax.

One form of malware called *ransomware* uses encryption to hold the user's data captive until a ransom is paid. For example, Ransom-A, one of the first ransomware Trojans, encrypted the user's data files and demanded \$10.95 to be paid through Western Union. It threatened to delete a file every 30 minutes until the ransom was received.

A *worm* does not attach itself to other programs but instead acts as a free agent, replicating itself numerous times in an effort to spread to other computers or overwhelm systems. For example, within 10 minutes of its introduction, the Slammer worm had attacked more than 75,000 computers. Thirty minutes later, some believe the worm had disrupted one in five data packets sent over the Internet.

In 2010 the world saw the first worm that experts believe was designed for cyber warfare. The Stuxnet worm was an extremely sophisticated piece of code, designed to attack industrial software and equipment. More specifically, the worm appears to have been designed to attack the centrifuges used to enrich uranium at a nuclear power plant in Iran. Most security analysts suspect that Israel or a Western power was behind the creation of Stuxnet.

*Spyware* is software installed on a computer without the user's knowledge, either to monitor the user or to allow an outside party to control the computer. Spyware is so prolific that any computer that spends time on the web, if not protected, has

probably contracted it. Spyware differs from viruses and worms in that it does not self-replicate. Spyware is often used for commercial gain by displaying pop-up ads, stealing credit card numbers, distributing spam, monitoring web activity and delivering it to businesses for marketing purposes, and hijacking the web browser to show advertising sites.

Spyware is distributed by deceiving the user into installing it by hiding it in legitimate apps, email attachments, webpages, or other online resources. Spyware is often installed by a virus or worm. Once on a system, spyware runs in the background, unknown to the user, carrying out the wishes of its creator. Spyware can communicate with its creator over the Internet.

A computer that carries out actions (often malicious) under the remote control of a hacker, either directly or through spyware or a virus, is called a *zombie*. Thousands of computers are added to the ranks of zombies each week. Zombie computers can join together to form zombie networks, or botnet armies. Botnet armies apply the power of multiple PCs to overwhelm websites with distributed denial-of-service attacks, to crack complicated security codes, or to generate huge batches of spam. It has been estimated that a very high percentage of spam originates from zombie computers.

The goal of the malware engineer is to get the user to run the software that installs the malware. Although sending malware as email attachments used to be the preferred method of distribution, today most malware is spread from webpages. A common trick is to infect a website so that when users visit the site, a pop-up instructs them to install a software update. Instead of legitimate software, malware is installed on the user's PC. Even worse, in *drive-by downloads*, users aren't even prompted to download the software. Just visiting the site infects their computer. By distributing the link to an infected website through social networks or email, millions of computers can be infected. Once infected, a PC can then act as the attacker and spread malware to other PCs, either over a network or through email, social networks, instant messaging systems, shared files, or webpages (if the infected machine is a web server). Good antivirus software protects a computer from the vast majority of these types of attacks.

## Antivirus Software

**Antivirus software**, also known as virus scan software, uses several techniques to find viruses, worms, and spyware on a computer system; remove them if possible; and keep additional viruses, worms, and spyware from infecting the system.

### Why This Matters

Implementing some form of virus protection is a necessity on all types of PCs: Windows and Macs. Without some form of virus protection, it is almost assured that an Internet-connected PC is—or will soon become—infected. Antivirus software is

one of the four pillars of information security, the others being firewalls, software patches, and safe, cautious online behavior.

### Essential Information

The number-one tool against malware, including viruses, worms, and spyware, is antivirus software. Antivirus software is only effective if it is continuously running to guard against attacks, and if it is continuously updated with new virus information as it becomes available. For this reason, Internet subscription services, such as Microsoft Security Essentials, Norton AntiVirus and McAfee VirusScan—which update automatically when necessary—are preferred. Antivirus software is often packaged with firewall software, backup software, and other security tools as a security software suite that covers all aspects of computer security.

In addition to using antivirus software, knowledge and caution play a big part in protecting PCs against viruses and worms. Follow these practices to protect your PC from malware:

- Don't open email or IM attachments that come from friends or strangers unless they are expected and inspected by antivirus software.
- Keep up with software patches for your operating system, your web browser, your email software, and your IM software.
- Avoid clicking links sent to you through email or sent to you through text messages or social networks.
- Use caution when exploring websites created and maintained by unknown parties.
- Avoid downloading software or plug-ins from websites created and maintained by unknown parties.
- Avoid any software from untrusted sources.
- Be cautious if you use P2P file-sharing networks; they do not effectively protect users from dangerous files that are being swapped.
- Don't download antivirus software when prompted to do so in an email or on the web—it's often a ploy to get you to install malware.

### Botnet

A **botnet**, or **botnet army**, refers to a collection of computers autonomously or automatically working together toward some goal; these are often zombie computers that are synchronized to perform illegal activities on the Internet.

### Why This Matters

Botnets harness the power of hundreds of thousands of compromised computers to carry out monumental attacks over the Internet. Computers are drafted into botnet armies through the use of malware. It is possible that your computer is a soldier in a



botnet army. Understanding botnets will help you to free your computer if it has been enslaved and protect your computer from becoming a zombie.

### **Essential Information**

Millions of computers on the Internet are leading double lives. They service their users as usual without any indication that anything is amiss while they simultaneously live secretive second lives as zombie computers working in botnet armies. The Kraken botnet is one of the largest, with more than 400,000 zombies carrying out its commands. It is estimated that Kraken uses its zombies to crank out more than 9 billion spam email messages per day. Another botnet, Storm, at its height in early 2008, was believed to control as many as a million computers. Once discovered, Microsoft implemented a security update that squelched Storm on many computers.

Computers are drafted into botnet armies when they are infected with malware. A computer under the control of an outside party working in a botnet is referred to as a zombie computer. Botnet armies are controlled by botnet command and control (C&C) servers that disperse the commands of the hackers who created them. The Shadowserver Foundation maintains a map of C&C servers worldwide that is updated daily (see figure). Botnet armies are used to distribute spam, viruses, and worms. They are also used in *distributed denial-of-service attacks (DDoS)* in which many computers simultaneously access a web server, making it impossible for the server to respond to legitimate requests.

The power of a botnet can surpass that of today's most powerful supercomputers. With that kind of power, a botnet can be used to crack encryption codes and hack accounts through brute force methods. Botnet owners lease out their botnets for all kinds of online jobs. Botnet armies are a major tool in cyber warfare. In 2007, a botnet was used to bring down the information infrastructure of the country of Estonia, in an act that the country viewed as a military attack.

## **Cyber warfare**

**Cyber warfare** extends traditional forms of warfare to the Internet and the web, including espionage, psychological warfare, and attacks.

### **Why This Matters**

Heavy dependence on information technologies and the Internet creates a significant vulnerability for individuals, businesses, and governments. Those wishing to harm a population for political or ideological reasons may use information systems as tools in their quest and may target information systems in order to disrupt the lives of their enemies. In this manner, the Internet has become a primary tool for terrorism and international attacks.

## Essential Information

Attacks over the Internet are a serious and well-known threat to nations. All of the major world powers invest significantly in guarding their online resources—including government servers that contain confidential information—and their critical national infrastructure, such as hospitals, utilities, transportation, and commerce. The U.S. Pentagon has stated that the United States reserves the right to retaliate with military force against a cyber attack and is working to sharpen its ability to track down the source of any breach. U.S. intelligence officials have accused China and Russia of systematically stealing American high-tech data for their own national economic gain. Attacks originating in China against the U.S. and its allies, and China's complaints of being attacked by Western governments, have become so numerous that some are calling it a cyber cold war.

Terrorist organizations such as al-Qa'ida have made effective use of the Internet and the web for promoting their causes, recruiting new members, and terrorizing populations. There is no doubt that such terrorist organizations are also seeking to use the Internet to harm their enemies through hacking and attacking online. *Cyberterrorism* extends traditional forms of terrorism to the Internet and the web.

The United States Computer Emergency Readiness Team (US-CERT) was established to monitor the security of U.S. networks and the Internet and to respond to cyber warfare and cyberterrorism. US-CERT is part of the National Cyber Security Division of the United States Department of Homeland Security. The US-CERT website, [www.us-cert.gov](http://www.us-cert.gov), gives network administrators and computer users up-to-date information on security threats and defenses. Recently, a new branch of the Pentagon has been established to defend the U.S. against cyberattacks. The Pentagon's Cyber-Security unit is the fastest growing unit in the U.S. Department of Defense, with plans to grow from 900 on staff to more than 4,000 over the next few years.

Fighting international cyber attacks is difficult as there are currently no global cyber crime laws. The laws of one country cannot be enforced in another without the cooperation of both governments. A computer attack may be designed by hackers in country A and launched in country B to attack computers in country C. Some countries are discussing the establishment of a global cyber-crime task force, similar to the INTERPOL international police network. One step in that direction was the Council of Europe's convention on cyber crime in 2001 and its more recent Dialogue on Internet Governance (EuroDIG). The convention on cyber crime produced a treaty that calls on countries to work together to create international laws that address cyber crime.

Just as traditional international warfare is governed by the Geneva Convention and other international treaties, cyber warfare will soon be governed by its own set of international rules. The NATO Cooperative Cyber Defense Center of Excellence has nearly completed a set of rules called the Tallinn Manual, named for the Estonian capital where it was compiled. The rules protect civilian targets such as hospitals,

dams, and nuclear power stations. Hacking a dam's computer controls to release its reservoir into a river valley is just as serious as breaching it with explosives, the authors argue, and should have similar rules and responses. They argue as well that medical computer systems should get the same protection that brick-and-mortar hospitals do.

## Identity Theft

**Identity theft** is the criminal act of stealing information about a person to assume that person's identity in order to commit fraud or other crimes.

### Why This Matters

The U.S. Federal Trade Commission (FTC) receives hundreds of thousands of consumer fraud and identity theft complaints each year. Yearly losses to U.S. consumers total more than a billion dollars. Individuals between the ages of 18 and 29 are hardest hit by ID theft.

### Essential Information

Using a person's Social Security number (SSN), birth date, or other personal identifiers, an identity thief can apply for a new credit card in the victim's name and have it delivered to a post office box. Identity thieves can make purchases on stolen credit card numbers, make bank withdrawals, apply for loans, or buy a car. The information could also be used for more serious crimes. For example, an illegal driver's license might be created for use by a non-U.S. citizen to gain access to services and benefits provided only to citizens. The damage caused can be quite serious. An identity thief can also do damage to a victim's reputation by perpetrating crimes under the victim's identity.

Identity thieves use several methods to steal personal information. In a technique called dumpster diving, personal information can be found by going through someone's trash. Store clerks and cashiers can steal customer credit card information when processing a sale. *Phishing* is a technique used to trick a person into providing personal information on a fake website that looks like a reputable website. Identity thieves might submit a change of address form for a victim in order to have personal information rerouted to their own post office box. Personal information is often stolen by stealing wallets and purses or by stealing database records from businesses. *Social engineering* is a technique that uses social interaction to manipulate individuals into giving up personal information. For example, a criminal may phone a system administrator, pretending to be someone else in order to get access to a network account. Criminals might also buy personal information from other thieves, using underground networks and marketplaces that exist on the Internet.

People can protect themselves from identity theft by being cautious with their personal information and by following these tips:

- Keep Social Security numbers private; be suspicious of anyone who asks for your SSN.
- Shred documents containing personal information prior to disposal.
- Use caution online and verify the ownership of websites that ask for personal information.
- Store personal information in secure locations, both in physical and digital formats.
- Use encryption to safeguard information that is stored on your computer and transmitted over networks.
- Opt out of services offered by online stores that want to store your personal information for faster checkout.
- Be careful about storing digital copies of personal information on your own computer and in business and organization databases; keep these to a minimum.

## **Internet Fraud**

**Internet fraud** is the crime of deliberately deceiving a person over the Internet in order to damage them or to obtain property or services unlawfully.

### **Why This Matters**

The FBI receives more than 200 million Internet fraud complaints each year. Hundreds of millions of dollars are stolen each year by online criminals. With increasing amounts of business taking place online, Internet fraud is more prevalent than ever. It is essential to be able to recognize common types of fraud and to protect yourself against them.

### **Essential Information**

The FBI and the Internet Crime Complaint Center collect data each year on cases of Internet-related fraud. The most common form of Internet fraud is Internet auction fraud, accounting for a little more than one third of fraud cases. Auction fraud involves being swindled by sellers or buyers on auction sites like eBay. The second most common type of fraud is non-delivery of merchandise, which accounts for around 25% of Internet fraud. This involves purchases from e-tailers that process the payment and never deliver the goods (see video). There are numerous cases of credit card fraud and check fraud, where online customers use fraudulent checks or stolen credit card numbers to purchase items. There are also cases of phony loan company or bank websites that pretend to assist consumers with debt problems but really rob them blind.

The Nigerian letter fraud (see image) has been around for a long time. In this online scam, the victim receives an email from a prominent figure outside of the country asking for assistance, perhaps in the form of utilizing the victim's bank account to store a large sum of money. Of course, the victim will be well compensated for the inconvenience. Although often the author of the message claims to be from Nigeria, there are many variations on the theme. Once the victim supplies a bank account number, that account is cleaned out.

Often scammers set up fraudulent websites that appear legitimate but are actually covers for identity theft. Users may receive fraudulent emails inviting them to visit the phony website where they are asked to enter private information.

Impersonating legitimate businesses on the w or in email is referred to as *spoofing*. Phishing scams utilize spoofed email and webpages to fool users into believing the source of the email is legitimate.

## Digital Certificate

A **digital certificate**, also called an **SSL certificate**, is a type of electronic business card that is attached to Internet transaction data to verify the sender of the data.

### Why This Matters

Because so much of the information we send over the Internet is confidential, it is important that the identities of individuals, businesses, and organizations involved are positively verified. For example, consumers need to make sure that they are giving their credit card number to a legitimate and trustworthy business, and businesses need to confirm that the customer is the owner of the credit card being used. Transaction data must be accessed only by intended parties, and not be intercepted by outsiders. Two technologies are available to assist individuals and businesses in meeting these goals: digital certificates and encryption.

### Essential Information

Digital certificates are provided by *certification authorities* such as VeriSign and Thawte. They can be used to verify the sender of email and other forms of Internet communication. Digital certificates for use in encrypting web communications and credit card transactions cost the provider between \$350 and \$1400, depending on the level of security and type of communications. Certificates cost more for ecommerce than for nonbusiness use. Digital certificates for personal email are provided by Thawte for free.

Digital certificate information can be accessed on any https page by clicking the lock icon in the status bar or by right-clicking the page and viewing its properties (Windows) or info (Mac). A digital certificate contains the owner's name, a serial number, an expiration date, and a public key (see figure). The public key is used in encrypting messages and digital certificates. Encryption uses high-level

mathematical functions and computer algorithms to encode data so that it is unintelligible to all but the intended recipient. Through the use of a public key, (a large number) and a private key kept by the certification authority, an encrypted message can be decrypted back into its original state.

Digital certificates combined with *Secure Sockets Layer (SSL)* technology and a more recent version of SSL called *Transport Layer Security (TLS)* enable encrypted communications to occur between web browser and web server. This combination of technologies is used to secure usernames, passwords, and credit card information when they are typed into a web form and sent to a web server. The presence of an SSL connection is usually indicated by a URL that uses *https://* rather than *http://*. Also, a closed lock icon appears in the address line or status bar of the browser window when the connection is secure. New versions of browsers that support Extended Validation SSL go even further by showing a green background in the address bar for secure sites.

## Phishing Scam

A **phishing scam** combines both fraudulent email and websites in order to trick a person into providing private information that can be used for identity theft.

### Why This Matters

There are many forms of Internet fraud designed to trick users into giving out private and valuable information. Phishing scams are some of the most difficult to detect. The figure shows a suspicious email received by the author. Would you think that it's authentic or a scam? It turned out to be a scam. The more you know about the various types of phishing scams, the better protected you will be.

### Essential Information

A phishing scam combines both spoofed email and a spoofed website in order to trick a person into providing private information. *Spoofing* is the act of impersonating a person, business, or organization on the web or through email. In a phishing scam, the hacker sends out mass emailings (often using a botnet) that appear to come from a legitimate company, such as PayPal, a credit card company, or a bank. The email warns of some trouble with your account and provides a link that should be clicked to address the problem. The link may look safe— such as *https://www.paypal.com/customer-service*—but when you click it, it takes you to a different web address that looks just like the real PayPal login page, so you don't notice a slightly different URL in the address box. The page looks like the PayPal page because the hacker copied the page exactly from PayPal to his or her own web server.

From this point in the phishing scam, a number of things can occur. Most commonly, the user logs in as requested. The hacker has then attained his goal of stealing the

user's login information. Then the user may get a message like "Incorrect Password. Click here to try again." When the user clicks to try again, the software may send the user to the login screen of the real website, where the user can log in without any trouble. The victim is totally unaware of the fraud or identity theft that has occurred.

In addition to stealing login information, and depending on how long the user can be strung along, phishing pages can also install spyware on a computer. The website [www.antiphishing.org](http://www.antiphishing.org) receives around 2500 phishing reports each month.

Phishing tactics are getting more sophisticated. In an attack called *spear phishing*, private or personal information is used to target a specific individual. The fraudulent email received can be so convincing that it is impossible to guess that it isn't a legitimate request.

In a bold scheme, several hacker tricks were combined to ultimately blackmail Monster.com users. Monster.com reported that information about 1.3 million job-seekers had been stolen from its servers. The usernames, email addresses, and other information stolen from Monster.com were used in a spear phishing scam. Each of the users received email that appeared to come from Monster.com, inviting the user to try a new "Monster Job Seeker Tool." Those who took the bait ended up downloading ransomware that encrypted their files and demanded \$300 to unlock them.

To protect yourself from phishing scams, avoid clicking links received in emails. Instead, type URLs directly into your web browser. Examine web addresses closely to make sure that they are legitimate and include an *https://* for forms or a closed lock icon or green background in the address bar.

In the criminal act of *pharming*, hackers hijack a Domain Name System (DNS) server to automatically redirect users from legitimate websites to spoofed websites in an effort to steal personal information. In pharming, a user may type [www.paypal.com](http://www.paypal.com) into the web browser address bar; but when the request is received at the DNS server, rather than routing the packets to the PayPal server, they are hijacked to the hacker's web site. Pharming strikes a serious blow to the underlying architecture of the web as it is nearly impossible to detect. The ability of hackers to corrupt DNS computers could undermine the public's faith in ecommerce and the Internet altogether.

## Laws

Information security **laws** seek to protect the civil rights of populations from abuses of information systems and the Internet.

### Why This Matters

Securing networks and the information they store takes effort by individuals, businesses, and governments. Information security is so important that the United Nations has taken an interest in managing it. The Obama administration has also

developed a Comprehensive National Cybersecurity Initiative (CNCI) to establish a front line of defense against threats to the national infrastructure.

### Essential Information

A number of U.S. laws have been created for the purpose of securing information and protecting privacy. The following table lists the most important such laws.

**Table: U.S. Information Security Laws**

Law	Description
Consumer Internet Privacy Protection Act of 1997	Requires data collectors to alert people that their personal information is being shared with other organizations
Children's Online Privacy Protection Act of 2000	Gives parents control over what information is collected from their children online and how such information may be used
Information Protection and Security Act of 2005	Gives the Federal Trade Commission (FTC) the ability to regulate the sale of personal information
Notification of Risk to Personal Data Act of 2003	Requires businesses to notify individuals when their personal information is stolen
Identity Theft Protection Act of 2005	Requires businesses to secure sensitive data physically and technologically and to notify consumers nationwide when data is compromised
Health Insurance Portability and Accountability Act (HIPAA) of 1996	Requires those in the health industry to protect the privacy of health information and provides policies and procedures for doing so
Sarbanes-Oxley Act ("Sarbox") of 2002	Fights corporate corruption by imposing stringent reporting requirements and internal controls on electronic financial records and transactions
Gramm-Leach-Bliley Act (GLBA) of 1999	Requires banks and financial institutions to alert customers of their policies and practices in disclosing customer information



## Digital Media

**Digital media** refers to digital technologies of all kinds that serve and support digital publishing and broadcasting, and digital audio, video, and graphics.

### Why This Matters

Digital technology and information systems are tremendously useful in many practical ways. Digital media brings information systems to life with stunning and vivid imagery, powerful sound and music, and realistic, interactive animated 3D environments. If technology were alive, digital media might be considered its heart and soul. Digital media not only provides a technical venue for people to express themselves through audio and visual output, but also provides productive tools for use in nearly every career. Digital media also provides the means to digitally publish and broadcast content traditionally distributed through television, newspapers, magazines, and books.

### Consider This

Consider the late Steve Jobs and Apple computers, one of the largest and most successful businesses in the world. Apple's success has been attributed to its use of elegant product design, brilliant marketing, and CEO Steve Jobs' charismatic and inspiring personality. All three of these components rely heavily on aesthetics—a commitment to beauty in appearance and function. In this, Apple raised the bar for its competition and, in a way, for businesses of all types. Steve Jobs demonstrated that it's not just what you say, but how you say it, that influences people. His famous presentations featured beautiful graphics, music, and video. Digital media has been a major tool for Apple and other companies in designing and promoting products. The reason is simple: pictures, music, and video are able to communicate and influence where words fail.

Today, more than ever, all kinds of professionals benefit from understanding good design principles. Steve Jobs credits his design education for much of his success. As you read this chapter, consider how professionals in your discipline use design in music, online publishing, graphics, and video to promote success.

### Essential Information

You don't need to be artistically or musically inclined to use and appreciate digital media. Computers (desktop, notebook, and handheld), eBook readers and tablets, digital music players, digital cameras, video game consoles, DVD and CD players, and smart phones all serve up digital media. Common examples of digital media include:

- eBooks and publications
- MP3 music
- DVD and Blu-ray movies
- Digital photos and artwork
- Motion picture special effects

- Animated movies and cartoons
- Interactive video games
- Virtual reality and augmented reality

Digital media is transforming how we access news and entertainment. Now, many people prefer the Internet over television for information, news, and entertainment. Today's consumers have a preference for on-demand media. *On-demand media* is television programming, movies, music, and other forms of digital media that can be viewed or listened to at any time rather than at a time dictated by television, cinema, and radio schedules.

Another trend in today's digital media is the empowerment of ordinary people. Digital technologies have made it easy to capture professional-quality images and video, to create music and audio recordings, and most importantly, to share them with the world. No longer is media production solely in the hands of professionals. Whether posting a video to YouTube or Twitter, a podcast to iTunes, a book to lulu, or a collection of photos to Facebook or Flickr, digital media technologies and the Internet have provided a means for everyone to express themselves to the world.

### **Ethical Dilemmas**

Of all the industries, those that produce media—music, movies, books, photographs, and art—have been most impacted by the digital revolution. The digitization of intellectual property has transformed books, recordings, movies, and photographs into streams of bits that can be easily transferred over the Internet and shared with anyone. Intellectual property rights have been in many cases disregarded, as the public freely shares favorite tunes and movies. Piracy is a problem in the U.S., but in some overseas countries it runs unchecked as those governments turn a blind eye to businesses profiting from intellectual property theft. The movie and eBook industries apply strong digital rights management technology to content in an effort to hamper illegal distribution. But, like the music industry, they are fighting a losing battle. Are stronger laws and punishments the answer? Should the Internet be censored to stop illegal distribution? In cases of intellectual property rights, the strategies of media companies are often at odds with privacy and civil liberties.

### **Digital Media Topics**

- Digital Publications
- Digital Audio
- Digital Graphics
- Digital Photography
- Digital Video
- Interactive Media

## Digital Publications

**Digital publications** include eBooks, electronic magazines, online newspapers, blogs, and other forms of traditional publishing that have moved online.

### Why This Matters

The term *media* is closely associated with communication, and one of the most powerful forms of communication is the written word. Traditional print media uses newspapers, magazines, and books to deliver information and entertainment. The popularity of the web provided a digital platform for print media that made it easier to distribute print publications to more readers. With the recent popularity of eReaders like the Kindle and tablets like the iPad, increasing numbers of people are reading digital rather than printed characters. The Pew Research Center reports that the number of consumers aged 16 and over who read eBooks rose from 16 percent to 23 percent over the course of 2012. During that same period, the number who read printed books fell from 72 percent to 67 percent.

### Essential Information

Industries involved in print publications are scrambling to adjust to a public that is reading more online than on paper. Book publishers, including textbook publishers, are creating versions of their products for distribution on digital platforms such as the Kindle, tablets like the iPad, smart phones, and the web. They are concerned that they may lose control of the distribution of their products, so they lock them down with digital rights management (DRM) technologies. While the move to electronic delivery may be threatening to those in the print industry, it is also liberating to individuals. Businesses like lulu.com enable anyone to publish their own books online, and have them printed and bound if desired.

Newspapers across the country and around the world are shuttering print production operations and reinventing themselves as digital media companies. The new world of online news has newspapers, radio stations like NPR, and television networks, competing head-to-head online with news delivered as a combination of text, audio, video, graphics, photos, and interactive media.

Magazines are moving online as well, developing interactive content that readers can manipulate on their smart phones, tablets, and computers (see video). The digitization of print is forcing the publishing industry into a new arena where it must compete against other forms of media and carve out a niche for itself.

### Digital Publications Topics

- eBooks
- Online Newspapers and Magazines

## eBooks

**eBooks** are books published in a digital format and viewed online or with special eBook software on a dedicated reading device—an eReader, smart phone, tablet, or PC.

### Why This Matters

Increasing numbers of old books and newly published books are going through a digitization process, transforming them into eBooks. eBooks provide many advantages to readers. They are easy to acquire, and millions can be stored on one lightweight device. Plus, software can make it easy to search in a digital book and to look up unfamiliar words. Of course, there are some disadvantages as well. Some people prefer to read from paper rather than from a computer display. Backlit displays like those used on tablets are difficult to view outdoors in sunlight. E-paper displays only provide black and white images. But whether you prefer reading from paper or display, eBooks are here to stay.

### Essential Information

eBooks have been around for quite a while, nearly as long as computers. However, it wasn't until the birth of Amazon's eBook reading device, the Kindle, in 2007 that they gained more widespread acceptance. Several features of the Kindle appealed to the general public. First, the Kindle featured ePaper, a display that does not include backlighting like traditional displays. Some feel that ePaper is less harsh on your eyes than using a backlit display. Second, the Kindle was light and compact, similar in size and weight to a paperback book, but much thinner. Finally, Amazon created a vast library of eBooks that could be purchased and downloaded to the Kindle over a wireless network free of charge. By 2009, dozens of electronics manufacturers were offering eBook readers. By 2010, color eReaders like the Barnes & Noble Nook appeared, using a backlit color display instead of ePaper.

In the same year, Apple unveiled the iPad tablet. The iPad has a form factor similar to but larger than eReaders and with a color backlit display. As an eBook reader, the iPad functions much like other eReaders. In fact, Kindle and Nook software is available for the iPad to provide users with access to Kindle and Nook books. While the iPad makes an excellent eBook reader, it also provides thousands of other applications. The iPad launched a mobile computing revolution that has led to dozens of manufacturers designing their own tablets in a variety of sizes, most with eReader capability and varying levels of other features and functionality.

Today, high-end eReaders like the Kindle Fire HD and Nook HD allow users to read eBooks, view HD movies, listen to music, play games, and utilize a wide variety of apps. These high-end eReaders blur the lines between eReaders and tablets. Shoppers need to consider closely the lists of features of each device to decide which device best serves their needs.

Besides the Kindle, Nook, iPad, Samsung Galaxy, and other tablets, there are many ways to access eBooks. You can access eBooks on the web, download them to view on your PC, or read them on your smart phone. There are dozens of eBook formats. Some are proprietary, such as Kindle's .azw format that can only be viewed with Kindle software. Other formats, like the Adobe EPUB format, can be read on many different devices and software packages, including Apple's iPad.

In recent years, textbooks have begun migrating to eBook readers. Top textbook publishers provide versions of their titles for the Kindle and other eBook formats. Apple has released an iPad app for authoring iBooks textbooks that feature videos, media, and interactive content. The app allows educators to create textbooks for the iPad.

Many libraries now offer hundreds of titles for patrons to download to their eBook readers. While most publishers have approved the loaning of their books in electronic form, most of those publishers have placed restrictions on how many copies can be loaned at a time. So, as tablets and eReaders become more popular, eBook waiting lists are growing lengthy.

Google has partnered with libraries to digitize over 10 million books in its Google Books Library Project. Books may be previewed online, and depending on copyright, may be downloaded for free or purchased in Google's eBook store. Amazon loans some Kindle books for free to members of Amazon Prime, a subscription service that offers its customers many perks. Unlike the digitization of the music industry, digitized books are being distributed to the public in a much more controlled manner, utilizing strong DRM to keep the books from being freely copied.

## Online Newspapers and Magazines

**Online newspapers and magazines** include electronic versions of print newspapers and magazines as well as online-only publications that provide news and information in an increasingly multimedia format.

### Why This Matters

Ever since Gutenberg's work on the printing press centuries ago, people have been getting their news printed on paper. All of that is changing as today more people are turning to online news and information. This trend is forcing newspapers like the *Seattle Post Intelligencer* to abandon traditional newsprint in favor of digital delivery in order to cut costs and increase revenues. Magazines are in a similar position as newsstand sales decrease and online views increase. Today, those in the news business are struggling to find a new online business model that can keep their businesses afloat, and eventually provide new business opportunities. Meanwhile, news consumers are finding no lack of free news and information from a multitude of sources online.

## Essential Information

Every major newspaper and most minor newspapers have an online version of their publications. It is a simple matter to go online and find out what's happening in New York, LA, Chicago, London, and hundreds of other cities at any time by viewing newspapers published online in those cities. While most of those newspapers provide access to their online editions free of charge, an increasing number are starting to charge for access. With paper subscriptions at an all-time low, newspapers have to look online for ways to generate money. *The New York Times*, for example, provides free access to ten articles per month, but charges \$8.75 per week for unlimited access to articles online and through mobile apps.

Online newspapers are delivered through the paper's website, through RSS to news readers, and through apps on mobile devices including phones, eBook readers, and tablets. Online newspapers generate revenue through paid advertisements, subscription charges, or both. One popular business model being explored by the *Wall Street Journal* and others is to provide only headline stories for free, giving full access to paid subscribers only. *The Wall Street Journal* charges iPad users \$16 per month for full access, which also includes sponsored advertisements.

Many popular columnists also maintain their own blogs. *The New York Times* features dozens of blogs on a wide variety of topics. Blogs provide journalists with a more casual platform on which to publish their thoughts and opinions and collect responses from readers.

Like newspapers, magazines are being pressured by declining subscriptions and increasing online readership to move online. Some magazines are embracing online publishing and designing new ways for readers to interact with content. *Wired*, *GQ*, *People*, *Time*, and others have redesigned their online magazines to be interactive, incorporating animation and new approaches to navigating through articles.

## Digital Audio

**Digital audio** is any type of sound, including voice, music, and sound effects, recorded and stored digitally as a series of 1s and 0s.

### Why This Matters

The ability to digitize sound has dramatically altered phone networks, radio, television, and the entertainment and music industries. Digital audio and music touches our lives in many ways. Understanding how sound is digitized and put to productive use helps to further understand the positive aspects of digital technologies in our lives.

## Essential Information

Digital audio and music play a part in many industries. Digital phone networks digitize speech and send it as bits over cables or through the air. The radio industry is being transformed by satellite and Internet-delivered digital radio services. Digital audio in the form of voice, sound effects, and music is embedded in television programs, motion pictures, animated media, and computer games to provide high-quality and sometimes dramatic realism. The digitization of music has fundamentally altered production and distribution mechanisms within the music industry, providing musicians with powerfully creative tools (see video), improving the quality of recorded music, and providing listeners with more convenient access.

Digitized sound has many advantages over analog sound. It can be easily duplicated and transmitted without any degeneration. It can have a relatively limitless life span. It is easy to manipulate and process and can be encrypted for secure communications.

Many professionals use digital sound technology in their work. Journalists, lawyers, investigators, and other professionals whose work involves interviewing people rely on digital voice recorders to keep their facts straight. Doctors and other professionals use digital voice recorders to record notes for future transcription.

Scientists have used digital audio to study various natural phenomena. For example, the Australian Marine Mammal Research Centre uses digital recordings to study the songs of migrating whales off the coast of Australia.

Digital sound also plays an important role in law enforcement. *Forensic audio* uses digital processing to de-noise (remove nonessential sounds and audio interference), enhance, edit, and detect sounds to assist in criminal investigations. A spectrographic sonogram provides a visual fingerprint for various sounds in a recording. Gunshots, car engines, and voices all have a unique pattern when viewed as a spectrographic sonogram. The process of identifying a recorded human voice is known as voice-print identification. The technique is considered highly reliable and has been used as evidence in thousands of criminal cases.

Digital audio production plays an important role in music, movies, radio, television, video games, and Internet media. A sound production studio uses a wide variety of audio hardware and software to record and manipulate music and sound recordings. Studios that specialize in recording music are known simply as recording studios. Sound studios that work with motion pictures are typically referred to as production studios.

## Digital Audio Topics

- Sampling
- Digital Audio Production
- Podcast
- Audio File Formats

- Digital Music Player
- Digital Music Software
- Digital Music Distribution

## Sampling

**Sampling** is the process of capturing the value of a sound wave at regular intervals, typically thousands of times per second, to store sound and music digitally.

### Why This Matters

Music is digitized through the process of sampling. Through techniques such as sampling, the world that we experience through our senses can be represented and recreated in a computer system. Understanding the process of sampling enables users to capture and store digital audio at a quality level best suited to their tastes and needs.

### Essential Information

In the natural world, sound is the displacement of air particles caused by vibration and sensed by the eardrum. One way to quantify sound is by measuring air particle displacement and charting it over time to create a graph, called an analog sound wave. An *analog signal* is a signal that varies continuously over time. An analog sound wave can be transmitted electrically using varying voltages of electricity, as is done over old-fashioned telephone networks, or by using varying radio waves, as is done for AM/FM radio. Another more recent way of quantifying sound is to digitally represent sound waves with numbers through a process called *analog-to-digital conversion (ADC)*.

ADC uses sampling to encode a sound wave as binary numbers. When you digitize, or sample, a sound wave, you measure and record its amplitude (height) at regular time intervals called the sampling rate. The shorter the time interval, the higher the sampling rate, which makes the reproduction of the sound more accurate. For example, the sampling rate for audio CDs is 44,100 samples per second, whereas the sampling rate of your voice on a digital cell phone is only 8,000 times per second.

Digitized sound is transformed back into its analog form in a process called *digital-to-analog conversion (DAC)*. The analog signal typically causes a speaker cone or the diaphragms in headphones to vibrate to create audible sound. Although the recreated sound wave is not an exact duplicate of the original live sound, a sampling rate of 44,100 times per second is close enough to the original sound to satisfy our less-than-perfect hearing.



Several variables control the quality of digitized sound. They include:

- **Sampling rate:** This is the number of times per second that a sound wave is sampled.
- **Bit depth:** This refers to how many bits are used to store the sampled value—typically 8-, 16-, or 20-bit. Music sampling uses 16-bit. The higher the bit depth, the more precise the description of the sound.
- **Mono or stereo:** Stereo sampling requires two values for each sample and therefore results in larger files.

Often, the quality of digital music is expressed as a bit rate. A *bit rate* combines the sampling rate (the number of bits used with each sample) and either monaural (mono) or stereo, depending on the type of music, to determine the total number of bits processed per second. The bit rate has a big impact on sound quality and is expressed in kilobits per second, or Kbps. Computer users encounter bit rate settings when acquiring digital sound through software like Garage Band, Audacity, or iTunes.

**Table: Bit Rate and Quality of Digital Audio**

Bit rate	Quality
4 Kbps	Minimum necessary for recognizable speech
8 Kbps	Telephone quality
32 Kbps	AM radio quality
96 Kbps	FM radio quality
128–160 Kbps	Decent quality
192 Kbps	Good quality
224–320 Kbps	Near-CD quality

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## Digital Audio Production

**Digital audio production** refers to methods of capturing, creating, editing, and enhancing digital audio.

## Why This Matters

Digital audio production takes place in multimillion-dollar production studios, in homes and apartments, in all types of businesses, and out on the street. Capturing audio and music at all levels of quality and manipulating it to satisfy a need or desire is a rewarding objective of many digital audio professionals and amateur enthusiasts. Even individuals not interested in digital sound production are active in acquiring and enjoying digital sound.

## Essential Information

Digital audio is acquired through a host of audio devices with analog-to-digital capability. Once in existence, a digital audio file can be copied and transferred to a variety of formats and media. Audio recordings are distributed as binary data files on CDs, embedded in motion pictures and video games, distributed over the Internet as MP3 files and files using other audio formats, and streamed through the air on satellite radio and hi-def radio signals.

One of the simplest ways to digitize audio is using a digital voice recorder. A *digital voice recorder* refers to a handheld audio recording device designed to capture and digitize sound. Digital voice recorders range in quality from simple voice recorders to high-quality stereo recorders that can be used for recording live music. They receive sound through microphones and sometimes through an audio cable. Digital voice recorders typically store more than 100 hours of audio in standard digital sound formats, which can be transferred to a computer for transcription, editing, or final production.

Although digital audio processing has many industrial and professional applications, it is most strongly connected with the music industry. Today's recording studios are high-tech digital processing centers that use analog-to-digital converters to transform the recorded sound of voices, violins, horns, and other acoustic and electric instruments into digital signals that can then be manipulated. Musicians, sound technicians, and engineers have many tools available for creating and manipulating sound, including multitrack recording devices, mixing boards, synthesizers, samplers, drum machines, and sequencers.

Most music production studios have large racks of interconnected digital audio devices, called outboard devices, to process digital music and audio signals. The *Musical Instrument Digital Interface (MIDI)* protocol is a standard language for digital music devices to use in communicating with each other. Using MIDI, a musician can connect and control many devices from a single synthesizer keyboard or computer. MIDI is used in computers to control the onboard synthesizer that is housed on a computer's sound card. You may have seen audio files with a .mid file name extension. These files contain the instructions that cause a MIDI synthesizer to play music on your computer.

Digital audio production has become a favorite pastime for amateur and semi-pro musicians and DJs. Using a MIDI card and sequencing software, such as Apple's Logic

Platinum, a personal computer can become a self-contained recording studio. Easy-to-use digital recording software like Audacity for Windows and GarageBand for Mac has allowed many amateurs to create music and podcasts of high quality. Websites like Beatport provide a distribution channel for independent artists to get their homegrown music to the masses.

## **Podcast**

A **podcast** is an audio file that contains a recorded broadcast distributed over the Internet.

### **Why This Matters**

Seasoned broadcasters and amateurs alike are turning to podcasting to distribute their messages. Podcasting gets its name from the Apple iPod, but the technology can be used on any digital music player or digital music software that supports the MP3 format. Podcasts can contain news and information, interviews with celebrities, commercial radio programs or talk shows, music, comedy, instructional training, self-guided walking tours, academic presentations, personal discussions and commentaries, and more. Some podcasts have evolved from audio to video, offering followers a choice between the two.

### **Essential Information**

Podcasting provides a platform for individuals wishing to share their views, humor, talents, or musical taste with the rest of the world through audio or video. Traditional radio broadcast companies such as National Public Radio, along with television and newspaper companies, are turning to podcasting to grow their businesses over the Internet. Major news agencies such as Reuters and the BBC have turned to RSS for online distribution of content.

Tens of thousands of free podcasts are available on the web. Most are regularly produced publications with new episodes available daily, weekly, or monthly. Although the iTunes store has the most popular podcast directory, there are other good sources, such as Podcast Alley, Juice, and the Podcast Directory.

A podcast can be downloaded from the web and played using a PC media player like iTunes or transferred to a portable music player. Podcasts are also distributed using RSS technology. RSS is the technology used to distribute blogs and other regularly updated online content to which people can subscribe. Aggregator software uses RSS to allow you to subscribe to your favorite podcasts from one application. Apple iTunes is the most popular and easy-to-use podcast management software. Other podcast managers include Juice and Doppler.

Podcasting is another liberating force in our digital life. Rather than having to wait for a given time to listen to your favorite programming, podcasts allow you to listen

at your convenience. Also, since podcasts are easy to produce and distribute, they give a voice to many individuals who might not otherwise have one.

## Audio File Formats

Digital **audio file formats** define the manner in which digital audio is stored in a digital file, offering varying benefits in compatibility, storage capacity, or sound quality, depending on the format.

### Why This Matters

One challenge of working with digital music software and devices is deciphering file formats and compatibilities. Understanding the differences between file formats enables users to properly pair digital music services with compatible players. It also empowers consumers to get the best quality sound, in files that are the most efficient and flexible. Most users will confront format decisions when they transfer music from one media to another. For example when a CD is imported into Apple iTunes.

### Essential Information

Different media and operating systems use different “native” digital audio formats that were developed to store and play back audio on those platforms. Because the native formats often require a large amount of computer storage and bandwidth to transmit, *digital audio compression* technologies were developed to greatly reduce the size of audio files with little loss in sound quality. The most recognized compressed digital audio file format is MP3. The *MP3* file format compresses CD music files to less than one tenth their original size. With MP3 compression, you could shrink 10 CDs’ worth of music onto one CD. Some formats also include digital rights management (DRM) technologies to prevent music files from being illegally copied. The following table lists popular native and compressed digital audio formats.

**Table: Popular Digital Audio Formats**

Format	Description
.wav (Waveform Audio)	Windows audio file (native)
.aiff (Audio Interchange File Format)	Apple audio file (native)
.mp3 (MPEG-1 Audio Layer 3)	Compressed audio format
.wma (Windows Media Audio)	Windows audio with compression and DRM

.aac, .m4a, and .m4p	Apple audio with compression and DRM
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## Digital Music Player

A **digital music player** is a portable or home electronics device that plays digital music that is stored on the device or streamed from a computer or the Internet.

### Why This Matters

There are hundreds of portable and home digital music players on the market. Not all players work with all formats of digital music. It pays to understand the differences in players and the music formats they support in order to choose the one that best suits your needs.

### Essential Information

The first consideration when purchasing a player, or mobile phone to be used as a player, is the audio file formats that it supports. Shoppers should make sure that the player they select can play the format of the music files they own. While a few years ago, players and their music software primarily supported only their own proprietary formats, today, the major platforms are able to import music in a wide variety of formats. Those major platforms are Apple iTunes (for iPhones, iPads, iPods, and Macs), Google Play (for Android phones and tablets), Microsoft Xbox Music (for Windows 8 PCs, tablets, and phones), and Amazon's Music Store (for Kindle). All of these platforms feature tools that scan a hard drive for all music files and import them into a cloud-based service for access from any of the user's devices.

The second consideration when selecting a player is storage capacity. Smart shoppers first determine how they will use the player and how much music they wish to store. An iPhone with a 64 GB hard drive could store your entire music collection, all of your photos, and dozens of videos with ease. On the flip side, if you purchase a 16 GB iPhone and load a few motion pictures on it, you won't have much room left for music. One should consider movies, apps, and music needs when deciding on the storage capacity of a new device.

However, storage capacity is becoming less of an issue, as users are beginning to store their music in the cloud, on Internet servers. Cloud music services make music accessible to the owner from any Internet-connected device, including smart phones. However, streaming music from the Internet can be costly in terms of data transfer limits and fees on cellular data plans. Cloud music plans from Google, Apple, and Amazon are inexpensive if not free. For example, Amazon Cloud Player stores 5 GB of music for free and delivers it to the Cloud Player app on Kindles, iPhones, or Android phones. For \$24.99 a year, Apple's iTunes Match service will provide

online storage for ALL of your music, including tunes ripped from CDs and elsewhere. An additional benefit to cloud music is that it provides an effortless method of synchronizing and backing up a music collection.

Digital music can be enjoyed around the house, at the office, or in the car without the need for headphones. There are speaker systems designed for mobile phones and portable digital music players. For example, you can simply plug your iPhone into a dock, and the music is played through larger stereo speakers. You can use adapters in the car as well to connect your iPhone to the car stereo system.

Some digital music enthusiasts use their home PC as their primary home stereo, utilizing a wireless home network. Systems such as Sonos and Apple AirPort Express allow you to send music from your PC to powered speakers anywhere in your house.

## Digital Music Software

**Digital music software** is used to acquire, manage, and listen to digital music and to encode music to various audio formats.

### Why This Matters

Not long ago, a person's music collection was stored on CDs stacked on shelves. Today, most people store their music collections on their computers. Digital music software provides control over the hundreds or thousands of songs that individuals maintain. No longer bound to the order and collection of songs as distributed on CD, users can create their own playlists to suit various occasions and situations. Understanding digital music software empowers music fans to experience music on their own terms.

### Essential Information

*Media player software* such as iTunes, Android music player, Amazon Cloud Player, Windows Media Player, Xbox Music, and RealPlayer allows users to organize and play digital music on PCs and mobile devices. Media player software can search for all music files on a PC and sort and arrange them by artist, genre, album title, song title, ranking, or other criteria. It also allows users to create custom playlists that can be transferred to a CD or portable player. Most popular media players provide a music download service so that users can conveniently purchase and add tunes to their digital music collections.

Media software typically allows you to synchronize, or sync, music across devices through the USB port, a Wi-Fi network, or the cloud. You can either automatically sync user-defined playlists or manually sync playlists and songs. When you automatically sync your music, any new songs added to your PC or to specific playlists will automatically be transferred to devices the next time they connect to

the software. For example, if you subscribe to podcasts, automatic syncing will make sure that the latest podcasts are transferred to your portable player.

Many music fans are turning away from traditional music software like iTunes, and using online music services. Pandora is a Web-based music service and player that builds a streaming “radio station” around the listener’s musical tastes. Type in an artist or song, and Pandora will stream similar songs, allowing the listener to vote songs up or down and refining the play list to match the listener’s tastes. Spotify is software that is downloaded from [spotify.com](http://spotify.com) to play just about any album you might like to hear. Playlists can be created around artists or tunes and shared with friends on Spotify. Unlike Pandora, Spotify listeners can listen to any track anytime. Spotify makes money by playing short ads every few songs and allowing users to upgrade to a paid, ad-free, premium service.

Numerous software utilities are available for working with digital music files, many of which are built into popular media players. *Jukebox software* allows computer users to categorize and organize their digital music files for easy access. The process of transferring music from CD to MP3 or other digital audio format is called *ripping* a CD. *Ripper software* can be used to transfer your favorite music CDs to MP3 files on your hard drive. Digital music files can be transferred from one audio format to another using *encoder software*.

## Digital Music Distribution

**Digital music distribution** takes many forms to address many listening environments, including CD, online music services, cell phone music services, podcasts, Internet radio, satellite radio, and HD radio.

### Why This Matters

There are numerous methods of acquiring digital music today—some legal and others illegal. Understanding the options, benefits, costs, and risks of obtaining digital music is important when building a music collection.

### Essential Information

Online music services work with the recording industry to distribute music over the Internet. There are several types of online music services, including music stores that let you buy and download music, subscription services that charge a monthly fee for access to music, and free streaming music services. Some of the more popular online music stores include Apple iTunes, Amazon, Google Music, Microsoft Xbox Music, and Rhapsody.

Most of the popular digital music services provide the option of paying for and owning music, usually using the per-song or per-album model. Subscription services such as Rhapsody charge a monthly fee to provide the additional benefit of having

free access to millions of songs that you can listen to during the time that you are a member. When and if your membership expires, you lose access to the library of songs but can keep any songs that you purchased.

The freemium model of music distribution, allows listeners to enjoy free music online with ads, or without ads for a monthly fee. Spotify is an example of a freemium service that allows listeners to create their own playlists. Pandora is a freemium service that creates personalized radio stations.

*Internet radio* is similar to local AM and FM radio except that it is digitally delivered to your computer over the Internet, and there are a lot more choices of stations. Internet radio provides a means to listen to your favorite local stations online from anywhere in the world. For example, fans of the DJs and music selections on WXRT in Chicago can listen live any time, anywhere at <http://wxrt.radio.com>. Similarly, the colorful programming of Tampa's community radio station, once only reserved for residents in and around Tampa Florida, can now be enjoyed by anyone online at <http://www.wmnf.org>. Live365 provides access to thousands of local radio stations in more than 200 musical genres. Some Internet radio stations charge a subscription fee, but most do not.

*Wi-Fi radios* have emerged as music devices for the home that directly connect to Internet radio over a Wi-Fi network. Wi-Fi radios allow listeners to access thousands of radio stations on the Internet, including Internet-only stations, radio stations from other countries, and many AM/FM radio stations that simulcast online. Wi-Fi radios also allow music to be streamed from a PC connected to a Wi-Fi network.

*Satellite radio* is a form of subscription digital radio that receives broadcast signals via a communications satellite. Unlike traditional AM and FM radio, as long as there is no major obstruction between the receiver and the satellite, the user can listen to the same channels from any location in range—which could cover entire hemispheres of the planet. The most popular satellite radio service in the U.S. is SiriusXM, formed when the formerly separate XM and Sirius services merged. Satellite radio provides subscribers with commercial-free music, comedy, news, talk, sports programming, and specialty channels providing music or features not typically available on commercial radio. Satellite service subscription runs between \$15 and \$18 a month.

Each type of music service and technology has benefits and drawbacks. For example, storing music on your PC hard drive is convenient in some respects; but if your hard drive crashes, you will lose all of your music (unless you have it backed up). Ripping CDs and sharing music with friends is easy and fun, but it's also usually against the law. Downloading music to your cell phone is convenient, but it's difficult to play for your friends.

Most of us rely on several methods of acquiring music. The music industry is slowly zeroing in on a universal model for music distribution and consumption. Apple, Amazon, and Google have emerged as the three giants of music distribution.



Microsoft is working hard to catch up. With the arrival of cloud music services provided by all four companies, users are gaining more freedom in how they can access their music. Unfortunately, music fans are still forced to commit to one service or another since moving music collections from one to another can be problematic. Music services have become tied tightly to smartphone platforms. Apple iPhone and iPad owners are likely to go with Apple's music ecosystem, while Android platform users are likely to use Google. Amazon is the most open ecosystem since Amazon music can be enjoyed on any platform.

## Digital Graphics

**Digital graphics** refers to computer-based media applications that support creating, editing, and viewing 2D and 3D images and animation.

### Why This Matters

At first glance, digital graphics might appear to be the exclusive domain of artists and professional designers. In reality, people from many disciplines are finding themselves called upon or inspired to create digital artwork for personal and professional use. Easy access to powerful tools for graphics production has created a digital graphics explosion online, with many people posting photos and artwork to sites like Flickr and Deviant Art. On popular social media sites, members communicate with words, photos, images, and movies. Clearly, a picture is worth a thousand words, and understanding the basics of digital graphics provides both professionals and amateurs with potent tools for communication.

### Essential Information

The simple fact that graphical images can be represented digitally with binary numbers has brought us digital cameras, camcorders, flatbed scanners, digital cable TV, DVD movies, hi-def TV, digital video recorders, and phenomenal advances in motion picture production techniques, not to mention access to photos, animation, and video everywhere and anywhere we wish to view them—on TVs, YouTube, Vimeo, Hulu, and Flickr, and on digital devices from mobile phones to home media centers. The fundamental technology behind all of these advances rests on a small point of light or a dot of ink called a pixel.

Digital images are made up of a grid of small points called *pixels* (short for picture element). This is a good term to remember, as you will see it used in describing the quality of displays, printers, scanners, and digital cameras. Representing an image using bytes is simply a matter of storing the color of each pixel used in the image. Images stored in this manner are called *bitmapped graphics* or *raster graphics*.

In bitmapped graphics on a computer display, colors are expressed using numbers that represent combinations of intensities of red, green, and blue (called the RGB color palette). One or more bytes may be used to express the individual intensity of

red, green, and blue. For example, 0, 0, 255 would imply no red, no green, and full intensity of blue—and the resulting color is blue.

Bitmapped graphics are ideal for representing photo-realistic images as they can capture minute details in an image. However, they do have some drawbacks in that they are difficult to edit and enlarge. Pixilation, or fuzziness, occurs when bitmapped images are made larger than the size at which they are captured (see the top image in the figure).

Simpler images, such as those used in clip art, can be represented using vector graphics. *Vector graphics* use bytes to store geometric descriptions that define all the shapes in the image. Although vector graphics are impractical for representing photo-quality images, they are preferred for creating and storing drawings. Vector graphics are easier to edit and manipulate than bitmapped graphics, and they use far fewer bytes to store an image. In the figure, you can see that vector graphics keep the same quality when they are enlarged.

Vector graphics pictures can be combined in a series to create an animation. Animation is stored in the computer as a series of images called frames. When shown in quick succession, the frames can create the illusion of movement.

**Table: Digital Graphics Provide Personal and Professional Benefits**

Digital Graphics Benefit	Description
Studio art	Digital art is a relatively new form of expression that uses computer software as the brush and the computer display as the canvas.
Photographic art	Photographers and videographers use digital graphics software to edit digital images for the purpose of creative expression.
Presenting information	Commercial graphics designers depend on graphics software to create visually appealing designs. Web designers are specialists in creating attractive webpage designs. Desktop publishers use desktop publishing software to design page layouts for magazines, newspapers, books, and other publications.
Communicating ideas	Pictures, photographs, illustrations, graphs, animation, and video can communicate ideas in a more powerful manner than the printed or spoken word alone.

Exploring new ideas	Scientific visualization uses computer graphics to provide visual representations that improve our understanding of some phenomena. Scientific visualization can be used to represent quantities of raw data as pictures.
Entertainment	Artists in a variety of entertainment industries, including cartoonists, animators, illustrators, and motion picture special effects artists, use digital graphics to produce products for the enjoyment of their audiences.
Designing real-world objects	Computer-aided design (CAD) software helps designers, engineers, and architects to design three-dimensional objects—from the gear mechanism in a watch to suspension bridges—which can then be printed to serve as a blueprint or used to create 3D models on a 3D printer.
Documenting life	Photos and home movies preserve visual memories and act as a witness to special moments in our lives. Photojournalists as well as amateurs are moving to digital cameras and image processing for collecting, managing, and manipulating photographs and films for historical and sentimental value.

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### Digital Graphics Topics

- RGB Color
- Vector Graphics Software
- Graphics File Formats
- 3D Modeling
- Visualization
- Computer-Aided Design (CAD)
- Animation

### RGB Color

**RGB color** refers to a method of specifying color digitally, using values for the intensity levels of red, green, and blue (RGB) as combined to create all colors.

### Why This Matters

The RGB method of describing colors is called the additive color model because it describes colors in terms of combining colored light. Electronic displays use the RGB

model because they create images with pixels of light. Understanding how colors are expressed digitally using RGB is an essential and fundamental skill in digital graphics. Many graphics applications require the user to specify colors in terms of RGB, sometimes using hexadecimal numbers. Understanding RGB is also useful when shopping for consumer electronics such as hi-def televisions and video cameras.

### Essential Information

In the RGB model of expressing color, one or more bytes may be used to express the intensity of red, green, and blue to define the color of a pixel. The number of bits used to store color is called the *bit depth*. If one bit is used, two colors are represented—typically black and white. If one byte is used, 256 colors can be represented—this is sometimes used for monochrome images using shades of gray. For RGB, typically three bytes are used: one each for R, G, and B. This provides for more than 16 million total possible colors ( $2^{24}$  since there are 24 bits total). For example, the value 0, 0, 255 would imply no red, no green, and full intensity of blue—since 255 is the largest value a byte can hold. See the figure for more examples. Whenever all three bytes are set to the same value, the resulting color is a shade of gray—with 0, 0, 0 being black (no light), and 255, 255, 255 being white.

The hexadecimal number system often is used to represent colors. Hexadecimal (or hex) uses 16 digits—0 through 9 and then letters A through F. F is the highest value. Artists use two hexadecimal digits each for red, green, and blue to express colors. So #00FF00 would indicate no red, full green, no blue, and the resulting color is green. Hexadecimal numbers, commonly called hex, are typically preceded by a pound sign to indicate that they are hex.

When creating printed color, the CMYK color model is used to define colors. *CMYK* stands for Cyan, Magenta, Yellow, Black. As opposed to RGB, which is referred to as the additive color model, CMYK is referred to as the subtractive color model because it describes colors created from light reflected off a surface rather than those created directly from light. CMYK may be familiar to you from its use in printer ink cartridges. You are probably also familiar with CMYK from experience with blending paints. Most kindergarten children know that orange is made from blending yellow and red—this is CMYK, the subtractive model. In RGB color, orange is made from blending red and dark green, and yellow is made from red and green.

With a basic understanding of how colors are created through the additive and subtractive methods, you can progress to learning color theory. *Color theory* provides practical guidance for mixing and blending colors in a pleasing and effective manner. Color theory guides all kinds of digital artists and designers in creating effective color palettes for digital graphics.

## Vector Graphics Software

**Vector graphics software**, sometimes called drawing software, provides tools to create, arrange, and layer graphical objects on the screen.

### Why This Matters

Vector graphics software is the most popular software for graphics design. It allows graphic artists and designers to layer and arrange shapes and objects, drawn figures, and even photographed objects to create composite images for commercial and artistic uses. Once learned, vector graphics software empowers novices to create professional-looking designs and enables professionals to accomplish much more than is possible with traditional media.

### Essential Information

Vector graphics software uses an object-oriented approach that recognizes pictures as being made up of multiple layers of objects—some in the foreground, some in the background, and some in between. Objects in a vector graphics image can be layered and grouped into larger objects. Each object's properties, such as color and opacity, can be adjusted.

Microsoft PowerPoint is an example of a very basic vector graphics software application. More advanced vector graphics software such as Adobe Illustrator and CorelDRAW provide more detailed tools to create and manipulate vector graphics. Filtering and effects tools are provided to further manipulate objects in a picture. Filter tools allow you to adjust the color of an object by altering the levels of brightness, contrast, hue, and saturation. Effects tools range from subtle effects, such as changing the sharpness or blurriness of edges within a drawing, to dramatic effects, such as changing a picture so that it looks as though you are viewing it through a glass block. When finished, vector graphics images can be exported as .gif, .bmp, .jpg, or in other graphics file formats.

## Graphics File Formats

**Graphics file formats**, such as .bmp, .gif, .jpg, and .tif, are designed to store various types of graphics images for varying purposes.

### Why This Matters

When working with digital graphics, it is useful to know what types of graphics formats support various types of graphics files, such as digital photos and drawings. It is also important to know what types of file formats are compatible with different types of graphics software and web browsers. Most users are confronted with image format decisions when they save an image (see figure), or when they scan or acquire images on their digital camera.

## Essential Information

There are many graphics file formats, most of which are proprietary—that is, they depend on the software with which they were created. For example, if you work on a photo in Adobe Photoshop, the file is saved by default as a .psd file that can be opened and manipulated only with Adobe products. The following table lists a few graphics file formats that have become standards.

**Table: Common Graphics File Formats**

Format	Description
.bmp (Windows Bitmap)	Used by Microsoft Windows operating systems and recognized by most graphics software. However, it is not recognized as a valid web format.
.gif (Graphics Interchange Format)	A standard for the web. Typically used for vector graphics, it is limited in that it supports only 256 colors.
.jpg or .jpeg (Joint Photographic Experts Group)	Another standard for the web and the default format on most digital cameras; .jpg (pronounced “jay-peg”) is typically used for bitmapped graphics and includes compression technology that allows images to be stored in less space.
.png (Portable Network Graphics)	Developed to replace .gif on the web, this file format supports more colors than .gif, is not patented and licensed as .gif is, and employs lossless compression for higher-quality images.
.tiff or .tif (Tagged Image File Format)	An industrial-strength format used by many professional photographers and graphics artists for high-quality graphics.

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Some graphics file formats support different types of file compression to reduce the file size. There are two types of compression:

- *Lossless compression* allows the original data to be reconstructed without loss.
- *Lossy compression* accepts some loss of data to achieve a smaller file size.

Savings in file size can be considerable and essential for fast-loading webpages. For example, a 7 MB .tif file can be reduced to a 605 KB compressed .jpg file, less than one-tenth its original size, with little noticeable loss in quality. The difference translates to a website loading in 1 second rather than 12 seconds.

File sizes and image quality can also be controlled by adjusting the color depth. Color depth can range from black and white (1 bit) to millions of colors (24 bits). The higher the color depth, the larger the file size. Image files can range from a few kilobytes to megabytes, or even gigabytes, in size depending on color depth, image size, and compression type.

## 3D Modeling

**3D modeling**, also called ray tracing utilizes sophisticated software graphics tools to create realistic 3D models that can be rotated and viewed from any angle in a virtual environment.

### Why This Matters

As more of our lives are spent in virtual space, 3D graphics are becoming increasingly important. Engineers, architects, and designers can save time and expense by designing 3D objects in virtual space using 3D modeling software. Video game designers, artists, animators, and motion picture producers all make heavy use of 3D modeling software to entertain and impress their audiences.

### Essential Information

Three-dimensional modeling takes the object-oriented approach of vector graphics to the next level. The process of changing two-dimensional objects, such as those created with vector graphics applications, into 3D models involves adding shadows and light. Three-dimensional modeling is often referred to as *ray tracing* because the software must trace rays of light as they would interact with the models in the real world. Three-dimensional modeling also requires that surface textures be defined. Surface textures are an important element in the interaction between light and a model. Consider the way light interacts with the model in the image of the woman's eye on the right. Although this figure looks a lot like a photograph, it is actually a computer drawing by digital artist Liam Kemp.

The creation of 3D digital art takes place in a scene on a virtual 3D stage. The artist selects surface textures for each model and positions the models on the stage. The artist selects a background for the scene and a light source in order to define the shadows that provide the illusion of depth. Then the software renders the scene. *Rendering* is the process of calculating the light interaction with the virtual 3D models in the scene and then presenting the final drawing in two dimensions to be viewed on the screen or printed.

3D models are used in many ways. CAD software uses 3D models to create blueprints for manufactured products. Virtual reality applications use 3D models to build virtual worlds in which users can interact with the models. 3D models are a fundamental component in computer-generated animation for video games and motion pictures.

## Visualization

**Visualization** is a general term that refers to the use of imagery to communicate an idea. However, in the area of digital graphics, it typically refers to using imagery to experience information in a manner difficult to experience through any other medium.

### Why This Matters

Visualization enables people to present information in a more accessible and meaningful manner than text and numbers, and also to discover meaning in data that might not otherwise be perceived. Professionals in many fields use visualization to learn and to get a message across.

### Essential Information

A basic example of visualization is the use of graphs and charts to illustrate numeric data—for example, a pie chart in an Excel spreadsheet. This idea has been amplified hundreds of times to help scientists visualize and study scientific phenomena that are otherwise inaccessible. This type of visualization is referred to as scientific visualization.

*Scientific visualization* uses digital graphics to provide visual representations that improve our understanding of some phenomenon. There is a wide range of applications of scientific visualization, from the presentation of football team statistics for predicting the winner of the Super Bowl to studying the interaction of subatomic particles. Scientific visualization can be used to represent quantities of raw data as pictures. Meteorologists use visualization to study weather patterns. Cardiologists use it to study irregular patterns in heartbeats. Scientific visualization can at times turn into beautiful imagery, as shown in the figure at the top of this page. This picture, from a large gallery of visualization graphics from Eric J. Heller, illustrates the flow of electrons through a nanowire. See more such images using the links below.

## Computer-Aided Design (CAD)

**Computer-aided design (CAD)** uses software to assist designers, engineers, artists, and architects in designing two-dimensional and three-dimensional objects.

### Why This Matters

CAD software has become the primary tool of design professionals. CAD allows designers to build accurate models within the computer that reflect the physics of the real world. Designs created in CAD software can be rendered as a 2D or 3D model and output as a blueprint or as a physical prototype using a 3D printer.



## Essential Information

Computer-aided design (CAD) software assists designers, engineers, and architects in designing three-dimensional objects. CAD software provides tools to construct 3D objects on the computer screen, examine them from all angles, and test their properties. CAD can turn designs on the computer into blueprint specifications for manufacturing. CAD output can also be used to directly control the manufacturing of products and parts. Using a 3D printer, engineers can take a CAD drawing and turn it into a 3D model or prototype. Urban and regional planners use CAD to design neighborhoods, shopping malls, and other large-scale construction projects.

CAD is not used just for 3D manufacturing, however. Professionals in the textile industry rely on computers to help design the graphical patterns for material. Computer systems are also used to apply those designs to the fabric.

## Animation

**Animation** involves displaying digital images in rapid succession to create the illusion of motion.

### Why This Matters

Advances in processing power and digital graphics technologies have allowed artists to render realistic worlds in virtual space. Computer animation plays an important role in today's motion pictures and interactive media. Most blockbuster movies and video games owe their success to the computer programs used to create their realistic virtual environments. Simulating 3D virtual worlds is one application of digital animation. There are many other simpler applications that are equally useful. Even simple 2D animations can serve to communicate ideas more effectively than pages of text.

## Essential Information

Animation and video are stored in the computer as a series of images called frames. When shown in quick succession, the frames create the illusion of movement. Television uses a rate of 30 frames per second (fps), while many videos use 24 fps.

Graphical animation can be as simple as a stick man jumping rope or as complex as a major motion picture like *OZ The Great and Powerful*—where actors performed in front of green screens, and environments were mostly computer generated. Animated graphics employ either 2D or 3D objects, with 3D animations requiring the most advanced graphics software and processing power to create.

You may have seen simple animations on the web—simple drawings that repeat the same motion over and over, endlessly. This is the most basic form of animation, called an *animated GIF* (pronounced “jiff”). Animated GIFs are created with simple

tools that allow the artist to draw several images that, when played in succession, create the illusion of motion.

For more complex web animations, artists have traditionally turned to programming languages, such as Java, or to web animation development platforms, such as Adobe Flash or Microsoft Silverlight. Because most animators are not computer programmers, Flash has become a popular tool for creating animated web content. Flash provides a timeline tool that is used to cue movement in the animation. Unlike animated GIF tools, Flash automates the frame production process. For example, a picture of a rocket can be placed in the upper-left corner of the Flash workspace at time unit 1; at time unit 10, the rocket could be placed at the right side of the workspace. Flash will “fill in” the movement from left to right evenly over the time between 1 and 10, according to your instructions.

Flash can be used for simple or advanced web animations and applications. Full-blown animated films as well as interactive games can be produced. Recently Flash has fallen out of favor with a number of major tech companies, including Apple, which decided not to support Flash on its iPhone, iPod Touch, and iPad products. Instead, Apple is utilizing HTML5, the most recent version of HTML, which provides support for developing and displaying animation. HTML5 has seriously cut into the monopoly that Flash has held over web animation. To adjust, Adobe has created tools that transform Flash productions into HTML5 productions.

Three-dimensional computer animation is much more complex than 2D computer animation. *3D computer animation* includes all of the complexity of 3D graphical rendering, multiplied by the necessity to render 24 3D images per second to create the illusion of movement. Three-dimensional animation software is typically packaged with 3D modeling software. These animation programs, such as LightWave from NewTek and Mental Ray from Softimage/Autodesk, are used by professionals to create popular animated television shows, commercials, and movies, and they range in price from \$1,595 to \$13,000.

Three-dimensional computer animation software can move animated characters according to the direction of the artist and director. Rather than drawing and painting individual frames, animators are more like puppeteers who direct the animated characters around the set. After the action is recorded, rendering computers apply the 3D effects and lighting to each frame. Even with powerful computers, high-quality rendering, such as that used for major animated motion pictures, takes hours per frame. Virtual actors and scenes in today’s 3D computer-generated films are nearly indistinguishable from real actors in the real world. In fact, many popular motion pictures use a blend of both.

## Digital Photography

**Digital photography** is a form of photography that captures, stores, and manipulates photographs digitally as a series of 1s and 0s.

## Why This Matters

With easy, inexpensive access to digital cameras and photo processing, photography has become a favorite hobby for many people. Digital photography has made it easy for amateurs to take and share professional-quality photos and for professionals to capture and create photos unlike anything previously possible. Understanding the basics of digital photography can enrich your life and add valuable skills to your professional tool belt.

## Essential Information

Digital photography and digital photo editing are sometimes referred to collectively as *digital imaging*. Unlike drawing software that is used to create digital graphics by defining them as a collection of shapes, digital photography creates digital graphics by capturing images as a collection of pixels using a camera or scanner.

Digital photography has become very popular as the technology has become less expensive and has been integrated into mobile phones. Nearly everyone is taking digital photos and enjoying the instant gratification of viewing images as soon as they are taken and deleting unwanted photos—features previously not possible. Many people are developing a photographer’s eye and gaining a new appreciation of the beautiful world around them (see video).

Photo albums are transforming from dusty bound volumes on bookshelves to volumes stored on hard drives and online services. The number of digital photos being generated is at its highest ever, and hundreds of new devices, software, and services are being introduced to the market in support of the digital photo fever. This section surveys the latest technologies for creating, editing, sharing, and printing digital photos.

## Digital Photography Topics

- Digital Camera
- Photo Editing
- Photo Printing
- Online Photo Album

## Digital Camera

A **digital camera** is a camera that captures photographs, and sometimes video, and stores them digitally rather than on film.

## Why This Matters

There are many different types of digital cameras on the market. They range from inexpensive compact cameras to professional-grade SLR (single-lens reflex) cameras. Learning what kind of camera and camera features best suit your needs can save money and provide you with the most benefits. Today many people use the

digital camera features of their mobile phones (covered in later pages), but this page focuses on stand-alone digital cameras.

### Essential Information

Digital photos are created or acquired using a digital camera or scanner and are saved as bitmapped images. Digital cameras are ranked by the amount of *megapixels* they can capture (1 megapixel = 1 million pixels) and the features they include. An entry-level camera costs between \$49 and \$200 and provides up to 16 megapixel images but has very few features. A midrange camera costs between \$200 and \$600, provides roughly 12- to 16-megapixel images, and includes lots of features to assist in producing good-looking photos. It's also small enough to slip into your pocket. A digital SLR (single lens reflex) camera uses the same mirror and lens principles as professional-grade 35 mm cameras to produce professional images, typically 16–24 megapixels. SLR cameras often use detachable lenses that may need to be purchased separately. SLR cameras are expensive—some selling for as much as \$2800—but are gradually coming down in price to the \$500–\$1000 range. The following table lists digital camera specifications to consider.

**Table: Digital Camera Features**

Feature	Considerations
Resolution	6 megapixels or more for recreational use; more than 12 megapixels for serious hobbyists; and more than 16 for professionals—in general, most cameras sold today have high enough resolution to accommodate most needs.
Lens and Sensor	The quality of the lens and sensor in a camera contributes to image quality. High-quality components capture the most realistic images. Good cameras boast a high-quality lens and sensor, and the result will be evident in demo photos.
Price	\$49 to \$200 for most recreational-grade cameras; \$200 to \$600 for serious hobbyists; more than \$600 for professional-grade cameras
Camera size	Although some very small cameras can produce very good quality, the largest digital cameras (SLRs) offer the best quality. Small cameras offer the benefit of portability.
Display size and quality	Since digital photography uses an LCD display to line up the shot, it's important that you get one that is large enough to see and bright enough to see in direct sunlight.

Lens type	Most people insist on a zoom lens with a range encompassing at least 38 mm to 114 mm. Digital SLR cameras have detachable lenses that can be swapped out for different effects.
Storage media	Flash memory card with a lot of capacity; roughly 1 MB per photo for good quality images
Photo file format	JPEG for recreational use, TIFF for professionals
Interfaces	USB, NTSC/PAL television connection for offloading and viewing photos
Exposure controls	Automatic, programmed scene modes, exposure compensation (for tweaking the automatic exposure)
Focus controls	Automatic for recreational use; pros will want manual control as well
Flash modes	Automatic, fill, red-eye reduction
Software	Photo editor, photo stitching (combining photos into panoramas), photo album creator, slide show
Multimedia	VGA (640 x 480), 30-fps video-clip recording
Battery	Rechargeable or disposable battery models
Other useful features	Ultracompact design, webcam capability, voice recording, wireless transfer

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## Photo Editing

**Photo editing** is the process of altering digital photographs, using software tools.

### Why This Matters

Photo-editing skills are useful for both professional tasks and personal enjoyment. Amateur photographers use photo-editing software to improve the quality of their

photos, altering hue, saturation, and brightness to achieve appropriate color and removing red eye. Many artists have turned to photo editing as a way of creating interesting works of art. For professional photographers, photo editing often takes up the majority of their time. Photo-editing skills or the lack thereof can make or break a career for a professional photographer.

### **Essential Information**

Photo-editing software—such as Adobe Photoshop and Photoshop Elements, Apple iPhoto, and Google Picasa—includes special tools and effects that you can use to improve or manipulate bitmapped photograph images. Photo-editing software allows you to:

- Alter the hue and saturation of the colors in the photograph to give skin tones a healthy glow or to enrich colors in a landscape
- Smooth surfaces or remove flaws in surfaces
- Remove red eye—the effect of the camera flash on the eyes of subjects, which causes eyes to appear red in a photograph
- Smooth edges and sharpen focus
- Crop and realign photos

Photo-editing tools also include special effects, such as the ability to transform photos into watercolor paintings. Or you can use edge detection to remove an object from one photo and insert it into another.

Many of today's photos are captured using mobile phones. Photo apps have emerged as a way to collect, edit, and share photos right from your phone. Instagram is one such app that provides a wide assortment of filters and effects that can be added to photos, which can then be shared on your favorite social network (see video).

The ability to alter digital photos to embellish or alter one's perception of reality has created interesting social and legal issues. Photographs can no longer be used as evidence in a court of law since it is impossible to determine if they have been edited and falsified. Some are concerned that photographs of supermodels and celebrities in magazines, altered to make them appear closer to the perception of perfection, are setting false expectations of human appearance that frustrate and disappoint.

Photo editing has become a serious concern in the news media. A photojournalist is responsible for capturing newsworthy events to help tell a story, convey the reality of a moment, and document that moment for history. Some photojournalists have been criticized for using photo-editing software to make the photos more interesting than what was originally captured by their cameras.

## Photo Printing

**Photo printing** refers to the methods and resources available for transforming digital images into printed images.

### Why This Matters

Although photos can be viewed on a computer screen, most people still like to have prints created from their photos—especially if they want to frame and hang them. There are several options for printing digital photos. Choosing the right one can save time, effort, and money.

### Essential Information

As with most aspects of the rapidly expanding digital photo industry, options for printing photos are bountiful. Today, many printers are designed specifically for printing photos. Photo printers use photo-quality paper and toner to get professional-looking prints. Some printers allow the camera to be connected directly or accept the camera's memory card as input. Some photo printers include a small display that allows the images to be altered and edited before printing.

Although photo printers empower users to print as many photos as they please whenever they want, there are considerable drawbacks. Often, photo-quality paper and toner end up costing as much as having the photos professionally printed. It is also sometimes difficult to get professional results with home photo software and printers. For these reasons, many people find the price, convenience, and quality of professional photo printing services irresistible.

Facebook has apps from Walgreens, CVS, and other companies that can be used to order prints of Facebook photos. Printicular is an app for iPhone and Android that will order prints of Instagram photos from a smartphone (see video). Yahoo!'s Flickr photo service has partnered with Target stores to offer photo pickup service. Many retail outlets, including Walgreens, Walmart, Target, and CVS, provide digital photo uploading and processing services from their websites. Photo-editing software like iPhoto, Shutterfly, and Snapfish provide printing services as well.

Photo kiosks are another popular option for printing digital photos. There are tens of thousands of photo kiosks in the United States. Photo kiosks read photos from CDs, USB drives, or any of the popular media cards, allow you to crop and edit each image, and then print out your photos—perhaps while you do a little shopping. Kiosks are popular for their ease of use, print quality, and speed, as well as for the amount of control they offer the user.

## Online Photo Album

An **online photo album** is typically hosted by a service that allows members to upload photos to web servers to share with individuals or the entire web population.

### Why This Matters

Since the birth of digital photography, the number of photos that people create and collect has grown rapidly. Systems have emerged to help people manage and share photos and photo albums. Online photo-album services help photographers of all kinds share photos with family, friends, and strangers if so desired. They may also include tools for photo editing and organizing files. They typically also provide a service for ordering prints online.

### Essential Information

The most popular online photo album services are Yahoo!'s Flickr, Google's Picasa, Shutterfly, SmugMug, Snapfish, and Photobucket. Social networks like Twitter and Facebook also have photo album capabilities. Membership is free for all of these services, while some offer a premium service for a fee. All of these services provide an easy method to upload photos from your computer either one at a time or in batches. Once uploaded, photos can be arranged into albums, captions and tags can be added, and the photos themselves can be edited with a limited toolset.

Since many photos are taken on mobile devices, apps are available to automatically upload mobile photos to online albums. Facebook and Twitter provide apps that allow mobile photographers to upload, store, and share their photos. Recent versions of Apple iOS for iPhones and iPads include the ability to upload photos and other content to Facebook.

Photos and albums can be shared from the online service with other members that you specify, the entire member community, everyone on the web, or no one. Other users typically can download photos—under copyright restrictions that the owner specifies—and order prints. Most of these free services make their money from prints and other photo-centered merchandise.

Note that most free online photo-album services do not take responsibility for photos uploaded to their servers. If photos are lost, damaged, or destroyed due to equipment failure, then the user suffers the loss. However, some of the premium services and fee-based services do guarantee your photos from danger.

SmugMug Pro is a premium online photo-album service designed for professional photographers. It provides a secure place for photographers to store and sell their photographs. Each SmugMug client receives a customized online gallery in which to present their work.



## Digital Video

**Digital video** stores a progression of digital photographs and displays them at 24 to 30 photos, or frames, per second (fps) to give the illusion of a smoothly flowing scene.

### Why This Matters

Advances in digital technologies, broadband communications, and information systems are having a profound effect on the creation, distribution, and enjoyment of video. Digital video is becoming increasingly accessible for personal enjoyment as well as professional use.

### Essential Information

Both digital photography and digital video are used in a variety of research and other professional areas. *Forensic graphics* is used to create animations and exhibits to use in courts of law to explain theories and present evidence. For example, a forensic graphics expert might study video of a convenience store robbery to ascertain the identity of the thieves. Video cameras mounted at intersections are increasingly being used to catch drivers who run red lights, by recording the license plate number of the vehicle in the video image.

By studying digital video, athletes and trainers can review the movement of athletes and determine how to perfect their abilities. Digital video is used to study pedestrian and traffic patterns. Scientists also use it to study the activity of microbes and other organisms.

Digital video is also finding a home in the hearts of consumers as a primary form of entertainment. Taking in a movie is a favorite pastime for all ages. Digital cable networks, on-demand television, and DVDs and Blu-ray have brought popular motion pictures to home television. Large super high-definition and 3D displays along with surround sound systems provide theater-quality experiences at home. Broadband Internet and service providers are bringing motion pictures, television programming, and other video services to PCs and cell phones. Digital camcorders allow us to capture the important moments of our lives in motion. YouTube has become a key medium for the world to express itself through video.

### Digital Video Topics

- Camcorder
- Video Editing

## Camcorder

A **camcorder** is a digital video camera.

## Why This Matters

Camcorders allow ordinary people to create professional-looking videos in regular-definition, high-definition, and 3D formats. Videos allow us to capture important moments in our lives from gatherings with friends to life events like weddings, graduations, and recitals. Camcorders also bring out the creative side of people, inspiring us to capture the beauty and artistry of the world around us.

## Essential Information

Digital video cameras, called digital camcorders, are available in a wide range of prices with wide-ranging capabilities. At the low end of the spectrum are disposable camcorders that sell for less than \$30. At the opposite end of the spectrum are high-definition and 3D camcorders selling for more than \$1000.

Because most popular camcorders cost between \$200 and \$500, many consumers are settling for the video capture capabilities of digital cameras and mobile phones at half the price. Most digital cameras and some camera phones can capture short video clips at relatively low resolution (320 x 240 or 640 x 480). However, when it comes to recording soccer games, ballet recitals, and weddings, camera phones and digital cameras don't have the memory capacity that is typically desired; a camcorder is the tool for the task.

As with digital cameras, there are important specifications to consider when purchasing a camcorder. Size and price are major considerations. Other less obvious considerations are listed below.

**Table: Camcorder Features**

Feature	Description
Sensors	Camcorders use different types of sensors to capture the image: a charge-coupled device (CCD) sensor, or a complementary metal-oxide-semiconductor (CMOS) sensor. Both types deliver similar high-quality images. Better cameras come with three sensors, so options may include CCD, CMOS, 3CCD, or 3CMOS.
Pixels	As with digital cameras, image quality is measured by the number of pixels in each frame. For video, 2 to 4 megapixels is typical, and some hi-def cameras have even more; for still images, 3 to 6 megapixels is typical. The type and amount of sensors have a large impact on pixel amount.

Hi-def	Some camcorders can capture hi-def images, which capture a larger amount of pixels—typically 3.3 or 5 megapixels. Hi-def formats include 720p, 1080i, and 1080p, specified in camcorder specifications as the digital video format AVCHD (Advanced Video Codec High Definition).
3D	3D camcorders utilize two lenses that act like our eyes to capture the world in 3 dimensions. 3D video requires a 3D TV to view.
Widescreen	Most new camcorders have a widescreen mode. The size ratio for standard television format is 4:3, and widescreen is 16:9. Widescreen support does not imply hi-def, although hi-def cameras all support widescreen. Having an option for both ratios is desirable.
Zoom	A camcorder that has at least 10x optical zoom is desirable.
Low light recording	Camcorders include a minimum lighting specification that describes the lowest level of light acceptable for recording. Seven lux or lower is desirable.
Storage media	Many options exist: DVD, MiniDV, Hard Disk Drive (HDD), Solid State Drive (SSD), High-Definition (HD), and Flash memory. Consider capacity and convenience when choosing media.
Image stabilization	These systems keep your image steady when your hand shakes. Optical and digital stabilization systems are available. Of the two, optical is considered smoother.
Sound	Front-mounted or top-mounted microphones for standard recording and additional “mic in” and “headphone out” jacks are useful for achieving professional-quality sound. Microphone volume control is also useful for professional quality.
Digital stills	Most cameras offer the capability to capture still photos, although the quality of these digital photos will vary widely from camera to camera.

LCD/viewfinder	The size and quality of the LCD display on the camcorder are important for framing and reviewing shots.
Ports and connectors	It is important to have the correct port or connector for transferring video to computers, televisions, and other video devices. Options include FireWire, A/V, USB, and S-Video.
Focus and exposure controls	Camcorders should support recording in all types of environments.

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## Video Editing

**Video editing** makes use of special software that allows professionals and amateurs to edit video footage by deleting scenes, combining scenes, and adding transitions and other effects to create a professional-style video production.

### Why This Matters

Editing video is an important skill for amateur and professional videographers. Video editing allows you to extract the good portions of video and place them creatively in a timeline along with transitions and other effects.

### Essential Information

With the increasing popularity of digital camcorders, more PC users are finding it useful to edit their digital videos on their home computers. Much of the footage captured on video is often not worth saving. Video-editing software allows professional and amateur videographers to remove bad footage and rearrange the good footage to produce a professional-style video production. Popular video-editing software packages include Pinnacle Studio; Adobe products such as Premiere Elements, available for both Windows and Apple computers; Windows Live Movie Maker; and iMovie and Final Cut Pro for Apple. Many of today's camcorders include the ability to edit video directly on the camera. The tools provided are simple to use but not as powerful as video-editing software.

Digital video can be transferred to a computer directly from a camcorder or read from a DVD. Video takes up a significant amount of space on the hard drive—roughly 1 GB for one hour of video. For this reason, most home users do not store many videos on their PC, but copy them to DVD after they finish editing.

Video-editing software uses a storyline on which to build a video production. A storyline allows the videographer to arrange video scenes sequentially and to specify the transition effects between each scene. The videographer can add still images, background music, and text to the storyline as well as video scenes. When the storyline is complete, it is saved to one of many possible video formats on a hard drive and usually burned to DVD to be viewed on TV.

The growth of online video sharing sites like YouTube and Vimeo has energized the home video industry. Now anyone can share home-recorded videos with the world, and many do. Thousands of short videos, and even commercial-quality programs, are posted on YouTube in categories that include Autos & Vehicles, Comedy, Entertainment, Film & Animation, Howto & Style, Music, News & Politics, People & Blogs, Pets & Animals, Sports, and Travel & Events.

Digital movies, which might otherwise require hundreds of gigabytes or even terabytes of storage space, are compressed to less than 10 GB in order to fit onto a DVD. Digital video compression involves analyzing each frame of the video and storing only the pixels that change from frame to frame. A video frame might display a million pixels but only have 1000 pixels that change from the previous frame, reducing the storage requirements from a million to a thousand pixels. The process of rendering a video is time consuming, often taking many times the length of the video itself.

## **Interactive Media**

**Interactive media** refers to digital media that involve user interaction for education, training, or entertainment.

### **Why This Matters**

The graphics power of today's computers enables programmers to extend their talents into virtual worlds created within the computer. Interactive media allow users to enter and manipulate virtual objects and to interact with other users in a virtual space. Interactive media are used in many industries for many purposes. The most popular use of interactive media is for entertainment, as in computer games.

### **Essential Information**

Interactive media are unique in that the audience is not passively observing the media; it is taking part in the creative or educational process. Interactive media typically combine digital audio, digital 3D graphics, and animation.

Video games make up a large portion of the interactive media market. Other forms of interactive media provide computer-based tutorials and training, and still others are commercial applications that support the sale of products and provide customer support.

The hand-eye coordination developed through the use of video games can be translated to skills in various professions. Video games have been used to help train surgeons, and Microsoft's Flight Simulator is used by professional and amateur pilots to learn how to fly a variety of aircraft.

Companies have jumped on interactive media to assist with employee training and offer customers additional services. Online customers can examine products in 3D, travelers can take virtual tours of destinations before booking a room, furniture buyers can "try out" different fabrics on a sofa, and hair stylists can show you "the new you" before snipping.

### **Interactive Media Topics**

- Video Game
- Virtual Reality
- Augmented Reality

## **Video Game**

A **video game** uses 2D or 3D interactive digital media to provide gaming entertainment for individuals or groups using handheld devices, game consoles, computers, and the Internet.

### **Why This Matters**

Video games are a favorite pastime for increasing numbers of people, rating equally with going to the movies and watching TV. There are a number of gaming platforms, each with different types of games for varying audiences. Understanding what is available assists consumers in selecting the best gaming equipment and software to meet their interests.

### **Essential Information**

In the area of interactive multimedia entertainment, the computer video game reigns supreme. Video games employ nearly every aspect of digital media, including audio, music, and 3D graphics. Gaming takes place on computers or special-purpose gaming devices. Game consoles come equipped with a fast microprocessor that works in conjunction with a graphics coprocessor to support fast-paced gaming action. The microprocessor is specially designed to handle the high demands of live-action 3D rendering. These units also include memory, storage similar to a PC, and an optional Internet connection to connect with gamers in other locations.

The Nintendo Wii broke new ground for game consoles by introducing a wireless, motion-sensitive game controller. The motion-sensitive controller allows players to swing and move the controller to roll bowling balls; swing tennis rackets, golf clubs, or swords; or otherwise control objects in the virtual space presented on the

display. The Wii and similar systems are considered social gaming systems because they are most fun when played in groups. The most recent version of the Wii, the Wii U, breaks new ground by utilizing two displays—the television and a touch-sensitive display on the tablet-like controller. Players can interact with games using the touch-display controller.

The quality of the video gaming experience has dramatically increased during the past few years. From thunderstorms rolling over panoramic landscapes to the minute detail of grass blades rustling in a soft breeze, today's video games use powerful algorithms to match the physics of the real world and go beyond them in games that defy the laws of physics. In the LucasArts game *Thrillville: Off the Rails*, roller coasters leave the rails, fly through the air, shoot through tubes, and parachute to the ground. Fantasy games allow players to fly through virtual space. Sports games allow players to jump higher and run faster than humanly possible. Today's computer games allow players to experience life as it might be in dreams but not reality.

The Sony PlayStation (PS) 3 and Microsoft Xbox 360 appeal more to the serious adult gamer. They provide more realistic virtual environments than the Wii through more powerful processing and graphics hardware. Both of these platforms offer unique games designed specifically for the console. Like the Wii, both can use body motion as a controller. The Xbox 360 uses a device called Kinect as a motion sensor that captures body motion to control game characters. *Halo* and *Gears of War* are popular games for the 360, while *Call of Duty* and *Mortal Combat* are popular on the PS3. To determine which console is best, a shopper needs to examine the game titles available for that console.

In efforts to engage teen and older gamers, games have progressively moved to more violent themes. The popular *Grand Theft Auto* has created a stir over its use of extreme violence. Some people have become concerned about the negative and desensitizing effects of prolonged exposure to violence on game users.

Gaming is becoming an increasingly popular mobile activity due to high-quality handheld game devices such as the Sony PlayStation Portable (PSP) and Nintendo DS.

Mobile phones have brought the gaming world to increasing numbers of adults. Using the accelerometer, an iPhone or Android phone can be tilted to control game movement. Games like *Angry Birds*, *Cut the Rope*, and *Real Racing* have saved many a smartphone user from boredom in waiting rooms and bus stops. There are thousands of games available for iPhones, Android phones, and Windows phones.

Social gaming has become popular on social networks. The popular social game *Farmville* launched its maker, Zynga, from a small unknown company, to one of the biggest game companies. Social games are played with friends on Facebook and Google+. For example you might have several simultaneous games of *Scrabble* going with your friends on Facebook, each taking turns whenever logged in.

## Virtual Reality

**Virtual reality** is a computer-simulated, three-dimensional environment that can be explored and manipulated by a user.

### Why This Matters

Virtual reality leverages the power of computing to empower people to create alternate imaginative worlds or to model the real world. Creating virtual environments enables scientists to explore physical phenomena, designers to create 3D models, and everyday people to enjoy immersive games and social environments. Virtual reality provides a powerful tool for visualizing ideas.

### Essential Information

When interactive media incorporate 3D graphical animation, the result is virtual reality. Virtual reality produces a simulated environment in which the human participant can move and manipulate objects. Adding surround sound makes the interactive experience more realistic.

*Immersive virtual reality* refers to a simulation in which the user becomes fully immersed in an artificial, three-dimensional world that is completely generated by a computer. Using a special headset with a computer-simulated view and stereo sound, you could turn your head and pan around your virtual world. Special gloves could allow you to manipulate objects in the virtual world. A treadmill could allow you to walk around the virtual landscape. Headphones and 3D stereo could create the illusion of sound from various locations in the virtual space. Such technology is useful for playing realistic games, training on the battlefield, or taking a tour of a building.

Lighter forms of virtual reality that do not require any special hardware are used on the web and home PC. Software tools allow developers to create 3D environments that can be manipulated with your mouse. You are probably familiar with websites that provide a 360-degree view of a product, such as a smart phone or a car. Other websites enable you to take a tour of a home or condo anywhere in the world, see inside the human body, or be on stage with a rock band.

Virtual reality's primary use is in video games. Today's 3D realistic game environments offer state-of-the-art virtual reality simulations. Virtual environments range from battlefields to alien landscapes to sports arenas to fantasy landscapes. Social networks such as Second Life employ virtual reality to provide an environment in which individuals can interact through the use of avatars. The virtual space created in Second Life to date is estimated to be more than 1871 square km. That's roughly the size of Australia.



## Augmented Reality

**Augmented reality** displays computer-generated information over objects viewed in real time and space.

### Why This Matters

One of the benefits of the information revolution is the ability to access information anywhere, anytime. Augmented reality takes this to the extreme by literally layering information over whatever your smartphone's camera is looking at. This technology informs you about the businesses and buildings around you and nearby, making it easy to find what you are looking for and learn about your current environment.

### Essential Information

For years, researchers have been working on augmented reality, but the state of technology has kept it out of reach for general use. While augmented reality has been used for military purposes for years, the introduction of GPS on cell phones was the first step towards realizing augmented reality for the general population. Using the cellular network and geolocation to provide a user's current location, augmented reality software could give some information about that location. When Apple added a solid-state compass to the iPhone 3GS, it sealed the deal for augmented reality. Now software can determine the user's location and the direction the user is facing and then determine what that user may be looking at.

Innovation in map applications like Google Maps and Bing Maps brought augmented reality software the information needed to provide details about most locations. Yelp and Layar are two apps available for smart phones that make use of augmented reality. Using the phone's camera, users are able to view nearby businesses and attractions overlaid as text boxes on the camera image.

Another technique to produce augmented reality involves pattern matching to identify objects in an image. Google Goggles, available on Android handsets, gathers an image from the camera, analyzes its shape, and provides related information on links in textboxes displayed over the image. Google is continuing its research and development in augmented reality with a new device it calls Google Glasses. Google Glasses uses a pair of eyeglass frames to mount a small transparent display at the corner of the eye. Using voice commands, the user can request information about the current environment, which is then displayed—or overlaid in the visual field.

Augmented reality applications are still in their infancy. However, with the burgeoning market in smartphones, these apps will grow rapidly to become some of the most useful applications available. They will contribute greatly to the development of the semantic web that will anticipate our every need based on personal profile, time of day, and location, and these apps will provide valuable information as it is needed.

## Intellectual Property Rights

**Intellectual property rights** concern the legal ownership and use of intellectual property, such as software, music, movies, data, and information.

### Why This Matters

Each time you use software, listen to music, read a book or newspaper article, or see a movie, you are enjoying someone else's intellectual property. The most valuable intellectual properties are typically the result of years invested in study and training. The sale of access to intellectual property provides an income for the creator and a return on his or her investment.

Intellectual property laws have been designed to legally ensure the rights of ownership to those who have created intellectual property. The digitization of intellectual property and widespread Internet use have made it very difficult to protect intellectual property from illegal distribution.

### Consider This

In early 2012, an intellectual property battle erupted over two pieces of U.S. legislation: PIPA (PROTECT Intellectual Property Act) was a bill floated in the Senate, and SOPA (Stop Online Piracy Act) was in the House. Both bills would have allowed the U.S. Department of Justice to seek court orders requiring Internet Service Providers, search engines, and online financial services to block websites that were accused of infringing on copyright. Sides were drawn between representatives seeking to protect the rights of businesses whose intellectual property was threatened and those who feared the bill would represent a significant step toward government censorship of web content. Groups protested the two bills across the country. Many websites blacked out for a day to call attention to the potential consequences of the bills. Ultimately, public pressure won out, and the bills were shelved—at least for the time being. A year later, the Cyber Intelligence Sharing and Protection Act (CISPA) was proposed, and some believed it to be a second, sneakier attempt at strengthening digital piracy laws. Once again there was a call for an Internet blackout, but this time few participated.

What negative impact do you think SOPA/PIPA would have had on the Internet and the content available there? What actions or laws would you recommend to protect intellectual property online? Explain your rationale.

### Essential Information

*Intellectual property* refers to a product of the mind or intellect over which the owner holds legal entitlement. Intellectual property includes ideas and intangible objects such as poetry, stories, music, and new ways of doing things or making things. Like tangible objects, intellectual property has value and is owned by an individual or organization.

Because software and so many types of intellectual property (books, music, movies, etc...) can be stored as bits, it is easy and convenient to copy and distribute them, sometimes without consideration of the creator. In the view of the creators or owners of the intellectual property, this is theft, just like stealing a physical item, such as an iPhone.

When intellectual property is copied and distributed by the public rather than by the legal distributor, it dramatically impacts the amount of money earned by the owner of the intellectual property. Rather than selling thousands of copies for thousands of dollars to thousands of fans, an artist might only be able to sell hundreds of copies for hundreds of dollars to hundreds of fans, who then make thousands of copies available to their friends. When those who produce intellectual property can no longer earn a living, they will turn to some other career, and creative capital in the country may wither.

Others argue that intellectual property is overpriced, and that those who manage the industry, such as recording and motion picture companies, are making a killing while the intellectual property creators, who have signed away the rights to their intellectual property to the corporations, are given only a small percentage of the profits. It is this point of view that has driven many musicians to resist signing recording contracts and instead make their own recordings independently and sell them directly to their fans.

Digitization, the Internet, and a general failure to protect intellectual property have combined to create serious issues for the software, music, motion picture, and publishing industries, and are dramatically altering the way these industries operate.

Protection of intellectual property can take many forms, including copyrights, trademarks, trade secrets, and patents.

**Table: Legal Tools for Protecting Intellectual Property**

Protection	Description
<i>Copyright</i>	Protects the words, music, and other expressions for the life of the copyright holder plus 70 years. The fair use doctrine describes when and how copyrighted material can be legally used. The Digital Millennium Copyright Act provides global copyright protection.
<i>Trademark</i>	Protects a unique symbol or word used by a business to identify a product or service.
<i>Trade secret</i>	Protects secrets or proprietary information of individuals and organizations as long as the trade secret is adequately protected.

<i>Patent</i>	Protects an invention by giving the patent holder a monopoly on the use of the invention for 20 years after the patent application was submitted.
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Some believe that copyright laws are too restrictive and pose a risk to the advancement of culture. For example, in his book, *Free Culture: How big media uses technology and the law to lock down culture*, Lawrence Lessing and his colleagues have developed a legal alternative to copyright, called Creative Commons, which allows intellectual property owners to more finely describe what can and cannot be done with their work.

Intellectual property theft extends beyond digital media. As cyber warfare and cyber espionage have become a common component in international relations, intellectual property has become a major target. In recent years, dozens of attacks have targeted national defense contractors, corporations, and manufacturers, stealing valuable research and development information that could be used to compete economically or militarily. Many of these attacks have been traced back to determine their origins. Some security firms have pointed to China as a likely culprit; others say the evidence on the source of attacks isn't clear.

### Intellectual Property Rights Topics

- Piracy
- Plagiarism
- Digital Rights Management (DRM)
- Digital Millennium Copyright Act (DMCA)

## Piracy

**Piracy** involves the illegal copying, use, and distribution of digital intellectual property, such as software, music, and movies.

### Why This Matters

The music, motion picture, and software industries claim to be losing billions of dollars in sales to piracy. Piracy ranges in degree of severity from a teenager's downloading or uploading music on the Internet to a Chinese merchant's selling hundreds of pirated commercial CDs and DVDs each day. The prolific amount of piracy is forcing technology industries and governments to react with repressive technologies and legislation that some feel inhibit the natural evolution of culture.

### Essential Information

Pirated software, music, and videos can be accessed on the Internet through file-sharing networks and other resources, or from other users on homemade CDs and

DVDs. Because technology allows media files to be copied, many otherwise law-abiding citizens feel as though it must be okay.

Organizations such as the Recording Industry Association of America (RIAA), the Motion Picture Association of America (MPAA), and the Software & Information Industry Association are making it known that piracy is not okay. The RIAA has sued thousands of individuals involved in illegal MP3 file sharing for significant financial settlements. In 2005, the Supreme Court ruled on the side of the RIAA, holding that businesses that encourage the theft of music should be held accountable for their actions. The RIAA followed this up in July 2005 with copyright infringement lawsuits against 765 illegal file sharers—predominantly college students—and continued to file thousands of suits each year through 2008. The RIAA has been successful in shutting down or helping shut down most P2P services, including Kazaa, Limewire, and Pirate Bay. More recently, the RIAA is pursuing other methods for penalizing copyright violators. The RIAA has also been instrumental in promoting legislation, such as SOPA, PIPA, and “3-strikes” laws, around the world. These highly controversial laws deny users Internet access if they are accused of copyright violations three times.

Although the MPAA has not engaged in lawsuits to the same extent as the RIAA, it is gradually ramping up its efforts as movie file sharing is becoming more common. In recent years, the MPAA has filed lawsuits against hundreds of individuals who provide pirated movies to others through file-sharing services such as BitTorrent (see figure), eDonkey, and Direct Connect. The Software & Information Industry Association’s Anti-Piracy Division has taken similar measures in its comprehensive, industry-wide campaign to fight software and content piracy.

International piracy is of great concern to those in the music, motion picture, and software industries. The vast majority of motion pictures sold in Russia are pirated. In Vietnam, China, and Ukraine, most software in use is pirated.

The Anti-Counterfeiting Trade Agreement (ACTA) has been proposed by the United States, the European Community, Switzerland, and Japan as an international effort to fight counterfeiting and piracy. While still under debate, many fear that the agreement will infringe on consumers’ privacy and civil liberties in its efforts to reduce counterfeiting and piracy.

## **Plagiarism**

**Plagiarism** involves taking credit for someone else’s intellectual property, typically a written idea, by claiming it as your own.

### **Why This Matters**

Giving credit where credit is due and respecting intellectual property rights are foundational principles of ethical behavior. Laws, conscience, and social pressure

discourage most people from plagiarizing—but convenience sometimes wins out over ethics, and rationalizations can blur the line between plagiarism and creative use of others' work. Utilizing plagiarism out of convenience, or rationalizing that a minor offense isn't ethically wrong, ends up placing otherwise law-abiding people in very embarrassing and sometimes costly situations.

### **Essential Information**

Plagiarism has been an issue of legal and social concern for as long as people have produced intellectual property. Stealing others' ideas and thoughts and presenting them as your own is a serious breach of ethics matched by serious penalties if you are caught. A student caught submitting another person's work for a grade may face expulsion. A professional journalist, author, or researcher could face an expensive lawsuit and loss of a career.

Although plagiarism has been a social issue for a long time, the digitization of the written word, the Internet, and cut-and-paste methods of writing have made it all the more common. Some websites provide students with free research papers for class projects. Submitting papers from such websites is considered plagiarism and is subject to strict and severe penalties by schools. Software such as Turnitin and iThenticate is used by many high school and college teachers to find instances of plagiarism in electronically submitted homework files, with a high rate of success. Some students find it useful to check their work for accidental plagiarism prior to turning in an assignment.

### **Digital Rights Management (DRM)**

**Digital rights management**, or **DRM**, is technology that protects digital forms of intellectual property by restricting the number of devices and applications on which a file can be opened and the number of times that the file can be copied and burned to disk.

### **Why This Matters**

Intellectual property owners will do whatever it takes to protect their property from being illegally copied and distributed. The most popular method of protecting it is through DRM. DRM can be found on some music sold online as well as on movies, eBooks, and even documents stored in PDF format. Most music and movie fans are frustrated by the inconvenient side effects of DRM, which keep them from listening to or viewing legally purchased products whenever and wherever they like. There is concern that restrictions on digital products may become tighter, pushing DRM onto hardware, so that it is impossible to make copies of any digital media.

## Essential Information

DRM is often associated with digital audio files but is used with other forms of online intellectual property, such as digital movies and eBooks. Microsoft's WMA and Apple's AAC file formats include DRM technology. DRM-protected AAC files use the .m4p file extension. Users who purchase songs online may or may not receive files with DRM. There are restrictions on what players can be used with DRM-hobbled files and how those files can be copied. The table below lists the DRM technologies used for different services and the specific restrictions that they enforce.

**Table: DRM Technologies**

DRM Technology, File Format, and Service(s)	Restrictions
<i>FairPlay</i> (.m4p) used by iTunes	<ul style="list-style-type: none"> <li>• Play only in iTunes player or iPod/iPhone/iPad</li> <li>• Copy to any number of iPods/iPhones/iPads</li> <li>• Copy to a maximum of five computers</li> <li>• Unlimited CD burns (burning to CD removes DRM from copy)</li> </ul>
<i>WMA DRM 9.0</i> also called Janus (.wma)—Microsoft's format used by Napster, Rhapsody, Urge, and most other services	<ul style="list-style-type: none"> <li>• Play only in approved players (Windows Media Player, Napster Player, etc.)</li> <li>• Play only on approved devices (Creative ZEN and others, but not iPod)</li> <li>• Copy to a maximum of three computers</li> <li>• Unlimited CD burns</li> </ul>
<i>WMA DRM 9.1</i> (.wma)—Microsoft's DRM for Zune	<ul style="list-style-type: none"> <li>• Play only using Zune player software and Zune device</li> <li>• Wirelessly transfer file to other Zune devices, which will only be able to play the song three times or for three days, whichever comes first</li> <li>• Copy to a maximum of three computers</li> <li>• No CD burns</li> </ul>

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DRM has become extremely unpopular with consumers. Defective by Design, a grassroots organization (see figure) has campaigned to “eliminate DRM as a threat

to innovation in media.” Most recording companies and music distributors now sell music without embedded DRM technology. However, DRM continues to be an issue with most other forms of media, including eBooks and video.

## **Digital Millennium Copyright Act (DMCA)**

The **Digital Millennium Copyright Act (DMCA)** is a U.S. copyright law designed to reduce illegal digital media copying by criminalizing the production, distribution, and use of technologies designed to circumvent DRM technologies.

### **Why This Matters**

Digital media companies and organizations, such as the Recording Industry Association of America (RIAA) and the Motion Picture Association of America (MPAA), have aggressively lobbied the government to create stronger laws to prevent people from making illegal copies of digital forms of intellectual property. In 1998, that lobbying paid off when the Digital Millennium Copyright Act was made law. In cases such as this, where laws are created that oppose common public practice, it is common for public unrest to grow around the issue. This is certainly the case for the DMCA. A Google search reveals many anti-DMCA websites and organizations. Other companies, like DMCA.com, provide services to help enforce the DMCA.

### **Essential Information**

On October 12, 1998, the U.S. Congress passed the Digital Millennium Copyright Act, and two weeks later President Clinton signed it into law. Since then, the DMCA has been used as a basis to shut down P2P file-sharing technologies, threaten thousands of people who have posted other people’s intellectual property on the web, impose serious fines on those caught sharing music and movies over the Internet, and even threaten to take down web giant YouTube.

The Electronic Frontier Foundation (EFF) claims that the DMCA has unintended consequences, including impeding scientific research, jeopardizing “fair use” of intellectual property, and discouraging competition and innovation. Still, the record companies and the motion picture industry praise the DMCA for enabling them to enforce copyright law and rein in runaway piracy.

The DMCA was designed to implement treaties signed in December 1996 at the World Intellectual Property Organization (WIPO) conference in Geneva, Switzerland. The law makes it a crime to circumvent antipiracy measures built into most commercial software. So, those who purchase movies, music, eBooks, or other digital media that include DRM are breaking the law if they make copies. Also, the DMCA outlaws the manufacture and distribution of software or hardware designed



to crack DRM codes. In addition, the DMCA holds Internet service providers responsible for pirated content stored in user accounts on their servers.

The DMCA also holds Internet radio companies and other webcasters responsible for paying those who hold the rights to the intellectual property being broadcast. This, in turn, caused Internet radio services such as Pandora.com to develop business models that bring in money to pay the licensing fees imposed by the record companies.

Media companies continue to push government for stiffer laws regarding copyright. The Prioritizing Resources and Organization for Intellectual Property Act of 2007, which was signed into law, increases civil and criminal penalties for copyright infringers.

## Database

A **database** is a collection of data organized to meet users' needs.

### Why This Matters

Without data and the ability to process it, an organization would not be able to successfully engage in business activities, nor would it be able to generate reports to support knowledgeable workers and decision makers, which in turn help's to achieve organizational goals; it would not be able to pay employees, send out bills, and or order new inventory. Databases have made it possible to map the structure of DNA, and for scientists to share their research; without databases, the human genome project would not be possible. Without databases, there would be no Google, Amazon, eBay, or Facebook. Databases and the systems that manage them are at the foundation of all successful information services, and they are becoming increasingly important as people generate more and more data for businesses and organizations to analyze.

### Consider This

In its Digital Universe study, market research firm IDC reports that the world's total stored data and information in 2012 was 2.8 zettabytes, up from 1.8 zettabytes in 2011. A zettabyte is equal to 1 billion terabytes. IDC predicts that by 2020, the amount of digital data produced will exceed 40 zettabytes—, or roughly 5,200 GB of data for every man, woman, and child on Earth, This far outpaces our ability to manage the information. IDC believes that about 33 percent of all data produced by 2020 will contain valuable information. The trick is building software tools that can uncover it. *Big data* is a term used to refer to data sets that are too large to process through traditional means. Many companies are working hard to develop efficient means to transform big data into valuable, actionable information.

As you read about databases, consider strategies to manage huge amounts of global data generated by transactions, human activity and communication, market research, scientific research, media production, interactions between people and things, and all types of human endeavors. What information is worth storing? What should be discarded? Who can be trusted to store and maintain your data? Where should it be stored? Should we trust automated systems to manage our data? What actions should be taken now, to help save the world from data overload?

### Essential Information

Data consists of raw facts, such as items in inventory, sales transactions, weather statistics, online activities of an individual, or song titles. For data to be transformed into useful information, such as quarterly profits, hurricane predictions, customized Web pages, or a music library, it must first be organized in some meaningful way. A database is a collection of data organized to meet users' needs. Throughout your personal and professional life, you will directly or indirectly access a variety of databases ranging from a simple list of music in your iTunes library to complex

business systems used for accessing customer information, transaction data, a corporate knowledge base, and many other types of essential information.

In a database approach to managing information, multiple applications share a collection of data files that are maintained in a database stored in a central location sometimes called a data center. A grocery store chain, for example, runs multiple applications, including transaction processing, inventory ordering, and payroll, from a common database system. This database approach allows the chain's management to obtain and analyze customer receipts from hundreds of stores.

Storing data in one centralized database is also more efficient and less prone to errors or mistakes. For example, a database approach to data management reduces data redundancy. Data redundancy occurs when multiple copies of data are kept. Redundant data is difficult to manage because any required change must be applied to all copies of the data, but often a copy is overlooked and becomes inaccurate. Inaccurate data can be more dangerous to an organization or individual than no data at all. Because a centralized database stores data only once, the problem of data redundancy is solved.

The advantages of using a centralized database system are summarized in the following table. Although databases and data centers can be costly to set up and maintain, companies and organizations find that the advantages more than justify the costs.

Table: Database System Advantages

Advantage	Explanation
Reduced data redundancy	<i>Data redundancy</i> is duplication of data in different locations.
Improved data integrity	<i>Data integrity</i> refers to the quality and accuracy of the data.
Easier modification and updating of data	Data is changed and updated in only one location.
Easier access to reports and data; convenience of shared data access	Many of today's databases produce reports accessible on the Web from any Internet-connected device.

Better data security	It is easier to implement security measures in a centralized system.
More efficient data storage	Having data in one location reduces storage needs.

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### **Ethical Dilemmas**

The amount of data collected about individuals by businesses and governments has created privacy concerns for some people and groups. Businesses and marketing companies want to collect as much detailed information about individual consumers as possible, so that they can market their products effectively at the lowest cost. At times, businesses have crossed the line with data collection practices and behavioral targeting, causing Web users to feel that their privacy has been invaded. Governments are interested in collecting information about individuals in order to safeguard citizens from terrorists and criminals. Governments have also been known to cross the line using surveillance technologies to collect private information against the will of their citizens. In the U.S., some are calling on businesses to establish a Code of Ethical Practices for data management. Where do we draw the line between what is acceptable data collection for businesses and governments and what is not?

Another ethical dilemma related to databases has to do with the risk of private data falling into the hands of hackers and criminals. Information theft has become a multi-billion-dollar industry with hackers utilizing tools to break through the security of databases, to steal valuable information and individuals' identities. Information security is an important consideration when designing databases.

### **Database Topics**

- Database Structure
- Database Tools
- Industrial Databases

### **Database Structure**

**Database structure** refers to the manner in which data is organized and stored.

#### **Why This Matters**

Databases range in size and complexity from simple personal information management (PIM) software to large industrial databases that manage petabytes of

data. The larger a database, the more time is required to define the relationships between the data and its underlying structure. A poorly designed database can cause chaos in an organization and waste the user's time.

### **Essential Information**

Because many of today's organizations are large and complex, and use large quantities of data in numerous ways, it is challenging to keep data organized so that it can be effectively utilized. A database should be designed to store all data relevant to the organization and provide quick access and easy modification. When building a database, careful consideration must be given to these questions:

- Content: What data is to be collected and at what cost?
- Access: What data is appropriate to provide to different types of users at what time and for how long?
- Privacy and security: How will the data be kept safe from unauthorized access?
- Logical structure: How is the data to be arranged so that it makes sense to users?
- Physical organization: Where is the data to be physically located?
- Management and coordination: Who is responsible for developing and maintaining an accurate database system?

### **Database Structure Topics**

- Database Management System
- Data Hierarchy
- Database Key
- Relational Database

## **Database Management System (DBMS)**

A **database management system** or **DBMS** consists of a group of programs that manipulate the data within a database. It provides an interface between the database and the user, or between the database and application programs.

### **Why This Matters**

Individuals use personal databases to store addresses and contact information, keep track of important dates, inventory valuables for possible insurance claims, catalog music and book collections, and store and manage other lists of personal data. We all interact with databases over the Internet. In fact, the Web itself could be viewed as the world's largest database management system. Business systems depend on databases for daily operations and strategic planning. Databases provide the foundation on which information systems are built, and database management systems provide the interface between the two.

## Essential Information

Database management systems range from small, inexpensive software packages to sophisticated systems costing hundreds of thousands of dollars. A few popular alternatives include flat file, single user, multiuser, and general-purpose and special-purpose systems. Open source databases are also available.

A *flat file database* stores database records in a plain text file. This method of data storage typically stores each record as a line of text, and uses commas, tabs, or other indicators within the line to separate the fields within the record. The most common type of flat file format is called *CSV* for *comma-separated values*. The contents of a file named `addressbook.csv` might look something like this when viewed with a text editor:

```
Smith,Jon,1881 Mango Ct,Atlanta,GA,31123
Peters,Linda,2991 Montrose,Chicago,IL,60645
```

Database software, and even spreadsheet software, can read a .csv file, using the line breaks and commas to interpret the data as a table. Most professionals come in contact with CSV files at some point in their careers. For example, teachers using Learning Management Systems, such as Blackboard, can download student grades in a CSV file and view them in Excel.

Databases for personal computers are most often designed for a single user. Only one person can use the database at any time. Microsoft Outlook and Quicken are examples of popular *special-purpose databases*. These DBMSs are used to store and manipulate personal data. Outlook organizes contacts, calendars, email addresses, and to-do lists, and Quicken is used for personal financial data.

Most small, medium, and large businesses require multiuser DBMSs that allow multiple employees to access and edit data simultaneously. These are typically referred to as *database development platforms* because they allow you to create a database and a DBMS for accessing and manipulating data in the database. Multiuser DBMSs utilize a unique manner of reading and writing data to provide users with simultaneous access to a shared database without the danger of overwriting each other's data.

Microsoft Access is one of the smaller database development platforms available for use by individuals as well as small businesses and organizations. Large corporations that manage huge quantities of data invest significantly in industrial database systems. IBM DB2, Microsoft SQL Server, and Oracle are much more powerful and expensive, and allow dozens, hundreds, and even thousands of simultaneous users. Such databases are custom designed to manipulate particular types of data to gain specific useful information. For example, data collected by smart grid technologies shows how electricity is used in homes and businesses. A DBMS is used to manipulate that usage data to discover opportunities for energy savings.

Oracle, Sybase, and IBM databases are examples of *general-purpose databases* that can be used for many different types of applications. Oracle is currently the market leader in general-purpose databases, with about half of the multibillion-dollar global database market. As in other software areas, open source DBMSs, including MySQL, PostgreSQL, and Ingres, are increasing in popularity due to their ease of use, low cost, and flexibility.

**Table: Popular DBMSs**

DBMS	Vendor	Database Model	Computer type
Access	Microsoft	Relational	PC, server, handheld
Approach	Lotus	Relational	PC, server
DB2	IBM	Object relational	PC, midrange server, mainframe
FileMaker	Filemaker	Relational	PC, server, handheld
Informix	IBM	Relational	PC, midrange server, mainframe
Ingres	Computer Associates International	Relational	PC, midrange server, mainframe
MySQL	MySQL AB	Relational, open source	PC, midrange server, mainframe
Oracle	Oracle	Object-relational	PC, midrange server, mainframe, handheld
SQL Server	Microsoft	Relational	Server
Sybase	Sybase	Relational	PC, midrange server, handheld
Versant	Versant	Object-oriented	PC, midrange server
Visual FoxPro	Microsoft	Relational	PC, server
OpenOffice.org Base	Apache	Relational, open source	PC, server

## Data Hierarchy

**Data hierarchy** refers to the manner in which data in a database is organized into sequential levels of detail.

### Why This Matters

The hierarchy that is defined for data within a database makes it possible for a database management system to manipulate the data to produce useful information. The hierarchy includes levels of data that combine to create other levels. Characters are combined to create fields; fields are combined to create records; records are combined to create tables; and tables are combined to create a database, as shown in the figure.

### Essential Information

Recall that in a computer, a byte is used to represent a character, which is the basic building block of textual information. Characters can be uppercase or lowercase letters (A, a, B, b, C, c,...Z, z), numeric digits (0, 1, 2,...9), or special symbols (![+][-]/€/¥...).

In a database, characters are combined together to form a field, the smallest practical unit in most databases. A *field* is typically a name, number, or combination of characters that in some way describes an aspect of an object (an individual, a song in a music library, an item in inventory, a photograph in an album) or activity (a business transaction, an interaction). Every field has a field name and can have either a fixed or a variable length. For example, EmployeeNumber is a field name for an employee number that is fixed at eight characters long. PartDescription is the field name for a part description, where the length of the description can vary depending on the part. Database syntax typically requires that field names not include any spaces. So a field that contains an employee identification number might be named “EmployeeNumber” or “employee\_ID”.

A collection of related fields that describe some object or activity is a *record*. You can create a more complete description of an object or activity by combining fields that represent various characteristics of objects or activities into records. For instance, a database record for music in the iTunes Store combines fields for Name, Time, Artist, Price, Release Date, Track #, and others to fully describe the track.

A collection of related records is a *table*, also called a *file* in some databases. For example, an employee table is a collection of all of an organization’s employee records. Likewise, an iTunes music library that includes all the songs in your collection is a database table or file.

At the highest level of this hierarchy is the *database*, a collection of integrated and related files or tables. For example, iTunes may store music data in one database file, movie data in another, TV show data in another, and podcast data in yet another. The combination of these files is the complete iTunes database.



Databases use entities, attributes, and keys to store data and information. An *entity* is a generalized class of people, places, or things (objects) for which data is collected, stored, and maintained. Entities are represented as tables in a database. Records are *instances* of an entity. For example, “customers” may be an entity in a database, and “Joanna Smith” an instance of the customer entity. An *attribute* is a characteristic of an entity. The specific value of an attribute, called a *data item*, can be found in the fields of the record describing an entity.

## Database Key

A **database key** is a field in a table used to identify a record, such as EmployeeNumber.

### Why This Matters

Records are an important element of the database hierarchy because they are used to store the database entities. A database must provide a method for identifying specific records in a table. Keys were designed to serve this purpose. Primary keys assist with differentiation as well as ensuring that there are no duplicate records in a table.

### Essential Information

As you have learned, a record is made up of a collection of fields. A key is a field in a record that is used to identify the record, such as EmployeeNumber. A *primary key* is a field within a database table that uniquely identifies each record. Each record in a table must have a unique entry in the primary key field. The primary key distinguishes records so that they can be easily and accurately accessed, organized, and manipulated.

Primary keys are essential for the functioning of a database management system. The U.S. Internal Revenue Service uses Social Security numbers as the primary keys for citizens to ensure that tax information and payments are routed to the correct individual. However, for privacy reasons, most schools have switched from using student Social Security numbers as primary keys to using a unique, assigned student- ID number.

In some cases, multiple fields may be combined as a primary key. For example, what would iTunes use as a primary key for its music files? The artist field might seem like a good option, but each artist has many tracks. The artist field is not unique for each record. The track title is another option. But some songs are recorded by multiple artists, so the track title may not be unique to each database record. One solution is to use the combination of artist and track title to create the primary key. This way, Joni Mitchell’s “Big Yellow Taxi” can be uniquely identified from other artists’ recordings of “Big Yellow Taxi.” If an artist has recorded the same song on multiple albums, it would be necessary to combine track title, artist, and album title

as a primary key. Database designers often get around these types of challenges by assigning each record a unique ID number that acts as a primary key.

Table: iTunes Music

Song	Artist	Album	Release date
Big Yellow Taxi	Joni Mitchell	Ladies of the Canyon	04/17/70
Big Yellow Taxi	Counting Crows/Vanessa Carlton	Hard Candy	07/09/02
Big Yellow Taxi	Amy Grant	House of Love	08/14/07

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Primary keys ensure that duplicate records are not stored in a database. In the iTunes example above, if the user attempted to download Joni Mitchell's *Big Yellow Taxi*, she would receive an error message stating that she already owned that track. Without primary keys, such cautionary fact checking becomes difficult.

Primary keys are also useful in creating relationships among multiple tables. A common attribute found in two tables—, such as a customer's account number in a transactions table and the same customer's account number in a customer table—, can be used to track down a customer's address for billing on a recent purchase. Making the account number the primary key in the customer table will ensure that only one customer is accountable for the purchase.

## Relational Database

A **relational database** organizes data into multiple tables that are related by common fields.

### Why This Matters

The data to be stored in a database often includes many categories of related data. For example, businesses typically store information on employees, inventory, customers, and sales. Storing all of this data in one large table would make for a huge and unwieldy database with a lot of redundancies. Relational databases resolve this issue by storing data in separate tables according to logical categorization, and relating the information by common fields.

## Essential Information

The structure of the relationships in most databases follows a logical model. Many types of database models have been used over the years, including hierarchical, network, relational, object-oriented, and object-relational. The object-oriented model encapsulates data and database functionality together in software objects. Object-relational databases combine features of the object-oriented model with the relational model. The relational model is by far the most popular.

The overall purpose of the relational model is to describe data using a standard tabular format. In a relational database, all data elements are placed in two-dimensional tables organized in rows and columns, simplifying data access and manipulation. Notice in the first figure (click the image to enlarge) that the tables are related by common fields: Item#, Customer#, and Employee#. Having tables related by common elements allows them to be linked to produce useful information. This example is simplified to make it easy to understand. Typical business databases include dozens of tables with hundreds of relationships.

Once data has been placed into a relational database, data inquiries and manipulations can be made using a DBMS. Two common data manipulations are selecting data and joining tables. *Selecting* involves choosing data based on certain criteria. For example, you might want to find all customers who live in Chicago, which might be expressed as City = "Chicago".

*Joining* involves combining two or more tables. For example, you could combine the inventory table from one company with the inventory table of another company when the two companies merge. Some in the tech world have called for an open, unified database of places— a database that stores information on every map location, including buildings and businesses. Such a database could be used as a source of information for countless useful applications. The endeavor would require Google, Microsoft, MapQuest, and other companies to join their database tables into one gigantic dynamic database.

The ability to connect data in different tables through a common field is sometimes referred to as a *relationship*. Relationships between tables can be illustrated through an *entity relationship diagram*. View the entity relationship diagram for an online auction database provided in the second figure. Notice that there are four tables in this database: Sellers, Auction Items, Bids, and Buyers. The fields included in each table are listed in the boxes. The key icon indicates the primary key for each table.

Notice the lines connecting the tables in the figure. These represent the relationships between the tables, and indicate which fields in the tables hold common information. For example, the seller\_ID field is used to connect the Sellers table to the Auction\_Items table.

Also notice the 1 and infinity symbols used on the relationship lines. These indicate a special kind of relationship called a one-to-many relationship. For example, the relationship between the Sellers table and the Auction\_Items table has a 1 on the

Sellers side. This is because there is only one record for every seller\_ID in the Sellers table, because seller\_ID is the primary key. However, there is an infinity sign over the Auction\_Items side of the relationship because each seller can have a limitless number of items up for auction—the seller\_ID is not a primary key in the Auction\_Items table. One-to-one and many-to-many relationships can also exist, depending on whether the field used is a primary key or not.

## Database Tools

**Database tools** include software and techniques for analyzing, maintaining, and manipulating data in a database.

### Why This Matters

The power of a database lies in the tools utilized to manage, maintain, and manipulate the data. These tools include schemas, data dictionaries, and data manipulation languages such as SQL.

### Essential Information

Creating relationships between tables becomes very important when trying to ensure that the content of a database is good. Good data should be nonredundant, flexible, simple, and adaptable to a number of different applications. The purpose of data analysis is to develop data with these characteristics. *Data analysis* is a process that involves evaluating data to identify problems with the content of a database.

The process of correcting data problems or anomalies is called *normalization*. It ensures that the database contains good data. Normalization usually involves breaking one table into two or more tables in order to correct a data problem or anomaly. Normalization is a very important technique in database management and is yet another advantage to using a relational database.

*Data integrity* refers to the quality of data: the degree to which it is accurate and up to date. There are many possibilities for inaccuracies in today's information-rich society. Some people have been unable to get credit cards, car loans, or home mortgages because data stored about them by credit bureaus was inaccurate. In some cases, a retail store may report that someone didn't pay his or her bills, when the bills were paid in full. These types of errors were caused by inaccurate data being entered into a database. The results are inaccurate output. This is sometimes referred to as *garbage in/ garbage out (GIGO)*. Computer systems are often blamed for such errors; but in reality, the errors are more often human.

Database management systems must be programmed to detect and eliminate data inaccuracies whenever possible. Although it is not possible to eliminate all data inaccuracies, good database design and development require that checks and balances be set up to detect and eliminate errors.

Besides tools designed to analyze and normalize data, tools are also used to query, filter, and organize data to meet particular needs. Data manipulation languages, the most popular of which is SQL, are the main tool of those who work with databases. Consider the data collected by FourSquare, the social media app that encourages users to “check in” at the businesses they visit. Electronics retailer RadioShack provided FourSquare users with a 10 percent discount for checking in on FourSquare. It provided a 20 percent discount to FourSquare users who established “Mayor” status at their local RadioShack. By querying the data collected through FourSquare, RadioShack was able to determine that FourSquare users generally spend 3.5 times as much money at RadioShack as non-users per transaction.

### Database Tools Topics

- Schema
- Data Dictionary
- Structured Query Language

## Schema

A database **schema** is a graphical representation of the structure of a database.

### Why This Matters

Schemas allow database administrators and users to visualize the structure of a database and understand the relationships between data and tables.

### Essential Information

One of the first steps in creating a database is to outline the logical and physical structure of the data as well as the relationships among the data in the database. This description is called a schema (as in schematic diagram). A schema can be part of the database or a separate schema file. The DBMS can reference a schema to find where to access the requested data in relation to another piece of data. Schemas are entered into the DBMS (usually by database personnel) via a data definition language. A *data definition language (DDL)* is a collection of instructions and commands used to define and describe data and data relationships in a specific database.

## Data Dictionary

A **data dictionary** provides a detailed description of each field and table in a database.

### Why This Matters

Data in a database is typically accessed by different individuals and software. A data dictionary provides specific details on the requirements of each field and table in a database, how they may be accessed, and the specific parameters and requirements imposed on the data they hold.

### Essential Information

An important step in creating a database is to establish a data dictionary, a detailed description of all data used in the database. The data dictionary includes information such as the name of the data item, who prepared the data, who approved the data, the date, a description, other names that may be used to refer to the data, the range of values for the data, the data type (numeric or alphanumeric), and the number of positions or amount of space needed for the data. Click to enlarge the figure to see an example of a data dictionary entry. A data dictionary provides standard definitions of terms and data elements that can be referenced by programmers, database administrators, and users to maintain data integrity.

## Structured Query Language (SQL)

**Structured Query Language (SQL)** is a popular data manipulation language used by the vast majority of database programmers and administrators for manipulating data to meet the needs of the users.

### Why This Matters

The power of a database lies in the ability to sift, sort, and query data to answer questions and discover patterns. For example, it is useful to discover which are the most profitable stores in your retail chain, who are the least productive employees, what airline offers the best deal on a particular route, which song is most popular, and what direction the economy is headed. The example in the figure (click to enlarge) illustrates a query that displays customers who purchased more than \$2000 worth of products. Queries are designed and query results are generated through the use of data manipulation languages such as SQL.

### Essential Information

Once a DBMS has been installed and a database and table(s) created, the data can be accessed and manipulated using specific commands in various programming languages and a data manipulation language. A *data manipulation language (DML)* is a specific language provided with the DBMS that allows database users to access, modify, and make queries about data contained in the database and to generate reports.

In 1986, the American National Standards Institute (ANSI) adopted Structured Query Language (SQL, also pronounced “sequel”) as the standard query language for

relational databases. Today, SQL is an integral part of popular databases on both mainframe and personal computers. The following query is written in SQL:

```
SELECT * FROM EMPLOYEE WHERE JOB_CLASSIFICATION = 'C2'
```

This query tells the DBMS to select all ( \* ) columns from the EMPLOYEE table for which the JOB\_CLASSIFICATION value is equal to C2.

SQL is actually a programming language, but it is easy for nonprogrammers to understand and use, thanks to its English-like commands. Programmers can use SQL on systems ranging from PCs to the largest servers. SQL statements also can be embedded in many programming languages, such as the widely used Java and PHP languages.

Table: Examples of SQL Commands

SQL Command	Description
SELECT ClientName, Debt FROM Client WHERE Debt>1000	This query displays all clients (ClientName) and the amount they owe the company (Debt) from a database table called Client, for clients that owe the company more than \$1000 (WHERE Debt>1000).
SELECT ClientName, ClientNum, OrderNum FROM Client, Order WHERE Client.ClientNum = Order.ClientNum	This command is an example of a join command that combines data from two tables: the client table and the order table (FROM Client, Order). The command creates a new table with the client name, client number, and order number (SELECT ClientName, ClientNum, OrderNum). Both tables include the customer number, which allows them to be joined. This is indicated in the WHERE clause that states that the client number in the client table is the same as (equal to) the client number in the order table (WHERE Client.ClientNum = Order.ClientNum).
GRANT INSERT ON Client to BGuthrie	This command is an example of a security command. It allows Bob Guthrie to insert new values or rows into the Client table.

Some commercial databases provide tools and wizards for automating the process of building SQL statements. Microsoft Access provides a Query tool and wizard where tables and fields are selected and criteria specified (see figure) to quickly generate SQL queries. There is also the ability to *query by example (QBE)*, where a database entity is selected as an example of the criteria to be queried. Query wizards and QBE automate the process of writing SQL commands, making manipulating databases easier and faster for novices.

## Industrial Databases

**Industrial databases** are large databases that function as the cornerstone of information systems in businesses and enterprises.

### Why This Matters

Corporations and large institutions depend on databases and database management systems. Several database technologies—such as data warehouses, data marts, data mining, distributed databases, and data centers—enable businesses to get the most out of their data.

### Essential Information

All organizations need to process routine transactions. Organizations of all sizes have to pay their employees. A small business needs to send out bills quickly to maintain a healthy cash flow. A religious organization might want to send out a monthly newsletter. A manufacturing company needs to pay its suppliers for parts and raw materials. These are all routine processing activities that can be implemented with a database system.

Amazon.com trusts its huge multi-terabyte database to support its online transactions. To meet Amazon's high demands, its database must provide personalized, rapid responses to customers. It is typical for huge databases to lag in response time, but not so with Amazon's. After greeting customers with a custom-designed Web page built on the fly, the database serves up product information, user reviews, lists of recommendations, and links to more products—all in the blink of an eye. The DBMS is optimized to provide both agility and power. When the customer is ready to make a purchase, the DBMS manages the entire process.

Businesses depend on many different types of database technologies to claim a competitive advantage. Of those available, the most powerful and popular are discussed in this section.

### Industrial Databases Topics

- Data Warehouse
- Data Mining
- Distributed Database



- Data Center
- Database Administrator

## Data Warehouse

A **data warehouse** is a very large database that holds important information from a variety of sources.

### Why This Matters

In the corporate environment, data is generated by a variety of functional units within the business: accounting, marketing, sales, human resources, etc. Business executives combine data from many sources and analyze it to get the big picture of what is occurring in the business. Data warehouses merge data from many sources into one large database designed for analysis. Data warehouses are an important part of many business systems.

### Essential Information

A data warehouse is a large database that holds information from a variety of sources. It is usually a subset of multiple databases maintained by an organization or individual. Data warehouses are used by many companies and organizations. A hardware store, for example, can use a data warehouse to analyze pricing trends. This can help the store determine what inventory to carry and what price to charge. With a data warehouse, all you have to do is ask where a certain product is selling well, and a colorful table showing sales performance by region, product type, and timeframe pops up on the screen. Similarly some police departments use data warehouses to store records of events such as complaints, arrests, criminal summonses, shootings, homicides, and other incidents. The data warehouse is tapped to provide real-time information for a centralized help desk that provides detectives with data needed to solve crimes.

A *data mart* is a small data warehouse, often developed for a specific person or purpose. It can be generated from a data warehouse using a database management system.

## Data Mining

**Data mining** refers to the process of extracting information from a data warehouse or data mart.

### Why This Matters

The amount of data collected by today's corporations is far too huge to be interpreted solely by humans. Computerized tools are needed to discover irregularities and trends in data. Data mining is the application of such tools.

### Essential Information

Data mining is the process of extracting information from a data warehouse or a data mart. The DBMS can be used to generate a variety of reports that help people and organizations make decisions and achieve their goals. Data mining has been used in the airline-passenger profiling system to block suspected terrorists from flying. Data mining is also used by government agencies to detect patterns of terrorist activity.

In a business setting, data mining can yield outstanding results. Often called *business intelligence* or BI, a term first coined by a consultant at Gartner Group, the business use of data mining can help increase efficiency, reduce costs, or increase profits. The business-intelligence approach was first used by Procter & Gamble in 1985 to analyze data from checkout scanners. Today, most companies use business intelligence to interpret the valuable information provided by collected data.

## Distributed Database

A **distributed database** takes available data stored in multiple locations and makes it appear as a single collection.

### Why This Matters

As companies become increasingly geographically dispersed, the ability to pull data from numerous sources has become a necessity. Distributed databases enable users from various locations to benefit from a universal view of corporate data.

### Essential Information

With a distributed database, also called a *virtualized database*, the actual data may be spread across several databases at different locations. To users, the distributed databases appear to be a single, unified database. Distributed databases connect data at different locations via telecommunications networks. A user in the Milwaukee branch of a shoe manufacturer, for example, might make a request for data that is physically located at the corporate headquarters in Milan, Italy. The user does not have to know where the data is physically stored.

In situations where a distributed database provides storage services to the public or other businesses, it is considered cloud storage. Cloud storage is an ideal way to store information shared across organizations or individuals. For example, Google has worked with DNAnexus to store the huge amounts of DNA data collected by

researchers. By using Google Cloud Storage, researchers around the world can easily gain access to the data.

A distributed database creates additional challenges in maintaining data security, accuracy, timeliness, and conformance to standards. Distributed databases allow more users to have direct access at different user sites; therefore, controlling who accesses and changes data is sometimes difficult. Also, because distributed databases rely on telecommunications to transport data, access to data can be slower. To reduce the demand on telecommunications media, some organizations build a replicated database. A *replicated database* is a database that holds a duplicate set of frequently used data. At the beginning of the day, an organization sends a copy of important data to each distributed processing location. At the end of the day, the different sites send the changed data back to be stored in the main database.

## Data Center

A **data center** is a climate-controlled building or set of buildings that house servers that store and deliver mission-critical information and services.

### Why This Matters

The world economy is increasingly dependent on data. Much of the world's data is stored in data centers of various sizes. Data centers are getting media attention because they consume large amounts of energy. New green technologies are being applied to help decrease the size and energy demands of the data centers that store our rapidly increasing amounts of data. Most of the energy required for a data center goes to keeping servers cool. Facebook built its European data center in Lulea, Sweden, on the edge of the Arctic Circle, where it benefits from cheap electricity and year-round cool temperatures.

### Essential Information

Corporate databases and database management systems are typically housed in facilities called data centers. A data center is a climate-controlled building or set of buildings that house servers that store and deliver mission-critical information and services. Data centers of large organizations are often distributed among several locations. Microsoft constructed a 400,000-square-foot data center in San Antonio, at a cost of \$550 million. Google constructed a \$600- million mega-data center in Lenoir, North Carolina, and a \$750- million data center in Goose Creek, South Carolina. Clearly, storing and managing data is a serious business.

The number of data centers being constructed for big companies like Google, Microsoft, Amazon, Apple, and Facebook is rapidly increasing as computer users are storing increasing amounts of data in the cloud. Cloud computing is gradually

moving all data off individual computers and onto Internet-accessed servers maintained in data centers.

While corporate and personal data sits in large supercooled data centers, the people accessing that data are typically in offices spread across the country or around the world. In fact, in the near future, the only personnel on duty at data centers may be security guards. Data centers are approaching the point of automation, where they can run and manage themselves while being monitored remotely. This is referred to as a “lights out” environment.

## **Database Administrator**

A **database administrator** or **DBA** is a skilled and trained computer professional who directs all activities related to an organization’s database, including providing security from intruders.

### **Why This Matters**

Data has become the most valuable property of a business. Maintaining data, getting it to the people who need it, and keeping it safe are the responsibilities of a database administrator.

### **Essential Information**

Managing a database is complex and requires great skill. Hiring a good database administrator, concentrating on important and strategic aspects of databases, training database users, and developing good security procedures are all important.

Databases and database management systems typically are installed and coordinated by an individual or group responsible for managing one of the most valuable resources of any organization: its data. These DBAs are skilled and trained computer professionals who direct all activities related to an organization’s database, including providing security from intruders. DBAs must work well with both programmers and users of the database. Database administrators typically hold college degrees in Computer Science, Information Technology, or Management Information Systems. Most database administrators are responsible for the following areas:

- Overall design and coordination of the database
- Development and maintenance of schemas
- Development and maintenance of the data dictionary
- Implementation of the DBMS
- System and user documentation
- User support and training
- Overall operation of the DBMS
- Testing and maintaining the DBMS
- Establishing emergency or failure-recovery procedures

## Ecommerce

**Ecommerce** or **electronic commerce** refers to systems that support electronically executed business transactions.

### Why This Matters

Ecommerce has provided a fresh platform for business that has changed the way businesses and consumers think about buying and selling. Increasingly, buyers and sellers turn to the web to buy and sell products and are enjoying the benefits. Conducting business online offers convenience and savings to both buyers and sellers. It also empowers consumers to find the best deals and service, placing additional pressure on businesses to meet consumer needs.

### Consider This

The U.S. Census Bureau's eStats Report shows that ecommerce makes up an increasingly larger percentage of overall U.S. commerce each year. According to web measurement firm ComScore, 14 percent more people shopped online during the 2012 holiday season than in 2011, spending \$42 billion. However, in-store visits are also up due in large part to online promotions. Increasingly, shoppers are combining online and in-store shopping to make purchases in the most convenient and economical way. Even so, online-only retailers such as Amazon are experiencing double-digit annual growth, and the volume of online business transactions has gone through the roof. Shipping companies such as FedEx and UPS are raking in the profits as they expand their fleets of delivery vehicles to deliver vastly increasing amounts of merchandise. Customers can purchase merchandise with just a couple taps on a smartphone, and membership programs like Amazon Prime make online shopping more attractive by offering free shipping and other perks.

As you read about ecommerce, consider how it is affecting our lifestyles, business profits, and commerce in general. With the convenience of ecommerce, are people purchasing more? What is the impact on the U.S. economy? On the global economy? If you were a business owner, how would you take advantage of ecommerce technologies?

### Essential Information

An increasing percentage of commerce is conducted online. From grandparents to grade school kids, just about everyone is spending money online. Kids' favorite meeting places used to be the playground or the mall, but today thousands are meeting, playing, and spending their parents' money online at Club Penguin, at Webkinz World, and on thousands of mobile apps. Brick and mortar businesses like Build-A-Bear Workshop are feeling the pressure from online sites, and creating their own online presences—such as bearville.com, where kids can make their stuffed and plushy friends come to life in a virtual town. But young people make up only a small portion of ecommerce purchases. All generations have become comfortable shopping online. When planning travel, a night on the town, or a

shopping spree, most Internet users begin with online research, and often conclude with an online purchase. Not only do individuals shop online, but so do businesses.

There are three primary forms of ecommerce: B2C, B2B, and C2C. Lands' End, shown at the top of this page, represents a form of ecommerce called B2C. *B2C*, or *business-to-consumer*, ecommerce uses the web to connect individual consumers directly with sellers to purchase products. B2C ecommerce is sometimes calledetail, a takeoff on the term "retail," as it is the online equivalent of a brick-and-mortar retail store.

Although B2C is the most visible form of ecommerce, consumers' online purchasing power pales in comparison to the amount of merchandise and services that businesses purchase online. *Business-to-business*, or *B2B*, ecommerce supports transactions between businesses across private networks, the Internet, and the web. Because businesses conduct frequent and high-volume transactions, B2B ecommerce is especially valuable.

It's easy to understand why businesses have adopted ecommerce for purchasing merchandise more rapidly than consumers have. Ecommerce saves businesses money and provides competitive advantages. Businesses use B2B ecommerce to purchase:

- Raw materials for production of products
- Tools, parts, and machinery for the production line
- Office furnishings, equipment, and products
- Transportation and shipping services

The third form of ecommerce is epitomized by the popular trend of consumers selling their own belongings on sites such as eBay and Craigslist. *Consumer-to-consumer*, or *C2C*, ecommerce uses the web to connect individuals who wish to sell to other individuals. Although eBay supports all forms of ecommerce, many credit it with being the first C2C ecommerce website. Craigslist, the online classifieds website, is a popular C2C site with more than 50 million people selling and buying items each month. Since C2C does not create revenue for businesses, it is not included in most economic studies, such as the one conducted by the U.S. Census Bureau. However, when you consider that more than \$59 billion of merchandise is sold on eBay annually, it is easy to see that people and companies are both very invested in buying and selling things online.

### **Ethical Dilemmas**

Ecommerce can bring up ethical dilemmas, especially around marketing practices that threaten consumer privacy. Behavioral targeting is a marketing practice that involves collecting information about consumer behavior in order to better improve marketing and advertising directed at individual consumer interests. Ecommerce, along with databases and data mining techniques, allows businesses to easily observe specific users' online behavior and display ads targeted at individuals based

on those behaviors. It has become common practice for online companies like Google and Facebook to sell detailed user information to businesses to assist them with behavioral targeting. Some people and privacy groups believe that businesses go too far in monitoring users' online behavior. If you consider behavioral targeting with location-based advertising, you can see how businesses could easily build detailed customer profiles that not only feature not only a person's online activities and interests, but also the various locations the person visits over time. Such information could reveal activities and lifestyle choices that consumers might prefer to keep private.

Ecommerce has also provided opportunities for fraudsters and criminals. Craigslist, eBay, and even Amazon have provided criminals with avenues to sell illegally acquired goods. Fraudulent business websites and email dupe visitors into providing credit card and other information, allowing thieves to steal identities and cash. Botnets are often used to distribute that email, and as well as spam, some of which is designed to spread malware. Such occurrences have become so common that they are undermining the public's trust in ecommerce.

Ecommerce also has had a big impact on globalization. When people and businesses shop online, the entire world is their marketplace. An individual may purchase an item from a business across the country to take 10 percent off the price tag. A business might purchase from another business in another country, or outsource a job to a company in a developing country, in order to save 40 percent on production cost. In this manner, ecommerce levels the playing field for new and small businesses, enabling them to compete with larger established companies. However, globalization has a negative impact on some local economies. A movement has sprung up around the U.S. that encourages consumers to "buy local" rather than giving money to businesses owned by strangers located elsewhere.

### **Ecommerce Topics**

- Ecommerce Implementation
- Ecommerce Technologies

## **Ecommerce Implementation**

**Ecommerce implementation** refers to the manner in which ecommerce addresses the needs of buyers and sellers.

### **Why This Matters**

When you think of ecommerce, you probably think of websites such as Amazon.com. B2C sites like Amazon are just the tip of the iceberg of ecommerce implementations. Some form of ecommerce is behind just about all business transactions today.

Studying a variety of ecommerce implementations helps to understand the true importance of ecommerce.

### Essential Information

Ecommerce works to address every aspect of buying and selling—from advertising products, to searching for products, from managing a warehouse (see video), to arranging delivery. The buying and selling process occurs at many levels and includes numerous scenarios. It could be a multimillion-dollar deal between an auto manufacturer and an auto parts manufacturer, or it could be a 15-cent text message sent from a cell phone.

**Table: Stages of the Buying and Selling Process**

Buying	Selling
Realizing a need	Conducting market research
Researching products	Manufacturing products
Selecting a vendor	Marketing and advertising
Providing payment	Processing payments
Accepting delivery	Arranging delivery
Accessing product support	Providing after-sale support

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Ecommerce tools are utilized in all types of transactions, for all kinds of commerce. Sometimes a transaction is obviously supported by ecommerce, such as using an online shopping cart and checkout. Other times it's more subtle, like printing a coupon sent through email to be used at a local store. Many businesses now allow customers to order items online and pick them up at a local store. Some businesses provide online floor plans of their stores so customers can navigate through the aisles using their mobile phones to find products. When they find a product they like in a store, many customers use their mobile phones to check prices online. The lines between traditional commerce and ecommerce have become blurred.

### Ecommerce Implementation Topics

- Etail
- Online Auctions
- B2B Global Supply Management
- B2B Electronic Exchange
- Mcommerce
- Online Advertising



## Etail

**Etail** refers to several forms of electronic retail business that make up B2C ecommerce.

### Why This Matters

Etail has dramatically influenced the way people shop by providing customers with product information and the ability to comparison shop online. Price battles rage on the web to the benefit of consumers. Websites such as Bizrate.com, DealTime.com, PriceGrabber.com, and NexTag.com provide product price quotations from numerous etailers to help you to find the best deal. Even if the best price can be found at your local warehouse store (check out shopLocal.com), shopping online provides the assurance that you are getting the best deal. With the convenience provided by mcommerce, shoppers can shop in retail stores and online simultaneously.

### Essential Information

There are several approaches to etail. A business can set up its own electronic storefront, such as [www.landsend.com](http://www.landsend.com) or [www.target.com](http://www.target.com), and provide visitors access to an electronic catalog of products — which far exceeds what could be displayed in a store — an electronic shopping cart for items they wish to purchase, and an electronic checkout procedure. Another etail option is to lease space in a cybermall. A *cybermall* is a website that allows visitors to browse through a wide variety of products from varying etailers (see figure). Cybermalls are typically aligned with popular web portals such as Yahoo!, Google, and MSN.

Ecommerce strategies are continuously evolving to offer customers more options, convenience, and savings. Consider Amazon, which began as a simple online bookseller. It then began selling other products online, much like Walmart sells products in stores. It then expanded to allow retail partners to sell merchandise through Amazon, vastly increasing its inventory and taking a percentage of all sales. Now anyone can sell new or used items through the Amazon website, providing shoppers with a choice of vendors for many items, and the ability to purchase used merchandise. Also, Amazon set up a membership plan, Amazon Prime—where, for a \$79 annual fee, members enjoy special discounts, free movies, and free 2-day shipping on most items—a model that Google has adopted for its own etail service. The benefits of selling online have allowed Amazon to become a larger and more successful retailer than Walmart.

Increasingly, especially in regard to digital media, etail is being integrated with branded devices and services. Amazon sells more ebooks than paperbacks due to the ease with which ebooks are sold and downloaded to Kindles, iPads, and other devices. Apple became the largest distributor of digital music due to the large number of people using its iTunes software on their iPhones, iPads, Macs, and PCs.

Apple, Microsoft, Google, and Amazon are all fighting to become your primary source for purchasing or renting all kinds of media—music, books, magazines, newspapers, games, apps, movies, and television shows. These media and services are sometimes tied to devices. For example, Google’s online media store, named Play, is designed to supply media to Android mobile devices. Apple iTunes is best used on iPhones and iPads. Microsoft’s Xbox Music delivers tunes to Windows 8 devices. Of the big four, Amazon is the only company that delivers digital media to all kinds of devices with equal convenience. Consumers must choose which digital “ecosystem” they wish to buy into.

Some items are easier to sell online than others. Some purchases are determined not by holding a product in your hands, but by the description or demonstration of the product. Such is the case with the digital media listed above. Tangibles—such as DVD players, clothes, and automobiles—are more difficult to sell online. However, examining tangible items online has become significantly easier with the development of 3D virtual imagery. Three-dimensional virtual imagery enables a web user to rotate objects on the screen and view them from every angle. This capability, combined with reading customer reviews, and perhaps with checking an item out in a local store, make the sale of any item online not only possible, but also commonplace.

The lines between in-store shopping and ecommerce are becoming blurred and may soon become nonexistent. As people lead increasingly online lifestyles, and as online services become more powerful, all commerce may soon become ecommerce, at which point the term *ecommerce* will no longer be needed.

## Online Auctions

**Online auctions**, clearinghouses, and marketplaces provide a platform for

### Why This Matters

Online auctions, clearinghouses, and marketplaces provide opportunities for online shoppers to find special deals. While these forms of ecommerce provide businesses with an avenue for selling overstocked items, they also provide consumers with a method to sell their own belongings in C2C transactions. Sites such as eBay and Craigslist have dramatically affected all forms of commerce by enabling consumers to compete as sellers against retailers. At the Amazon Marketplace, anyone can sell new or used items alongside Amazon and Amazon’s retail partners. More competition in the marketplace often means lower prices.

### Essential Information

Online clearinghouses, web auctions, and marketplaces provide a platform for businesses and individuals to sell their products and belongings. Online clearinghouses, such as uBid.com, provide a method for manufacturers to liquidate

stock and for consumers to find a good deal. Outdated or overstocked items are put on the virtual auction block and users bid on the objects. The highest bidder(s) when the auction closes gets the merchandise—often for less than 50% of the advertised retail price. Credit card numbers are collected at the time that bids are placed. A good rule to keep in mind is not to place a bid on an item unless you are prepared to buy it.

The most popular online auction/marketplace is eBay.com. eBay provides a public platform for global trading where anyone can buy, sell, or trade practically anything. eBay offers a wide variety of features and services that enable members to buy and sell on the site quickly and conveniently. Buyers have the option to purchase some items in auction-style format. For other items shoppers can choose to “buy it now” at a fixed price. Information about auction items on eBay includes how much time is left in the auction, the current highest bid, and information about the item and seller. On any given day, millions of items are listed on eBay across thousands of categories.

Auction houses such as eBay accept limited liability for problems that buyers or sellers may experience in their transactions. Transactions that make use of eBay’s PayPal service are protected. Others may be risky. Participants should be aware that auction fraud is one of the most prevalent types of Internet fraud.

Craigslist is a network of online communities that provides free online classified advertisements. It is a popular online marketplace for purchasing items from local individuals. Today, many shoppers turn to craigslist rather than going to the classifieds in the local paper.

## **B2B Global Supply Management (GSM)**

A **global supply management (GSM)** service provides methods for businesses to find the best deals on the global market for raw materials and supplies needed to manufacture their products.

### **Why This Matters**

Ecommerce has drawn businesses to the Internet and web to advertise and conduct transactions. Competition in nearly all markets is fierce, as former regional boundaries have been eliminated and markets have gone global. International commerce is complex and it is often difficult to know if suppliers are providing the best deal. Businesses offering global supply management (GSM) services have emerged as an important bridge in building relationships between corporate buyers and sellers. By understanding the markets and working in bulk, these intermediaries can find the best deals for companies looking to buy wholesale supplies and parts.

## Essential Information

By now you know that the Internet serves as an ideal way for businesses to connect. The real challenge lies in organizing relationships between businesses. For example, imagine that you have a great idea for a new product, such as a new lightweight, motorized campus scooter. You have test marketed the product, which students on campus greeted with great enthusiasm; you've done all the necessary background work and preparation; you've found a wealthy investor; and you are ready to go into production. You have a list of parts required for the manufacturing of your scooter. But how do you go about finding suppliers that are both reputable and offer a good price? The solution for your scooter manufacturing business is the same as for any business: global supply management.

There are many GSM products and services on the web that promise to lower a business's costs by providing connections to a wide variety of reputable suppliers, along with negotiation tools that enable a business to be assured that it is getting the best deal. Ariba, a GSM company, advertises that its services and software can cut total supply costs by 45%. GSM companies use a number of descriptive titles that include *collaborative business commerce solutions* and *spend management services*, but the gist is always the same—they are services intended to find the best deal for buyers in B2B transactions.

Alibaba is another GSM company that has been instrumental in building international relationships between businesses and in the global marketplace in general. Alibaba has provided businesses in China and elsewhere with global opportunities as exporters. Developing countries benefit from entry into the global marketplace, while businesses in developed countries benefit from lower prices.

## B2B Electronic Exchange

An **electronic exchange** is an industry-specific web resource created to provide a convenient centralized platform for B2B ecommerce among manufacturers, suppliers, and customers.

### Why This Matters

Businesses competing in the same industry sometimes find it beneficial to cooperate in order to advance the industry. Electronic exchanges are based on this philosophy and act as a bridge between competitors, buyers, and sellers within a specific industry. By providing software and a network that connects businesses within an industry, an electronic exchange serves a useful purpose that businesses are willing to pay for. Electronic exchanges often also offer supply chain management services.

### Essential Information

Some businesses join together with others in their industry to pool resources in web-based electronic exchanges. Electronic exchanges promote cooperation among competing companies for greater industry-wide efficiency and effectiveness. Through an electronic exchange, a manufacturer has access to a wide variety of industry-specific suppliers and services. Once business relationships are established among members, the electronic exchange provides the framework for fast and efficient transactions.

Covisint is an electronic exchange for a number of industries, including automotive manufacturers and healthcare. Founded by DaimlerChrysler AG, Ford Motor Company, General Motors, Nissan, and Renault, Covisint has created alliances among automotive manufacturers and suppliers, and contracted several of the largest technology providers to create what Covisint claims is “the most successful business-to-business electronic exchange the world has ever seen.” Covisint members have access to online catalogs and auctions, tools that assist in quality management and problem solving, and an industry portal shown in the figure.

### Mcommerce

**Mcommerce**, or **mobile commerce**, is a form of ecommerce that takes place over wireless mobile devices such as smart phones and tablets.

#### Why This Matters

Mcommerce has grown as mobile communications and computing devices have proliferated. Through mcommerce, users purchase tunes, apps, books, and movies on their mobile phones, for access from any of their Internet-connected devices. But mcommerce isn’t just about digital merchandise; today just about any product or service can be purchased from a mobile device.

### Essential Information

Mcommerce, or mobile commerce, is a form of ecommerce that takes place over wireless mobile devices, such as smart phones and tablets, as well as over emerging technologies like dashtop computers embedded in automobile dashboards. Mcommerce acts as an extension to ecommerce by supporting ecommerce technologies and providing additional benefits related to mobility.

There are currently five methods for delivering mcommerce services to cell phones and other portable devices:

- Directly from cellular carriers
- As mobile apps installed on a smart phone or tablet
- Via mobile web browsers

- Using Short Message Service (SMS) text messaging or Multimedia Messaging Service (MMS)
- Using short-range wireless data communications

The humble beginnings of mcommerce began prior to smart phones and involved cellular providers giving customers opportunities to purchase additional products and services from their cell phones, such as ring tones, wallpaper, games, stock updates, and news alerts. The introduction of smart phones with computing and Internet capabilities ushered in the next generation of mcommerce, featuring apps, games, media, and web-delivered products.

Today's smart phones provide a wide assortment of goods and services to users, and are a goldmine for numerous industries. Cellular providers are making huge profits from the data plans required to use smart phones, while they are working frantically to build out their networks to support the increased demand for bandwidth. Mobile platform providers such as Apple with iPhone, Google with Android, Microsoft with Windows Phone, and Amazon with Kindle are making a bundle as distributors of apps, games, music, movies, television programming, magazines, newspapers, and books. The media companies that own the apps, games, music, movies, etc., have an increased revenue stream because they can get their products to customers anywhere, anytime. An entire industry has sprung up around mobile apps, with independent developers, small and medium-size software companies, and huge software corporations competing side-by-side. Most forms of ecommerce translate easily to mobile web browsers. The only challenge is delivering services via the small display of handsets. Web developers use special CSS stylesheets and a new approach to web design called Responsive Web Design (RWD). RWD allows a web page to adapt so that it looks good on whatever display size is used to access it.

Besides standard web-enabled commerce, businesses also design mcommerce apps for smart phones. Mcommerce apps allow companies to utilize more features of a handset, such as GPS, accelerometers, and compass, to provide additional functionality. While most mcommerce apps simply provide tools to find and purchase items online, others are more creative. For example, Amazon's Price Check app allows customers to scan a barcode with the phone's camera to find the price on Amazon, and then purchase the item online. Retailers were not happy when they found customers in their stores scanning items to see if they could get a better price from Amazon. Some established store policies prohibit photographs in stores.

Cell phone text messaging, or texting, can be used to order merchandise or services, or it can be used for advertisements. Consumers can use SMS technology to purchase tickets to events and have them delivered electronically to their cell phone. Simply present your cell phone at the turnstile to enter the event. Many airlines are providing services that allow customers to use a code on their display to board a plane. At Starbucks, you can pay for coffee with a cell phone app, using your mobile account.

Short-range wireless technology enables some interesting mcommerce applications. The concept of a cashless society has been a dream of the technology industry for quite some time. In such a society, no one would need to carry wallets or money, and transactions would take place through automatic debits and credits to consumer and merchant accounts. Today such transactions can indeed take place using a small device such as a mobile phone and a short-range wireless data transmission, referred to as a *proximity payment system*. Google's Android platform supports proximity payment with a service called Google Wallet, and a few smart phones have implemented the system by including short-range wireless technologies. Google is simply waiting for stores and banks to begin supporting its technology. Apple and Microsoft are sure to follow suit with their mobile platforms.

## Online Advertising

**Online advertising** provides businesses with many options for informing the public about products and services on the Internet and web.

### Why This Matters

Online ads have become an essential part of the online experience. As people migrate to the web as their primary source of news, information, and entertainment, businesses are forced to move their advertising dollars online to garner attention. While advertising online is essential for businesses to stay afloat, it is also essential for many websites and services that offer their content for free but still need to make money. There are many methods for advertising online, including search engine optimization, online business partnerships, ad-sponsored websites, games and apps, pages on Facebook or Google+, email, social media, daily deals pop-ups, and location-based ads.

### Essential Information

The Internet and web provide opportunities for businesses to catch the eyes of many more users than through traditional advertising media. Businesses provide informative websites for their products and services, making it much easier for customers to discover products that suit their needs. The trick for businesses is getting users to find and view their advertisements and websites.

*Search engine optimization* is a set of techniques that businesses use to get search engines to place their links higher in the list of search results. The ultimate goal is to be the first link returned from a user's search on any related search term. However, competition is such that most businesses are happy just to appear on the first page of search results. To accomplish this, businesses create their web pages in a manner that allows search engines to easily identify the content and intent of the page. Then, they work to get other reputable businesses and individuals to link to their sites from their own pages in order to build a good online reputation. Search engines

often use a popularity index to determine which sites are most useful and reputable, and will place those sites high in search results.

Many free web services are financed with advertisements. Facebook, Google, Yahoo!, and other large Internet companies charge significant amounts to place ads on their sites. Some ads may be annoying and impossible to miss, as in the case of some banner ads, pop-up ads, and ads that block the page until you close them or a certain amount of time passes. Other ads may be subtle—targeted and designed not to intrude on the user experience—such as ads placed in the margins on Google and Facebook. Not only have ads become common on websites, but they have also begun to pop up in unexpected places like games and mobile apps. Which types of ads are most effective depends on the product and customer.

Social media plays a large part in online advertising, as companies work to get customers to spread the word about their products. Businesses can create pages on Facebook or Google+ that users can “follow” or “like.” Many businesses post promotional messages on Twitter, Facebook, and Google+ to members who follow them. This assures that advertisements are sent only to those who have requested them, unlike spam, which is sent out indiscriminately. Businesses are also smart to observe what others are saying about them on social media sites. *Reputation management* is the practice of tracking what users are saying about a company online and elsewhere, and working to minimize negative comments and propagate positive ones.

Businesses can also reach out to the public through email and other messaging services. If a customer has a good relationship with a particular company, then advertising items of interest may be well received. Unfortunately, much of the advertisements received through email are spam, and are either automatically filtered out by the email service or immediately trashed.

The online marketing company Groupon established a new model for advertising with discount coupons. Groupon works with local businesses to offer daily deals that it advertises to the public on its site and with direct messages to subscribers of the service. If enough customers commit to a deal, it is activated and everyone saves. Groupon’s model encourages customers to spread the word about deals through social networks and other means. This works out well for retailers since they are assured of a minimum number of sales for each discounted deal. The daily-deal model for local coupons has become extremely popular, and other companies have taken up the model, including Facebook with Facebook Deals.

With increasing numbers of mobile phones incorporating GPS technology, it has become possible to provide users with shopping information and coupons for businesses near their current location. *Location-based advertising* uses location technologies like the GPS and compass in smart phones to provide mobile users with location-specific commerce opportunities. When users “check in” to a location on apps like Foursquare, they may be presented with a coupon for a discount. On slow days, a business may opt to run ad-hoc specials to lure passersby. Based on a



customer's profile, the special deal can be customized to meet what the customer is likely to be willing to spend. Customers may also use a Layar app to “augment” reality by layering text and graphics over photos of nearby locations, showing information about restaurants or other businesses.

Today's marketing practices integrate all forms of advertising into one cohesive package. Integrated marketing combines television and radio advertising, print advertising, and web advertising—especially on social media—taking advantage of the unique features of each type of media to promote and spread a common message and brand image. Many businesses are calling on professional marketing companies to assist with extending their brand presence to social media.

## **Ecommerce Technologies**

**Ecommerce technologies** include software and systems that support safe and secure transactions over networks and the Internet, and make ecommerce possible.

### **Why This Matters**

Many technologies have grown up around ecommerce. Many of them, such as EDI, ecash, smart cards, and digital certificates, are designed to support safe and secure online transactions. Ecommerce hosting businesses have sprung up to make creating a reliable online business easier than doing it yourself. Still, working with an ecommerce host requires knowledge of the underlying technologies in order to maximize the benefits and minimize the costs. Understanding the benefits and challenges of various ecommerce technologies is useful for anyone involved with ecommerce.

### **Essential Information**

Implementing ecommerce requires a significant investment of time, money, and expertise. When a company decides to invest in ecommerce, it places itself at considerable risk. Because ecommerce is highly visible to the public, if it is executed poorly, it could tarnish the reputation of an otherwise well-respected company. Ecommerce requires not only significant hardware and networking capabilities to accommodate heavy traffic, but also expertise in online marketing, web technologies, system administration, software development, web design, and graphics design. Anything less than a professional approach in any of these areas could mean embarrassment for the company. For this reason, companies typically either hire specialists in these areas or contract the work to professional ecommerce hosting companies.

### **Ecommerce Technologies Topics**

- Electronic Data Interchange (EDI)
- Ecommerce Host
- Ecash

## Electronic Data Interchange (EDI)

**Electronic data interchange (EDI)** uses private communications networks called value-added networks (VANs), as well as secure Internet technologies, to transmit standardized transaction data between business partners and suppliers.

### Why This Matters

Long before the birth of the Internet, businesses and banks recognized the need for transferring funds electronically. Electronic data interchange was developed to meet this need. Today EDI flourishes, supporting secure transactions over both private value-added networks and the Internet.

### Essential Information

In the 1970s and 1980s, businesses extended their computer-based information systems beyond their corporate walls to connect with other companies' systems, using electronic data interchange (EDI). EDI utilized private network services called *value-added networks*, or *VANs*, provided by telecom companies to transfer financial transactions safely and securely. Automating transactions using EDI drastically reduced the amount of paperwork and the need for human intervention. This was the true beginning of ecommerce, even if it would take another 20 years for the term to be coined.

Even though it improved transactions between businesses, EDI had some problems and was costly. Only businesses that paid for a VAN connection could participate. For ecommerce to really take off, businesses and people needed an inexpensive universal network to which everyone could connect. The Internet provided the ideal platform for conducting EDI transactions as well as other forms of transaction processing between businesses. The web provided the first opportunity for businesses to conduct transactions with consumers over a computer network. Businesses and consumers alike embraced doing business online. The far-reaching implications of the web as a tool for executing business transactions soon became clear.

Many B2B transactions still take place over EDI networks. As mentioned earlier, there is a growing trend for EDI transactions to take place over the Internet, rather than over private networks. Walmart requires its more than 10,000 suppliers to implement Internet-based EDI. EDI enables Walmart to place product orders directly to a supplier's information systems without human intervention. In some cases, these orders can be automatically placed by software that recognizes when inventory becomes low. The convenience of automating B2B transactions saves buyers and sellers significant time and money.

## Ecommerce Host

An ecommerce **host** is a company that takes on some or all of the responsibility of setting up and maintaining an ecommerce website and system for a business.

### Why This Matters

Setting up and maintaining the infrastructure necessary for ecommerce is a big job. Most companies choose to outsource these tasks to professional ecommerce hosting companies. Hosting companies manage large servers that provide all the necessary software tools to deliver ecommerce applications, including an online catalog, a shopping cart, and transaction processing. Ecommerce hosting sites maintain backups of online data and guarantee an extremely high percentage of uptime—time that the system is functioning without problems—typically above 95%. Many hosting companies also offer online marketing strategies to help ecommerce sites succeed. Put simply, ecommerce hosting sites are often better equipped to deliver a quality online presence than the businesses they serve.

### Essential Information

Hosting services range in price from under ten dollars a month to thousands of dollars per month, depending on the size of the business and the services offered by the host. Companies such as Shopify provide everything needed for a simple ecommerce online business—online catalog, shopping cart, and transaction processing—beginning at about \$29.95 per month. For more money you can get more storage space, accommodations for larger inventory (stock-keeping units or SKUs), lower transaction fees, and additional services. See the table below for some of the options for typical ecommerce hosting services.

Very large companies with more complicated systems might contract IBM or Sprint to work with their business to develop web ecommerce solutions at a considerably higher cost. For example, Office Depot contracted IBM to design and implement a complex web-based system that would accommodate transactions with customers and businesses.

Whether you are creating and implementing your own ecommerce website or contracting the work out to a professional ecommerce hosting company, you need to understand the basics of ecommerce infrastructure, hardware, networking, and software issues. You also need to have a grasp of how to build website traffic, electronic payment systems, and international markets, as well as understand the information security and privacy issues involved.

**Table: Example Web Hosting Packages**

Feature	Basic	Pro	Business	Unlimited
Monthly fee	\$29	\$5	\$99	\$179
Bandwidth	Unlimited			
Storage	1 GB	5 GB	10 GB	Unlimited
SKUs	100	2,500	10,000	Unlimited
Transaction fee	2%	1%	1%	0%

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## Ecash

**Ecash** or **electronic cash** is a web service that provides a private and secure method of transferring funds from a bank account or credit card to online vendors or individuals.

### Why This Matters

Ecash (also called emoney, electronic cash, electronic currency, digital money, digital cash, or digital currency) facilitates online payments in situations where buyers or sellers are unable to participate in a standard credit card transaction. Ecash also provides a method for buyers to make purchases without sharing their credit card number or other private information with the seller. Ecash expands ecommerce to individuals who might not otherwise be able or willing to participate.

### Essential Information

In most ecommerce transactions, the customer typically pays with a credit card number (B2C) or a merchant account number (B2B). Using a secure encrypted connection, the buyer enters the account information into a web form and submits it. The merchant's web server passes the information along to the payment processing system, which checks the validity of the account number and the balance in the account. If the credit card checks out, the transaction is processed. The only difference between online credit card processing and in-store processing is that laws require online retailers to wait until shipping the product to deduct funds from the credit card. Because of this, retailers put a hold on the funds until the product is shipped, at which time the funds are transferred.

Electronic cash or ecash is a web service that provides a private and secure method of transferring funds from a bank account or credit card to online vendors or individuals. Ecash has three fundamental benefits. It provides:

- Privacy by hiding your account information from vendors (the ecash provider is the only one who knows this information)
- A method for ecommerce transactions in circumstances where the seller cannot process a credit card or the buyer does not have a credit card
- Elimination of the need to carry a wallet

Mobile phone makers and cellular providers are working to replace physical wallets with software on your phone referred to as a digital wallet, electronic wallet, or ewallet. Google Wallet software utilizes Android phones with near field communication technology, such as RFID, to allow shoppers to swipe their phone at checkout to pay for items. With Google Wallet, as well as with products from Apple, Square, Microsoft, PayPal, and others, shoppers can pay for products by clicking a button in a mobile app. The idea is to store a user's financial data, such as credit card information, online with one service. That service can then be used to conduct transactions that take place both online and in stores using an app. Even Amazon and Facebook are getting into the ecash payment business, allowing customers to pay for items using their Amazon or Facebook login.

One of the biggest roadblocks to ecash and ewallet technologies is fear. Users are concerned about their financial information being stolen, as well as about companies like Google gaining access to too much private information. However, storing financial information with one online company is likely more secure than providing it directly to hundreds of online retailers with whom a person does business. It's certainly more secure than carrying it around on a plastic card in your wallet. As people begin understanding this, ewallets are certain to take off, most likely in the very near future.

## Business Systems

**Business systems** are computer-based information systems that provide organizations with valuable information in a timely and effective manner to allow the functional areas of the enterprise to work together to achieve goals.

### Why This Matters

Decisions lie at the heart of just about everything people do. It is impossible to get through a day without making many decisions—some large, some small. In our careers, some decisions can have great significance and affect many other people. Business systems are designed to collect, store, and disseminate information needed to make good business decisions in all types of jobs and all types of professions.

### Consider This

Retail giant Macy's adopted business analytics software to help analyze its online marketing efforts. The software provided reports to Macy's decision makers that allowed the company to implement changes that reduced the amount of email advertising it sent out while increasing the number of customer visits to its website. Macy's was able to save \$500,000 a year by automating the process of collecting and analyzing data.

Macy's isn't alone. The Venetian Resort in Las Vegas analyzes business and market data to project future revenue, adjusting its rates to keep occupancy high even during off seasons and when the economy hits a slump. The Palo Alto Medical Foundation Research Institute and other health organizations use information systems to study the spread of diseases among specific populations.

The world's financial health is dependent on an information economy. Businesses generate profits based on how well they collect, interpret, and act on information. Not only do businesses depend on the flow of information, but governments, nonprofit organizations, research institutes, and others also benefit greatly from information management and analysis. As you read this chapter, consider what information is useful for professionals in areas that interest you. How have the leaders in those industries profited from collecting and interpreting information?

### Essential Information

There are many different business systems designed for various types of businesses, various functional areas within business, and different activities within business processes. For example, a transaction processing system, or TPS, is a business information system used to support the process of making a purchase; a management information system, or MIS, provides all types of factual information to managers to assist them with decisions; and an enterprise resource planning, or ERP, system is designed to connect all of the information systems within a business into one cohesive system.

This section covers the most common types of business systems used in today's businesses and organizations and discusses how those information systems are developed. Whether you intend to work in a large organization, be part of a small to medium size business, or run your own business, knowledge of business systems is essential to your success.

### **Ethical Dilemmas**

Information systems are able to “connect the dots” from many data sources to provide insight into otherwise neglected facts. While this process is often unobtrusive—such as tracking market trends—it can at times intrude into individuals' lives. Businesses and governments are able to piece together information from many sources to build a detailed profile of an individual. Since most significant actions that people take are recorded digitally through business transactions, government records, and online activity, today's information economy is slowly but surely eroding privacy. Although businesses may be able to offer customers a higher level of service through targeting their interests, many feel that their privacy is being violated in the process.

When information systems “go bad,” they have the potential for causing major problems. Bugs in information systems, as well as human error and threats to information security, can result in identity theft, fraud, financial loss, and serious damage to a business. Some worry that society has become overly dependent on information systems and will ultimately pay the price.

### **Business Systems Topics**

- Information Management
- Enterprise Systems

## **Information Management**

**Information management** refers to software and computer-based systems dedicated to collecting, storing, and manipulating data in a manner that produces useful information on which to base decisions.

### **Why This Matters**

If there is one lesson in business that has proven to be important, it is that information is power. In business, government, or any goal-oriented endeavor, the more accurate the information you have to work with, the more efficiently and effectively you will reach your goals. The challenge is in discovering which data is important and which is insignificant. As shown in the accompanying video, this is the era of “big data,” where our online dealings and transactions are generating enormous amounts of data each day. Our ability to collect and analyze that data to

produce actionable information has become increasingly difficult, but remains one of the most valuable business activities.

### **Essential Information**

There are thousands of different types of systems designed to manage information—millions if you count the custom-designed systems that are used in many businesses. However, most can be classified under one of four general headings: transaction processing systems, management information systems, decision support systems, and expert systems.

These four types of systems build one upon the other and become more complex and intelligent to serve various purposes, as shown in the opening figure on this page. A transaction processing system (TPS) serves as a foundation to the other systems. It collects information about transactions, including the sale of merchandise and services, the salaries paid to employees, and purchases of raw materials. A management information system (MIS) draws information from the database of transactions and other sources to inform managers of the state of operations such as inventory amounts, sales statistics, and product performance. A decision support system (DSS) draws on information from an MIS, a TPS, and other sources to provide problem-specific information to assist decision makers. An expert system applies artificial intelligence techniques, drawing from information provided from other systems, to aid higher-level decision making.

Since expert systems fall under the heading of artificial intelligence, they are covered in the AI section of *Emerge with Computers*. Other types of information management systems that are having a global impact include geographic information systems and medical and biological informatics.

### **Information Management Topics**

- Transaction Processing System
- Management Information System
- Decision Making
- MIS Reports
- Business Intelligence
- Decision Support System
- Geographic Information System
- Informatics

### **Transaction Processing System (TPS)**

A **transaction processing system (TPS)** is an information system used to support and record transactions such as paying for products or paying an employee.



## Why This Matters

Transaction processing takes place in many different environments, and the systems that support them are created to suit the environment. The electronic checkout system at Amazon.com is a TPS, as is the checkout system at your local bookstore or grocery store. The payroll system that calculates an employee's pay and cuts a check is also a TPS. The ATM at your bank is a TPS, as is the keypad on a gas station filling pump. The TPS is the foundation of today's economies.

## Essential Information

A *transaction* is a commercial exchange involving goods, services, and/or money, such as buying medical supplies for a hospital or purchasing and downloading music on the Internet. A transaction processing system (TPS) is an information system used to support and record transactions, such as paying for products or paying an employee. The transaction information collected by the TPS is fundamental to the operation of other information systems that support important decision making. For example, the company contracted to provide food services for a college campus uses a TPS to collect sales information from the cashier's point-of-sale terminal in the school cafeteria. That sales information is then processed by another information system, such as a management information system (MIS), to determine which food items are selling best. Items that aren't selling may be either discounted or discontinued and replaced with new items. Through this approach, the food service provider can use the transaction information to continuously improve its service to customers and its profit margin.

There are two methods of processing transactions: batch and real-time. In *batch processing*, transactions are collected over time and processed together in batches. Batch processing is useful in situations where transactions take place away from the computer system, or when processing would slow down the collection of transaction data. However, with pervasive wireless technologies and new transaction technologies like Square— which allows anyone to process credit card transactions online—, there are few places where transactions cannot be recorded at the time and point of sale.

With *real-time transaction processing*, the processing takes place at the point of sale. Real-time processing is especially important for time-sensitive merchandise. Concert tickets, flight reservations, and course registrations are all examples of transactions that must be recorded at the point of sale. If there is any delay between the time the sale is confirmed and recorded, there may be double-booked seats and over-booked flights.

All forms of transaction processing systems share a common set of activities called the *transaction processing cycle*. The stages of the transaction processing cycle include the following:

1. Data collection: Capture transaction-related data such as item number, quantity, and payment method

2. Data editing: Check validity of the data entered such as whether the item number and credit card number are valid
3. Data correction: Request correction if data editing reveals invalid data
4. Data manipulation: Process the transaction data and calculate totals, tax, shipping, etc.
5. Data storage: Store transaction-related data in the transaction database
6. Data output: Output receipts, picking lists for the warehouse, or other documents

The two primary categories of TPS are order processing systems and purchasing systems. An *order processing system* supports the sale of goods or services to customers and arranges for shipment of products. A *purchasing system* supports the purchase of goods and raw materials from suppliers for the manufacturing of products.

In each step of the process and in each subsystem, vendors strive to carry out the action in a streamlined manner with the least amount of effort and cost and the highest amount of speed and quality. In this way, transaction processing systems can assist a business in gaining an edge over the competition.

## Management Information System (MIS)

A **management information system** or **MIS** provides routine business information to decision makers in a useful and convenient format.

### Why This Matters

The primary purpose of an MIS is to help individuals, businesses, and organizations achieve their goals by providing reports and information to make better decisions. Individuals, for example, might want to get reports from their doctor on the results of a routine physical exam. A business manager uses MIS reports to maintain inventory levels so that there are no shortages or surpluses. By filtering and analyzing highly detailed data, an MIS can provide information to help people and businesses make important decisions.

### Essential Information

An MIS is fueled by databases. It pulls data from one or more databases, sorts and sifts the data based on specific criteria, and produces reports of useful information. The primary source of input for a business MIS is its transaction database. Transaction processing systems record data in a database for every transaction within a business—credits and debits. An MIS can mine transaction data for interesting trends and important statistics. For example, a hotel chain may find that occupancy at its hotels that provide free wireless Internet access is 8 percent higher than in locations where there is a fee for Internet access. Using this information, management may determine that the money made from Internet access is not as

much as would be gained by an 8 percent increase in occupancy, and begin offering free Wi-Fi at all hotel locations.

An MIS is also sometimes dependent on external data. External data may be stored on databases within the organization or in an external database. For example, a supplier may use an MIS that connects to a database of its customers in order to monitor inventory levels and deliver products just in time.

The output of most management information systems is a collection of reports, as shown in the figure. These reports can be produced on paper, and increasingly, distributed and viewed electronically. The main types of reports produced by an MIS are scheduled reports, demand reports, key-indicator reports, and exception reports.

Management information systems are often designed to meet specific needs within an organization. For example, Oracle's BI (for Business Intelligence) products include Financial Analytics, Human Resources Analytics, Supply Chain Analytics, Order Management Fulfillment Analytics, Sales Analytics, and Marketing Analytics. They provide each department within a business a foundation on which to manage effectively. For example, supply chain management (SCM) systems have become a necessity for businesses looking to streamline production. These systems allow a business to manage resources involved in taking a product from manufacturing to the customer's hands. SCM includes acquiring raw materials, manufacturing, shipping, and warehousing. Customer relationship management (CRM) systems are used by many businesses to gauge customer satisfaction and to respond to customer issues.

The term MIS is also frequently used to encompass all computer-based information systems. For example, many colleges offer degrees in MIS (see video), and there are many MIS professional and research organizations that focus on all issues surrounding IT and business information systems.

## Decision Making

**Decision making** is the key component of the problem-solving process that takes place in three stages: intelligence, design, and choice.

### Why This Matters

One of the highest compliments is to be recognized by your friends and coworkers as a real problem solver. In general, problem solving is the most critical activity an individual or organization undertakes. It makes the difference between success and failure, as well as between profit and loss. Computer-based information systems are extremely valuable to individuals, businesses, and organizations in their support of making the best decisions. To understand how information systems support the decision-making process, it helps to understand the process itself.

## Essential Information

Individuals, businesses, and organizations must make decisions in order to solve problems and take advantage of opportunities. The process of problem solving begins with decision making. Decision making takes place in three stages: intelligence, design, and choice. Problem solving includes and goes beyond decision making to implement a solution and monitor the situation.

1. Intelligence stage: In the intelligence-gathering stage, problems and opportunities are identified and defined. Information is gathered that relates to the cause and scope of the problem or opportunity. The problem or opportunity environment is investigated, and things that might constrain the solution are identified.
2. Design stage: During this stage, alternative solutions to the problem are developed. In addition, the feasibility and implications of these alternatives are evaluated.
3. Choice stage: This stage involves selecting a course of action.
4. Implementation stage: In this stage, action is taken to put the solution into effect.
5. Monitoring stage: In this stage, the decision makers evaluate the implementation of the solution to determine whether the anticipated results were achieved and to modify the process in light of new information learned during the implementation stage. The monitoring stage involves a feedback and adjustment process.

Individuals and organizations can use a reactive or proactive approach to problem solving. With *reactive problem solving*, the problem solver waits until a problem surfaces or becomes apparent before any action is taken. With *proactive problem solving*, the problem solver seeks out potential problems before they become serious. Both reactive and proactive problem solvers can turn problems into opportunities, but taking a proactive approach means you can identify opportunities earlier and exploit them faster. In reality, most organizations and individuals use a combination of reactive and proactive problem-solving approaches.

In the choice stage, a number of factors influence the decision maker's selection of a solution. One factor is whether or not the decision can be programmed.

*Programmed decisions* are ones that are made using a rule, procedure, or quantitative method. Programmed decisions are easy to automate using computer systems. It is simple, for example, for a clothing shop to program a computer to order more t-shirts when inventory levels fall to 10 units or less. Management information systems are often used to support programmed decisions by providing reports on problems that are routine and where the relationships are well defined; these types of problems are called *structured problems*.

*Nonprogrammed decisions*, however, deal with unusual or exceptional situations. In many cases, these decisions are difficult to represent as a rule, procedure, or quantitative method. Determining the appropriate training program for a new

employee and weighing the advantages and disadvantages of various diets are examples of nonprogrammed decisions. Nonprogrammed decisions require human knowledge or software that has human knowledge embedded in it. Decision support systems and expert systems are used to solve a variety of nonprogrammed decisions in which the problem is not routine and rules and relationships are not well defined. These are called *unstructured problems*.

Optimization and heuristic approaches are popular problem-solving methods used in decision support systems. An *optimization model* finds the best solution, usually the one that will best help individuals or organizations meet their goals. For example, an optimization model can find the best way to schedule nurses at a hospital. Airlines use optimization to create flight schedules that provide the best return on investment. Optimization models utilize problem constraints. A limit on the number of available work hours in a manufacturing facility is an example of a problem constraint.

*Heuristics* are used in decision making to define commonly accepted guidelines or procedures that usually find a good solution, but not necessarily the optimal solution. A heuristic procedure used by baseball team managers is to place those batters most likely to get on base at the top of the lineup, followed by the “power hitters” who’ll drive them in to score. An example of a heuristic used in business is to order a four-month supply of inventory for a particular item when the inventory level drops to 20 units or less.

## **MIS Reports**

**MIS reports** present useful information for management, often compiled by querying a database.

### **Why This Matters**

Reports of various types have become an integral part of both professional and personal life. Results from online searches are actually a type of report culled from online databases. A reminder from your dentist that it is time for a checkup is another kind of report. Credit reports are used to evaluate the financial reliability of borrowers. Businesses have many different types of standard reports, like quarterly earnings reports, that are used to assess the financial state of the business and plan for the future.

### **Essential Information**

Reports are the primary output of management information systems. There are several kinds of reports to accommodate different information needs. Reports may be printed or displayed. They may include lists of figures, or graphs and charts. The general classifications of reports produced by an MIS are scheduled reports, demand reports, and exception reports.

*Scheduled reports* are produced periodically or on a schedule, such as daily, weekly, or monthly. An investor can receive monthly statements summarizing the performance of his or her stock and bond holdings. A student receives a report at the end of each semester or quarter summarizing his or her grades.

A *key-indicator report*, a special type of scheduled report, summarizes the previous day's critical activities and is typically available at the beginning of each workday. The president of the United States, for example, receives daily reports in the morning on national security, terrorism, the economy, and many other areas.

*Demand reports* are developed to retrieve certain information at a person's request. In other words, these reports are produced on demand. A Starbucks manager, for example, may want to know how Caff  Latte sales compare to Caff  Mocha sales.

*Exception reports* are automatically produced when a situation is unusual or requires action. For example, a patient will get an exception report from a clinic only if a blood test shows a possible problem.

The following table lists the types of reports associated with the various functional units of a business. This illustrates that MISs are integrated with all areas of an organization's operations.

**Table: Types of MIS Reports**

Business area	Reports
Financial	<ul style="list-style-type: none"> <li>• Payables</li> <li>• Receivables</li> <li>• General Ledger</li> <li>• Profitability</li> </ul>
Human Resources (HR)	<ul style="list-style-type: none"> <li>• Compensation</li> <li>• HR Performance</li> <li>• Retention Workforce Profile and Compliance</li> </ul>
Order Management and Fulfillment	<ul style="list-style-type: none"> <li>• Business Performance</li> <li>• Billing</li> <li>• Order Fulfillment</li> </ul>
Supply Chain	<ul style="list-style-type: none"> <li>• Procurement and Spending</li> <li>• Supplier Performance</li> <li>• Inventory</li> </ul>
Sales	<ul style="list-style-type: none"> <li>• Profits by Product</li> <li>• Profits by Customer</li> <li>• Competition Analysis</li> </ul>
Service	<ul style="list-style-type: none"> <li>• Service Effectiveness</li> <li>• Employee Effectiveness</li> <li>• Customer Insight</li> </ul>
Contact Center	<ul style="list-style-type: none"> <li>• Customer Service</li> <li>• Agent Performance</li> <li>• Service and Delivery Cost</li> <li>• Contact Center Sales</li> </ul>

Marketing	<ul style="list-style-type: none"> <li>• Marketing Planning</li> <li>• Campaign Performance</li> <li>• Customer Insight</li> </ul>
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## Business Intelligence (BI)

**Business intelligence (BI)** refers to technologies that are used to gather and report information that supports intelligent business decision making.

### Why This Matters

BI is a contemporary term for an MIS designed for specific business needs. BI has become a buzzword in business because of its ability to propel a company forward. Good business intelligence makes for smarter decision making, giving a company a strong competitive advantage.

### Essential Information

The information produced in MIS reports is commonly referred to as business intelligence. Business intelligence provides important support for decision making. Business intelligence often focuses on *key performance indicators (KPIs)* to analyze a business's health. KPIs are statistics that provide insight into the state of a business such as sales figures and inventory turnover. Many corporations have adopted the term business intelligence to label their MISs. For example, Oracle has a division called Oracle Business Intelligence, Microsoft has SQL Server Business Intelligence, and IBM has Data Warehousing and Business Intelligence. Some argue that Business Intelligence differs from MIS in that it not only provides reports, but also provides the ability to forecast the future based on past events. In this manner, BI can act as a bridge between MIS and Decision Support Systems.

Some business intelligence systems display key-indicator data together on one page in a format called an *executive dashboard*. Executive dashboards can display graphs and charts and allow the users to drill down into the data to view more detailed reports. Management information systems providers such as Cognos, SAS, IBM, and Oracle provide real-time reporting through a dashboard-style display that allows decision makers to stay connected to dynamic changes in the business.

## Decision Support System (DSS)

A **decision support system (DSS)** is an information system used to support problem-specific decision making.

## Why This Matters

Unlike a management information system, or MIS, which supports decisions related to structured problems through database queries, a DSS focuses on decision-making effectiveness when faced with unstructured or semistructured problems. A decision support system assists people and organizations with all aspects of decision making. The DSS approach realizes that people, not machines, make decisions. DSS technology is used primarily to support making decisions that can solve problems and help achieve individual and organizational goals.

## Essential Information

As you can see from the list of DSS characteristics below, a DSS is “smarter” than an MIS. It is smarter in that it applies calculations, formulas, and sometimes mathematical models to data in order to reach conclusions (e.g., “Moving operations to Austin will provide higher revenues over five years than moving to Boston”). An MIS does little in the way of modeling data to analyze results, but instead provides the information from corporate databases that decision makers can then use to make calculations and models. With an MIS, the human user carries out the bulk of the calculations based on specific and valuable facts provided by the MIS. With a DSS, the system performs many of the complicated calculations required in the problem-solving activity. DSS capabilities are built into various Business Intelligence (BI) and Business Analytics products from SAS, IBM, Oracle, Microsoft, and others.

For a system to be more intelligent than a DSS, artificial intelligence (AI) techniques would have to be leveraged to give the system the ability to reach conclusions and offer advice, even with insufficient information on which to base a decision. These systems are called expert systems and are used to support specialized tasks for businesses, organizations, and individuals. Expert systems are covered in the Artificial Intelligence portion of *Emergence with Computers*.

**Table: DSS Characteristics**

DSS Characteristic	Explanation
Handle a range of data from small amounts to large amounts	From assisting individuals in selecting the best auto insurance, to assisting trading firms in performing sophisticated analyses on huge amounts of financial data, DSSs handle a wide range of problems.
Obtain and process data from different sources	DSSs may use information from small personal databases, large mainframe systems, or Internet sources to help solve problems.



Provide report and presentation flexibility	DSSs are more flexible than TPSs or MISs in reporting and presenting information to meet the full variety of decision makers' information needs.
Perform complex, sophisticated analyses and comparisons, using advanced software packages	Many of the analytical programs associated with a DSS are actually standalone programs. The DSS provides a means of bringing these together to combine and focus their strengths on one particular decision.
Support optimization and heuristic approaches	For smaller problems, decision support systems have the capability to find the best (optimal) solution. For more complex problems, heuristics are used.
Perform "what-if" and goal-seeking analysis	<i>What-if analysis</i> is the process of making hypothetical changes to problem data and observing the impact on the results. <i>Goal-seeking analysis</i> is the process of determining what problem data is required for a given result. DSSs use both techniques to find solutions to different types of problems.
Simulate various scenarios	With simulation, the DSS attempts to mimic an event that could happen in the future to test a variety of solutions and determine which has the best probability of succeeding.

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## Geographic Information System (GIS)

A **geographic information system (GIS)** captures, manages, analyzes, and displays geographically referenced information, often utilizing maps with overlaid data.

### Why This Matters

Geographic information systems allow researchers in many professions to relate abstract data to physical locations in order to understand the interplay between conditions on the ground and situations or phenomena represented by the data. GISs are useful to everyone, but they are particularly useful to professionals who work with populations or geographic phenomena and data, such as urban planners,

social workers, law enforcement personnel, sociologists, geologists, meteorologists, civil engineers, and those who work in government agencies.

### **Essential Information**

A map is the quintessential GIS, relaying geographical information—city locations, roads, distances between cities, elevations, and other information—on a graphical representation of the earth. GISs typically overlay maps with data and information related to the geographic locations. The virtual earth applications from Microsoft and Google are popular GISs. Using satellite imagery as a foundation, Google Earth and Microsoft's Bing Maps overlay different types of geographic information, such as roads, traffic density, items of interest, weather, and different types of businesses. With the advent of GPS in mobile phones, GIS has gone mobile, providing travelers and pedestrians with directions and information on nearby businesses, attractions, and even friends.

Another common GIS use is in the maps that illustrate weather patterns on your local weather channel or news program. There are also a multitude of special-purpose uses of GIS. A 911 operator uses a GIS to quickly determine the specific location of a caller with an emergency. Businesses use GISs to display sales information for a specific region of the country. The military uses GISs along with GPSs (global positioning systems) to target enemy forces. GISs are used to observe scientific phenomena, to assess the environmental impact of social action, to assist in urban planning, to assist law enforcement in identifying high-crime areas, to create effective marketing strategies, and to do many other professional activities.

GIS software is an important tool for professionals in geography, meteorology, urban planning, criminology, and social sciences. Learning to use GIS software, such as Autodesk and packages developed by Esri, consumes large quantities of time for students studying in these areas.

## **Informatics**

**Informatics** applies computer-based information system technologies to support traditional disciplines such as science and medicine.

### **Why This Matters**

Traditionally, computer-based information systems have had a business focus—, to provide information to decision makers to help their companies gain a competitive advantage. Today, professionals in many nonbusiness disciplines are utilizing computer systems to manage different types of information. Although informatics is a term that can be applied to all types of information systems, it is primarily used to describe the use of information systems in nonbusiness areas. Informatics is particularly popular in the sciences, where it is revolutionizing research in biology and helping to organize medical recordkeeping.

## Essential Information

Bioinformatics and medical informatics are two areas where informatics has had a large impact.

*Bioinformatics* combines biology and computer science. Also called computational biology, bioinformatics has been used to map the human genome and conduct research on biological organisms.

*Medical informatics* combines traditional medical research with computer science. Medical informatics seeks to reduce medical errors and improve healthcare delivery by using computer systems and technology.

Other areas of informatics include astroinformatics, organizational informatics, biodiversity informatics, cheminformatics, ecoinformatics, geoinformatics, neuroinformatics, and social informatics.

Many schools offer a degree in informatics, one that typically combines studies in a particular discipline (i.e. psychology) with studies in computing and information technologies in order to apply the technology to the particular discipline.

## Enterprise Systems

**Enterprise systems** are information systems designed to support the functions of an enterprise, including knowledge management, content management, and customer relationship management as well as the integration of such systems into enterprise resource planning systems.

### Why This Matters

Whether a business has only a few employees or is a global corporation with thousands of employees, it is important that everyone in the business have access to a common pool of information, preferably through a common user interface. Enterprise systems are designed to provide that common information framework. *Enterprise* is another word for business, but often it connotes a large, complex business with many interacting business units. Although enterprises are often very large global businesses, the information management practices of a large enterprise can also benefit smaller businesses. In fact, enterprise systems might be used in many sizes of business.

## Essential Information

In the several decades that computer-based information systems have been around, the role that they play in business has changed from supporting business processes to being an integral part of the process that businesses depend on to create and add value to their products and services. Today, information systems often control business processes, and good information systems provide a framework for best

practices in business management. Information system developers pride themselves on understanding key elements of business practices that are most valued in an enterprise, and they design systems that provide innovative processes to give a business a competitive edge.

Information systems such as knowledge management, content management, and customer relationship management can make or break a business. These systems are considered enterprise systems because they are fundamental to an enterprise. An enterprise resource planning system is the ultimate information system in an organization because it integrates all enterprise systems into one centralized system. A structured systems development process is often used by businesses to create and maintain information systems, and project management

### **Enterprise Systems Topics**

- Knowledge Management
- Customer Relationship Management
- Enterprise Resource Planning
- Systems Development
- Project Management

## **Knowledge Management (KM)**

A **knowledge management (KM)** system assists an organization in capturing, storing, and distributing knowledge for use and reuse by the organization and, sometimes, its partners and customers.

### **Why This Matters**

Knowledge is much more valuable to the world when it is shared. Unfortunately, much of what people learn remains untapped because they don't have the opportunity to share it. In a business environment, this can be costly. Training new employees is time-consuming and expensive. The longer an employee stays with a company, the more valuable the employee becomes because of the acquisition of corporate knowledge. If and when an employee leaves the company, it is a costly loss for the enterprise unless the knowledge the departing person has acquired can somehow remain in the enterprise. Knowledge management systems allow people to share and disperse their knowledge to help propel the group forward.

### **Essential Information**

In the mid-1990s, it was recognized that organizational knowledge existed primarily in the minds of employees, and that there was a need to record and dispense this knowledge in a way that benefited the organization. Thus, knowledge management systems were born. When individuals in an organization share their insight, it allows others with less experience or skill to learn and become more valuable to the

organization. Also, the ability to share knowledge with partners and customers fosters good communication and relationships. Although there are nontechnological approaches to knowledge management, technology has become key to collecting and distributing knowledge, and to providing communications channels between knowledge holders and knowledge seekers. The term *knowledge worker* originated in the field of knowledge management.

Knowledge management systems are diverse. All information systems assist in managing knowledge to some extent. Some are more directly focused on dispersing knowledge. Many businesses use knowledge management systems that include social networking features to more easily allow members of the organization to post their knowledge and experiences.

Some businesses and organizations provide a knowledge base that can be queried to find solutions to product or service related issues. Citrix Systems, Inc., a networking software company, set up an online knowledge base for its customers that reduced calls to its call centers by 30% within the first month.

Other companies are experimenting with wikis that act as knowledge bases for corporate information. A collaborative framework like a wiki provides an ideal tool for collecting and sharing knowledge in an organization. A number of software companies like Traction Software and Atlassian have built businesses around developing enterprise wiki software for the purpose of corporate knowledge management.

A knowledge base often includes all of the above, merging Web 2.0 social technologies, social networking, blogs, and wikis with traditional MIS and DSS systems that provide reports and charts with critical information. These services are usually provided through one central desktop portal that employees can access throughout the work day.

## **Customer Relationship Management (CRM)**

**Customer relationship management (CRM)** refers to the use of information systems to store detailed information on prospective, current, and past customers to improve customer service and support targeted marketing.

### **Why This Matters**

With competition in all businesses and industries at its peak, businesses and enterprises are turning to high levels of customer service to win customer loyalty. Customer relationship management (CRM) systems allow a business to track all interactions with customers, including in-store, by phone, and online, to better understand a customer's interests and needs so that they may be fulfilled.

## Essential Information

Customers appreciate personalized attention. That's the key to CRM. CRM ensures that employees within an organization are equipped with the information necessary to treat a customer like an old friend, – even if they've never met the customer before.

A good CRM system records all customer interaction with a business. Information on one particular customer can be accessed and entered by personnel from across an organization. Information can also be gathered automatically, such as when a customer interacts with the company's online website. For example, when Bob Butterworth phones Sunshine Electronics customer support, the operator can quickly pull up Bob's record to see that Bob phoned two weeks ago and ordered a new HDTV, and deduce that this call is probably in reference to the TV. Also, Bob has spent a considerable amount of time on the Sunshine Electronics website looking at surround sound systems; perhaps the operator could interest Bob in a special deal on a new sound system.

Businesses that implement CRM systems have found significant increases in the level of customer satisfaction and retention, along with reduced operating costs. CRM systems support many areas of an enterprise, including market research, sales, marketing, customer support, and product development. CRM system developers are quick to point out that CRM software by itself will not improve customer satisfaction. CRM should be approached holistically with a heavy emphasis on training personnel on how to interact with customers.

## Enterprise Resource Planning (ERP)

An **enterprise resource planning (ERP)** system integrates all data processing in a corporation (enterprise) into one unified system that draws from a central database system to streamline the flow of information throughout an enterprise and provide greater efficiencies and savings.

### Why This Matters

As information systems and technologies have advanced, many businesses haphazardly adopted the latest and greatest technologies and eventually found themselves with overly complex systems that were expensive, difficult to maintain, and complicated to use. Many businesses found themselves dependent on several information systems designed for various business units by different vendors with a variety of compatibility issues. Enterprise resource planning is used to overhaul an information infrastructure to create one integrated system that streamlines the flow of information throughout the enterprise, allowing decision makers to implement cost-saving efficiencies.

## Essential Information

An ERP system for a large business includes components for manufacturing, supply chain management, financials, projects, human resources, customer relationship management, and data warehousing. All of these systems share data, have a standardized user interface, and are centrally administered and maintained.

*Supply chain management* refers to the control of a product's development process through the supply chain, which includes acquiring raw materials for manufacturing, the manufacturing process itself, shipping, storage in warehouses, delivery to vendors, vendor inventory, sales, and after-sales support. ERP is valuable in part for its role in streamlining communication and information across the supply chain. For example, an ERP could inform a customer service representative of how long it will take for a replacement part to be shipped based on on-hand inventory amounts and a supplier's backlog. But ERP does much more than just manage the supply chain; it can include many other useful information systems.

Over the past decade, many corporations have implemented ERP systems with dramatic results. As you might imagine, adopting an ERP system is a major undertaking. Every information system in the organization is studied and redesigned. Old systems are gradually retired while the new systems are activated. For a large business, the process takes years and millions of dollars. Typically, a corporation contracts a professional ERP vendor to manage the design and installation of the system. Popular vendors include Oracle, Microsoft, IBM/Cognos, SAS, and SAP BusinessObjects. When the transition to an ERP system is complete, employees find that they can accomplish much more in less time.

**Table: Benefits and Drawbacks of ERP Systems**

Benefits	Drawbacks
<ul style="list-style-type: none"> <li>Improved access to data throughout the enterprise with less redundancy</li> <li>Elimination of outdated disparate systems</li> <li>Streamlined work processes</li> <li>Simplified maintenance or unified system</li> <li>Improved communication between functional areas</li> <li>Better corporate performance offering a competitive advantage</li> </ul>	<ul style="list-style-type: none"> <li>Expense in time and money</li> <li>Learning curve and employees' resistance to change</li> <li>Dependence on one vendor</li> <li>Failure is not an option—it typically means the collapse of the business</li> </ul>

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## Systems Development

**Systems development** is the activity of creating new or modifying existing information systems.

## Why This Matters

Information systems are developed to solve the problems of individuals, businesses, and organizations. Everyone who interacts with software and information systems should be involved with the process of systems development so that new systems are effective and efficient. Once the domain of systems analysts and computer programmers, systems development is now taking place at all levels of business, in a variety of environments, involving all types of professionals.

## Essential Information

Systems development efforts can range from a small project, such as purchasing inexpensive computer software, to a major undertaking, such as installing a huge system that includes hardware, software, telecommunications systems, and databases, and which requires new computer systems personnel. Some systems development projects can involve an investment of millions of dollars but are designed to create a quick return on investment (ROI). For example, in a multimillion-dollar systems development project, Verizon Wireless integrated 13 billing systems into one to support 62 million customers and 30,000 call center agents across the country, reducing operating costs by 15 to 20% and saving Verizon \$20 million a year.

Organizations have used different approaches to developing information systems. In some cases, these approaches are formalized and captured in volumes of documents. In other cases, less formal approaches are used. The steps of systems development vary from one organization to the next, but most approaches have six common phases: investigation, analysis, design, implementation, maintenance, and review. Combined, these stages are referred to as the *systems development life cycle (SDLC)*.

The systems development process is an ongoing and cyclic activity. Once a system is developed, it is reviewed and revised as needed over the life of the system. Systems investigation and analysis look at the existing system and determine if it can and should be improved. Systems design and implementation involve modifying an existing system or developing a new one and placing it into operation. Finally, maintenance and review make sure that the new or modified system is operating as intended.

At the conclusion of each stage of the SDLC, a report may be generated to review the progress of the project. It may be decided that the project must return to a previous stage to be reworked or perhaps even scrapped. If all is going well, the project is given the green light to continue on to the next stage of development.

Many people take part in the systems development process. A *systems analyst* is a professional who specializes in analyzing and designing systems. A systems analyst interacts with system stakeholders, business managers, software engineers, system users, and vendors to design a system that best supports the goals of the organization.



Systems development projects originate in a variety of ways. Businesses in today's information-driven economy often launch systems development projects to gain a competitive advantage. A process called creative analysis is used to discover opportunities where new systems can improve operations. Systems analysts also use critical analysis to examine existing systems to determine if they are effective and efficient.

Often systems development initiatives stem from efforts to meet organizational goals. Systems analysts engage in systems development planning to create new information systems that are in line with corporate goals.

## Project Management

**Project management** is the process of planning, monitoring, and controlling the sequence of events and resources required in a project, often using software tools.

### Why This Matters

Project management is a valuable skill in systems development and for management in general. Although the steps of systems development seem straightforward, larger projects can become complex, sometimes requiring hundreds or thousands of separate activities. For these types of systems development efforts, proper project management skills are essential. Studies show that college students graduating with project management skills find better-paying jobs more easily than those without such skills.

### Essential Information

Project management is strongly supported by software that helps managers keep track of project timelines and resources. Two techniques frequently used in project management are Program Evaluation and Review Technique (PERT) and Gantt charting. *PERT* is a formalized approach to project management that involves creating three time estimates for an activity: the shortest possible time, the most likely time, and the longest possible time. A formula is then applied to come up with a single PERT time estimate. A *Gantt chart* is a graphical tool used for planning, monitoring, and coordinating projects. A Gantt chart is essentially a timeline grid that lists activities and deadlines (see right portion of the figure). Each time a task is completed, a darkened line is placed in the proper grid cell to indicate completion of a task.

Both PERT and Gantt techniques can be automated using project management software, such as Microsoft Office Project or Serena's open-source OpenProj. This type of software monitors all project activities and determines if activities and the entire project are on time and within budget. Project management software also has workgroup capabilities, providing the ability to handle multiple projects and enabling a team of people to interact with the same software. Project management

software helps people determine the best way to reduce project completion time with the least cost. Reducing project completion time is called project crashing. This project management software feature can be very useful if a project starts to fall behind schedule or becomes more expensive than originally planned.

## Globalization

**Globalization** refers to changes in societies and the world economy resulting from dramatically increased international trade and cultural exchange.

### Why This Matters

The Internet and other forms of global telecommunications have supported a rapid increase in global business and business relationships. With the increase in global communications and cooperation among international businesses, our cultures and economies are becoming interdependent. Such an environment provides advantages for businesses in both developing and developed countries. It also provides new challenges and dangers.

### Consider This

In 2010, Google made history when it broke off relations with China and closed its offices in Beijing. Many, including some Google stockholders, called the move insane. China is well recognized as the world's largest growing economy. While every other business was bending over backwards to do business in China, Google was pulling out. Why? Because Google was no longer willing to censor search results in accordance with Chinese law. Google gave China an ultimatum—allow us to serve uncensored search results or we shut down—and without blinking, the Chinese government chose the latter. In the years since, Google has reopened google.cn and provided visitors with warnings when searching for censored keywords. For a time, Google even provided Chinese citizens with instructions on how to circumvent the great firewall of China and avoid Chinese police.

Google in China is just one of many instances where globalization failed. Apple has suffered severe criticism for being the most successful business in the world while ignoring dangerous or fatal conditions at its factories in China. Although Apple may have little control over conditions at the factories where its products are assembled, it is held up as an example of Western abuse of poor workers in developing countries. The company has plans to move its manufacturing to the U.S. where it can exercise better oversight.

As globalization creates business partners around the world, there are bound to be culture clashes and serious disagreements over how business should be conducted. What types of challenges do you imagine confront a business as it begins to expand abroad? How would you advise global corporations to contend with cultural differences? What would you recommend Apple do to correct its image problem?

### Essential Information

The largest contributors to globalization are computers, a global telecommunications infrastructure, and the Internet. High-speed fiber-optic networks make it possible to communicate with, befriend, and collaborate with individuals around the globe as if they were sitting across the table from you. These

technologies, which break the traditional barriers of time and space, have created a global community and economy.

Today many companies use a distributed workforce, where portions of product design and production take place through a collaboration of several companies, each providing a specialized service. Companies are chosen for collaboration based on quality, reputation, and price. Location is often not a consideration due to the conveniences provided by Internet and telecommunications technologies. These global partnerships aim to produce the highest quality product at the lowest possible cost. The distributed global business model has created intense competition, especially for businesses that compete with businesses in developing countries where labor costs are much lower.

### **Globalization Topics**

- Distributed Workforce
- Outsourcing
- Offshoring
- International Business Models

### **Distributed Workforce**

A **distributed workforce** combines the talents of individuals from different businesses and locations to work together on a common product or project.

### **Why This Matters**

Competition in the marketplace is fierce, and technology is the primary tool for gaining an edge. Businesses are continuously redesigning themselves to take advantage of the latest technological advances. Digital technology supports an increasingly distributed workforce, where portions of product development may be accomplished in different parts of the world. The goal is always to produce the most attractive product at the lowest possible cost. The distributed workforce requires professionals to adapt to a new work environment and routine. Knowledge workers must be fluent with communication technologies and able to collaborate well with others from diverse cultural backgrounds.

### **Essential Information**

The Internet makes it increasingly easy to communicate and collaborate with individuals from around the world. The Internet boom of the 1990s supported the growth of telecommunications infrastructure, including the installation of many undersea cables connecting most parts of the world. These connections supported high-speed data communications and brought Internet services to many parts of the world for the first time. This set the stage for new partnerships between businesses in developed and developing nations, providing opportunities for those living in

developing countries and cost savings for the businesses in developed countries. Innovative software was developed to support collaboration among workers in different locations, facilitating the growth of distributed work environments.

Today many businesses outsource portions of their work processes to take advantage of talent outside their own organization and to save money. It is not unusual for a product to be designed through a collaborative effort among several designers in different cities, to have its parts manufactured at a location overseas (offshoring), to be assembled by another company in another part of the world, to be tested by yet another company, and to be shipped and stored by yet others. The whole project is managed by the company that puts its logo on the finished product.

Participating in a distributed workforce takes unique talents. Communication and technology skills are valued. Meetings are often held online, with files shared among team members. Project management skills are particularly useful, as keeping track of the progress and budgets of multiple units is essential to ensure that no time or money is wasted.

Some companies are finding that managing work processes around the world has some drawbacks. Recently GM, Apple, and others have been bringing manufacturing plants back to the U.S., where they can more easily communicate with other branches of the company. In particular, companies find benefits in having engineers and designers work side-by-side with manufacturing to produce better products.

Still, from all indicators, it appears that the globalization and distribution of work processes are a major part of the global economy. It is highly likely that today's students will be interacting with individuals and businesses from around the world in their professional endeavors. It might be useful to consider acquiring skills that are unique and valuable and may not likely be offered at a lower price by others in a global market.

## **Outsourcing**

**Outsourcing** refers to a business' use of an outside company to take over portions of its workload.

### **Why This Matters**

Many businesses are finding that they can save significant amounts of time, effort, and money by hiring outside businesses to perform specialized tasks. A business might decide to hire IBM to create and manage its corporate information systems. Doing so might provide the business with a higher quality system and a lot fewer headaches. Another business might hire a plant in China to manufacture a component for its product and a plant in Taiwan to assemble the product. Doing so might save the company millions, due to the low cost of manufacturing in these countries compared to the United States or the United Kingdom. Outsourcing

provides benefits to some (those saving money, time, and effort; and those getting the work) and hardships for others (those unable to compete with the low wages of developing countries).

### **Essential Information**

Have you ever heard of the Y2K bug? The Y2K bug was the problem faced at the end of the 20th century due to computer systems using only two digits to represent years. When the year switched from 1999 to 2000 (Y2K), most computer systems would assume that they had gone back to year zero (00). Consequently, many people anticipated that electronic systems would fail in every industry, including vital areas such as banking, medical equipment, manufacturing, and transportation. Because there were not enough computer programmers available to prepare for Y2K, many companies outsourced their Y2K problems to India. When midnight of January 31, 1999, passed without any significant problems, many thought that the entire Y2K scare was all hype. It is more probable that the programmers in India were responsible for saving the day.

Indian programmers earned the respect of many large U.S. corporations, as well as corporations in other developed nations, through their participation in Y2K efforts and other projects. Because Indian programmers worked for pennies on the dollar, compared to workers in the United States and other developed nations, it wasn't long before most major companies called upon Indian programmers for many routine programming jobs. Communications lines between the United States and India became busy with IT business as teams in the two countries collaborated. Software to manage distributed project components became an urgent need, and software companies responded with sophisticated workflow packages. Workflow software empowered project managers to stay in touch with team members around the world and manage multiple project modules. Team members dispersed around the world could communicate in real time through text, voice, or video, and pass around project files as though they were sharing a conference table.

Bangalore has become known as the Silicon Valley of India. Technology companies, such as Microsoft, IBM, Texas Instruments, HP, and GE set up shop in Bangalore, building large corporate offices there. Any service that can be digitized and handled by the Indian workforce is being outsourced. Call center operations, U.S. tax returns, medical imaging analysis, news reporting, publishing, you name it—India can do it cheaper than developed countries. Although some of the work being outsourced consists of basic, low-skill services, one can assume that higher levels of work will be outsourced as Indian education levels rise. In fact, Microsoft has opened a major research facility in Bangalore.

Although India is the biggest destination of outsourced services, Russia, the Philippines, Ireland, Israel, China, and other countries also provide outsourced services. China especially has become popular since its huge and rapidly developing population is becoming one of the world's most valuable markets. Even the United States provides outsourced services. The difference between countries is in the type

of services they can offer. The United States, with its advanced technology skills, provides many services and products whose quality and price cannot be matched elsewhere.

If you are starting to see the big picture of nations trading services and competing with each other in price and quality on a global scale, you are beginning to understand globalization. Enlarging the marketplace from local to global can have a profound effect on national and international economics and development. For example, outsourcing low-end tech jobs to India has provided a boom in India's economy, while thousands of U.S. workers who once did the work being outsourced are laid off. The prosperity in India increases the demand for U.S. products in India, which in turn provides growth in some U.S. industries and the need to hire more labor. In the United States, there is a general shift in employment from low-skill labor to higher-skill labor and a demand for U.S. companies to be creative innovators in order to remain leaders in the global economy.

Recently, there has been somewhat of a backlash against outsourcing in the U.S. Some companies have moved their call center operations back to the U.S. so their customers can communicate with individuals who are culturally the same. Other companies are moving manufacturing operations back to the states in order to have more control over the process and closer communications between corporate units. The trend of repossessing previously outsourced operations is called *insourcing*. Outsourcing is reaching an equilibrium as corporations determine which operations are best to outsource and which are best to keep in house.

## Offshoring

**Offshoring** is a business practice that relocates an entire production line to another location, typically in another country, in order to enjoy cheaper labor, lower taxes, and other forms of lower overhead.

### Why This Matters

Offshoring has had a major impact on manufacturing in both wealthy and developing countries. In the United States, offshoring has devastated some industries, such as the textile industry, which cannot compete with China and other countries on price. Offshoring has, for the most part, elevated the economy of developing countries that are winning the business of their wealthier global neighbors. In some industries, offshoring has created a complicated market. For example, U.S. automakers have offshored some of their production to China and elsewhere, while many Chinese auto companies have cars that are wholly manufactured in the United States. In difficult economic times, offshoring is a hotly debated practice.

## Essential Information

Offshoring is somewhat different from outsourcing. With outsourcing, a portion of a work process is hired out. With offshoring, entire production lines are relocated to another country. If Bangalore, India, is the current global center of outsourcing, then Beijing, China, is the global center of offshoring. At the end of 2001, when China joined the World Trade Organization and agreed to follow international trade laws, it opened a floodgate for trade and innovation. Corporations around the world sought to take advantage of China's large population, cheap labor, and high-quality production to save in manufacturing costs. Textiles, furniture, consumer electronics, and a host of other products are manufactured in China for global distribution for a fraction of the cost of manufacturing in more developed countries.

Companies that take advantage of the cost savings by manufacturing in China and in other low-cost manufacturing centers in the developing world, like Eastern Europe, gain a considerable advantage over competitors that don't. Many business consultants recommend that U.S. companies offshore labor-intensive operations in order to stay competitive. Businesses in other developed nations are following suit. As with outsourcing, offshoring has created concerns for the labor markets in developed countries, especially in the United States. But, as with outsourcing, offshoring is predominantly used to save money on low-skill, labor-intensive manufacturing. Higher-level manufacturing still takes place in the United States. For example, General Motors may use some parts manufactured in China in vehicles assembled in Detroit.

As with India, a growing and prosperous China means increasing demand there for U.S. products. Many U.S. companies have opened branches in China in order to have first crack at the huge market that is developing there. The United States remains the world's largest manufacturer, leading the world in aerospace, pharmaceuticals, automobiles, and other high-tech industries. Through globalization, the field of competition has broadened significantly. As with outsourcing, offshoring is forcing U.S. businesses to stay innovative and competitive.

## International Business Models

**International business models** include methods of engaging in international business ranging from basic import/export to fully transnational businesses.

### Why This Matters

Engaging in a global market is complicated, with many models and levels of engagement. Understanding how companies approach global business is useful for understanding the global economy and its options as well as the challenges involved.



## Essential Information

With the benefits of working in the global arena come substantial challenges:

- **Culture:** Countries and regions have their own cultures and customs that can have a significant impact on individuals and organizations involved in global trade.
- **Language:** Language differences are another challenge. In some cases, it is difficult to translate exact meanings from one language to another. An exact translation of an advertising slogan, for example, might have a totally different meaning or even be offensive or disgusting to people in other countries.
- **Time and distance:** Time and distance issues can be difficult to overcome for individuals and organizations involved with global trade in remote locations. In other cases they can provide an advantage. For example, outsourcing to India enables a company to work 24 hours a day because it is day in India when it is night in the United States.
- **Infrastructure:** People and organizations operating in developed countries expect an excellent infrastructure. In some countries, electricity may fluctuate in voltage, damaging machines and computers, or may be off for large periods of the day. Water might be dirty, and phone and Internet service might be problematic.
- **Currency:** The value of different currencies can vary significantly over time. Sometimes currencies can dramatically fluctuate in a few days or less.
- **State, regional, and national laws:** Every state, region, and country has a set of laws that must be obeyed by individuals and organizations operating within the respective area. These laws can deal with a variety of issues, including trade secrets, patents, copyrights, protection of personal data, protection of financial data, and privacy.

Organizations participate in the global marketplace in several different ways, depending on where the organization's operations are located and how they are managed, as shown in the following table.

**Table: Types of Organizations in the Global Economy**

<b>Company type</b>	<b>Description</b>
<i>International company</i>	An international company maintains management and operations in its home country, exporting or importing products to and from other countries.
<i>Multinational company</i>	A multinational company maintains management in its home country and is supported by operations distributed across several countries. These companies typically market products specifically to satisfy the needs of their customers in different countries.
<i>Global company</i>	A global company is similar to a multinational company except that it markets its brand and products in the same way across all countries, regardless of cultural differences.
<i>Transnational company</i>	A transnational company has complex management distributed across multiple countries and operations. Often it is difficult to name a home country for a transnational business.

## Project Management

Managing projects becomes much easier with the use of project management software, which stores, manipulates, and presents project-related data in a manner that helps complex projects finish on time and within budget. A project often involves numerous people, resources, budgets, collaborations, and deadlines. Without good management, such projects would likely not conclude successfully. Whether your project is large or small, project management software can help you stay on time, within budget, and less stressed. Also, college graduates with project management skills often command higher salaries than those without such skills. Project management software performs many tasks and calculations for you, automatically generating charts, schedules, and reports based on resources, deadlines, and budgets. This lesson uses the OpenProj open-source project management software that runs on Linux, Mac, and Windows platforms.

### Lesson Topics

- The Value of Project Management
- Adding Tasks to a Project in OpenProj
- Defining Task Details
- Defining Task Sequence
- Defining Resources
- Project Views and Saving

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#### 1. The Value of Project Management

##### **Skills Covered:**

Project management is critical to success in school, in business, and in many other areas of life. If a project is not well organized, it may cost more in time and money, it may be delayed, or it may even be abandoned. To help avoid these situations, one solution is to use project management software.

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#### 2. Adding Tasks to a Project in OpenProj

##### **Skills Covered:**

Projects are made up of a number of tasks that can be completed in consecutive or concurrent order.

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### 3. Defining Task Details

**Skills Covered:**

Every task must have a name and duration but can include other details such as Percent Complete, Cost, and much more.

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### 4. Defining Task Sequence

**Skills Covered:**

Many tasks are dependent upon the completion of other tasks and therefore must be joined in a sequential path of execution. However, if a task can be completed independent of other tasks, it can execute concurrently with other project tasks.

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### 5. Defining Resources

**Skills Covered:**

Responsibilities are allocated through the assignment of resources. Resources may include human resources or material resources such as shipping and supplies.

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### 6. Project Views and Saving

**Skills Covered:**

OpenProj includes a multitude of different views to visualize and understand your project, and each serves a valuable function. The Gantt chart is the default view, but changing to a different view is as simple as clicking a view icon on the left. OpenProj projects can also be saved in different formats for compatibility with other project management software such as Microsoft Project.

## Artificial Intelligence (AI)

**Artificial intelligence (AI)** refers to the art and science of creating computer systems that simulate human thought and behavior.

### Why This Matters

Artificial intelligence, or AI, is of interest to many professionals, including computer scientists, psychologists, philosophers, neuroscientists, and engineers, who often collaborate on AI research. While some researchers are working to create computers that can think like humans, many are focused on developing software that can automate specific tasks that require a subset of human intelligence. AI technologies are being integrated into many software applications to make them more intuitive and responsive to human needs. Most of us use AI technologies every day without even knowing it. Web search engines use AI to provide useful links in search results, and ecommerce websites display products that you are likely to buy based on your previous behavior and purchases. The latest version of Google Android infers what information you may be interested in based on your location and behaviors. For example, if you recently purchased a plane ticket and you are driving toward an airport, Android will automatically provide you with flight departure updates and weather reports for your destination city. Our computing devices are becoming more “intelligent” day by day.

### Consider This

The processing power of the brain has been estimated to be around 100 million, million instructions per second. That’s 100 followed by 12 zeros. Today’s fastest supercomputers operate at more than 20 petaflops (20 thousand trillion floating point operations per second). That’s 20 followed by 15 zeros. While the human brain is not increasing in its processing speed, computers are getting faster every year. Moore’s Law states that computers double in speed every year and a half or two years. By 2020, it is expected that supercomputers will achieve exascale performance—that is, 1,000 petaflops. At petaflop speeds, supercomputers process data more than 10 times faster than a human brain. When computers reach exascale speeds, they will be hundreds of times faster than the human brain.

Clearly, computers process data faster than people can. That’s the primary reason we find them so useful. But can a computer become truly intelligent? Some think that computers will become more intelligent than humans by the mid 2020s and more intelligent than the entire human race by 2060. The Blue Brain project has already simulated the functions of a mouse brain in software. What will it take for computers to “think” like humans? What will happen when computer scientists can simulate the functions of the neurons and synapses in the human brain? Will they be able to create a thinking machine? What is thinking? What is the difference between human intelligence and computer intelligence?

## Essential Information

At a Dartmouth College conference in 1956, John McCarthy proposed the term *artificial intelligence* to describe computers with the ability to simulate human thought and behavior. Many AI pioneers attended that first AI conference; a few predicted that computers would be as smart as people by the 1960s. That prediction was off by decades, but many benefits of artificial intelligence research can be seen in software applications today.

We are entering the era of smart machines, when computers can process information as fast as or faster than the human brain. Comparing processors to brains is a bit like comparing apples to oranges. Brains process in a massively parallel manner using 100 billion processors (neurons) that work together simultaneously to form our thoughts. Neurons are slow compared to today's computers. But because they function simultaneously, our fastest supercomputers are only just now approaching brain-level power. Processing power is only one step in building a thinking machine. The tricky part is in the software.

To imbue computers with intelligence, we must be able to recognize the traits of intelligent behavior so that we can recognize them in computers. Certainly our ability to use our senses to observe the world around us and store knowledge (i.e., remember) is an important element of intelligence. Another important element is our ability to reach conclusions and establish new understandings by combining information in new ways. Another important element in exhibiting intelligence is our ability to communicate and use language.

All of these characteristics of intelligence are being duplicated in machine intelligence, or AI. There are many AI methodologies and applications. This unit presents those that have been most successful.

## Ethical Dilemmas

The area of artificial intelligence has been controversial since its origin. The thought of computers gaining intelligence that rivals human intelligence could threaten our very existence. The Singularity promises computers with "superintelligence." Would these computers continue to serve humankind or enslave us?

Even simple AI applications are considered by some to be a threat. Expert systems and robotics can carry out repetitive procedures with pinpoint accuracy, never tiring, getting bored, or complaining. Such systems have displaced many human workers. Some would argue that these systems free up the human workforce for more interesting and fulfilling careers. That argument fails, however, when the unemployment rate rises and government and industry are unable to find jobs for displaced workers.

AI and robotics serve many national defense applications. Drone aircraft are remotely controlled to carry out attacks in cities hundreds of miles away from their operators. Robots hunt down bombs and improvised explosive devices (IEDs), saving many lives. Other military robots are being armed with automatic weapons and being sent into combat. Critics of military and surveillance robots are concerned about what happens when these robots malfunction or fall into the wrong hands.

### Artificial Intelligence Topics

- AI Methodologies
- AI Applications

### AI Methodologies

**Artificial intelligence methodologies** consist of the various approaches to AI research that generally fall under one of two categories: conventional AI or computational intelligence.

#### Why This Matters

AI researchers have developed many approaches to AI in order to meet a wide variety of goals. From simple systems that offer suggestions as you type in a key term in Google, to systems that offer professional medical advice, to systems that mimic the biological functioning of the human brain, the goals for AI systems cover a broad spectrum of applications. Understanding AI methodologies helps us to understand the complexities of human thought.

#### Essential Information

AI systems typically include three components:

- A set of logical rules to apply to input in order to produce useful output
- Instructions for how to handle unexpected input and still produce useful output—i.e., the ability to “wing it”
- The ability to learn from experience to continuously improve performance, referred to as *machine learning*

Several formal methods are used to create intelligent software that has these components and capabilities. They fall under two categories:

- *Conventional AI* methodologies—such as expert systems, case-based reasoning, Bayesian networks, and behavior-based AI—that rely on the programmer to instill the software with logical functionality to solve problems
- *Computational intelligence* methodologies—such as neural networks, fuzzy systems, and evolutionary computation—that set up a system whereby the software can develop intelligence through an iterative (cyclical) process

It is often the case that AI developers combine methods from different methodologies to achieve their goals.

### AI Methodologies Topics

- Conventional AI
- Expert System (ES)
- Computational Intelligence
- Neural Network
- Turing Test
- Singularity

## Conventional AI

**Conventional AI**—also called symbolic AI, logical AI, or neat AI—uses programming that emphasizes statistical analysis to calculate the probability of various outcomes in order to find the best solution.

### Why This Matters

Conventional AI has led to the development of software that is more intuitive to use and systems that can automate the decision making process in certain professional activities. Conventional AI techniques such as expert systems, case-based reasoning, Bayesian networks, and behavior-based AI systems are embedded in many of today's popular software applications making them easier to use, and more useful.

### Essential Information

In conventional AI, advanced programming techniques are leveraged in order to imbue software with human qualities. *Heuristics* (rules of thumb) are used to assist software in reaching conclusions and making recommendations.

*Case-based reasoning* is an area of conventional AI in which the AI software maintains a library of problem cases and solutions. When confronted with a new problem, it adjusts and applies a relevant previous solution to the new problem.

Case-based reasoning relies on the four Rs for solving new problems:

- Retrieve: Find cases in the case library relevant to the new problem.
- Reuse: Map the solutions from a previous case(s) to the variables of the new problem, adjusting where necessary.
- Revise: Test the solution and revise if necessary.
- Retain: Store the new problem and its newly acquired successful solution as a case in the library.

AI software built on case-based reasoning is useful for help-desk support, medical diagnosis, and other situations where there are many similar cases to diagnose.



A *Bayesian network*, sometimes called a belief network, is a form of conventional AI that uses a graphical model to represent a set of variables and their relationships and dependencies. A Bayesian network provides a model of a real-life scenario that can be incorporated into software to create intelligence. Bayesian networks are used in medical software, engineering, document classification, image processing, military applications, and other activities. For example, the Combat Air Identification Fusion Algorithm (CAIFA) Bayesian network is used in missile defense software and draws on multiple, diverse sources of ID evidence to determine the allegiance, nationality, platform type, and intention of targeted aircraft.

*Behavior-based AI* is a form of conventional AI that is popular in programming robots. It is a methodology that simulates intelligence by combining many semi-autonomous modules. Each module has a specific activity for which it is responsible. By combining these simple modules, the resulting system exhibits intelligent behavior—it becomes smarter than the sum of its parts. Robosapien and other such robotic toys are controlled by behavior-based AI software.

Expert systems are very successful forms of conventional AI and are covered on the next page.

## **Expert System (ES)**

An **expert system (ES)** is a form of conventional AI that is programmed to function like a human expert in a particular field or area.

### **Why This Matters**

Many professional activities are tedious, redundant, and sometimes dangerous. In such cases, expert systems can assist human professionals. In other cases, decisions are made that can be programmed using AI techniques. In these cases, expert systems can provide solutions as a human expert would, freeing the human expert to focus on more creative and productive activities.

### **Essential Information**

Expert systems are created with the assistance of a human expert who provides subject-specific knowledge. The rules applied by the expert to perform some activity are programmed into the expert system software.

Like human experts, computerized expert systems use *heuristics*, or rules of thumb, to arrive at conclusions or make suggestions. A heuristic provides a solution to a problem that can't necessarily be proven as correct but usually produces a good result.

Many expert systems are used in various professions every day. Computerized expert systems have been developed to diagnose diseases given a patient's symptoms, suggest the cause of a mechanical failure of an engine, predict weather events, assist in designing new products and systems, test and evaluate chemical reactions, or detect possible terrorist threats. Some expert systems have become commonplace; users think of them simply as helpful software. For example, tax preparation software is yet another implementation of expert systems.

## Computational Intelligence

**Computational intelligence** is an offshoot of AI that employs methodologies such as neural networks, fuzzy systems, and evolutionary computation to set up a system whereby the software can develop intelligence through an iterative learning process.

### Why This Matters

Rather than programming intelligence into software through the use of statistics and probabilities, as in conventional AI, computational intelligence creates software that can learn for itself. Although computational intelligence isn't ideal for every AI application, it is useful in systems that mimic human perception such as pattern recognition.

### Essential Information

Computational intelligence is a branch of AI that uses methodologies such as neural networks, fuzzy systems, and evolutionary computation to enable computers to learn from experience.

Computers typically work with numerical certainty: certain input values always result in the same output. However, in the real world, certainty is not always the case. To handle this dilemma, a specialty research area in computer science called fuzzy systems, based on fuzzy logic, has been developed. *Fuzzy logic* is derived from fuzzy set theory, which deals with reasoning that is approximate rather than precise. A simple example of fuzzy logic might be one in which cumulative probabilities do not add up to 100%, a state that occurs frequently in medical diagnosis. Another example of fuzzy logic involves unclear terms, such as "tall" or "many." Fuzzy logic deals with ambiguous criteria or probabilities and events that are not mutually exclusive. Fuzzy systems based on fuzzy logic enable people to incorporate interpretations and relationships that are not completely precise or known.

A *fuzzy control system* is based on fuzzy logic and typically used to control machines. For example, the microcontroller that controls the anti-lock brakes in your car uses fuzzy logic to apply just enough brake to stop quickly while avoiding a skid based on varying road conditions.

*Evolutionary computation* includes areas of AI that derive intelligence by attempting many solutions and throwing away the ones that don't work—a “survival of the fittest” approach. A *genetic algorithm* is a form of evolutionary computation that is used to solve large, complex problems where a number of algorithms or models change and evolve until the best one emerges. If you think of program segments as building blocks similar to genetic material, this process is similar to the evolution of species, where the genetic makeup of a plant or animal mutates or changes over time. Some investment firms use genetic algorithms to help select the best stocks or bonds. Genetic algorithms are also used in computer science and mathematics.

Neural networks, covered on the next page, are a very popular form of computational AI that attempts to simulate the functioning of a human brain.

## Neural Network

A **neural network**, or neural net, uses software to simulate the functioning of the neurons in a human brain.

### Why This Matters

Simulating a human brain in a neural network provides many useful applications. However, an additional, perhaps even more important, result is a deeper understanding of how the human mind functions. Advances in neural networks are providing insight into treatment for mental illness and other brain-related diseases. Ultimately, the study of neural networks may reveal the essence of the human soul.

### Essential Information

Just as human brains gain knowledge by generating paths between neurons through repetition, so neural networks are programmed to accomplish a task through repetition. A neural network typically begins by running a random program. The output is measured against a desired output, which positively or negatively affects the pathways between simulated neurons. When the neural net begins getting closer to the desired output, the positive effects on the system begin to create circuits that become trained to produce the correct output. Similar to a child's learning, a neural net discovers its own rules. For example, a neural net can be trained to recognize the characteristics of a male face, and once trained, may be able to accurately identify faces in photos as male or female.

Once a neural net is trained, it can process many pieces of data at once with impressive results. Some specific features of neural networks include:

- The ability to retrieve information even if some of the neural nodes fail
- The ability to quickly modify stored data as a result of new information
- The ability to discover relationships and trends in large databases
- The ability to solve complex problems for which all of the information is not present

Neural networks excel at pattern recognition, and this ability can be used in a wide array of applications, including voice recognition, visual pattern recognition, robotics, symbol manipulation, and decision making. Neural networks can help us understand how our own brains work. Altering the rules of interaction between “neurons” in the network can lead to interesting and educational results. Neuroscientists study and tinker with neural nets to better understand emergent behavior in the brain.

## **Turing Test**

The **Turing Test** was devised by Alan Turing as a method of determining if a machine exhibits human intelligence.

### **Why This Matters**

How can you tell if a computer has acquired the capability for human-level intelligence? This is an important question, especially now that supercomputers have become as powerful at processing information as the human brain. Alan Turing thought it was an important question as well when he wrote his famous paper decades ago. Turing believed that thinking machines were just around the corner. Researchers today, over 60 years later, are thinking the same thing.

### **Essential Information**

Alan Turing was an English mathematician, logician, and cryptographer who is well known for his belief that computers would someday be as intelligent as humans. In his 1950 paper entitled “Computing machinery and intelligence,” Turing proposed a test, now known widely as the Turing Test, which he claimed would be able to determine if a computer exhibited human intelligence.

Turing described his test as follows: “A human judge engages in a natural language conversation with two other parties, one a human and the other a machine; if the judge cannot reliably tell which is which, then the machine is said to pass the test.” Passing Turing’s test is no simple feat. No computer has successfully passed the Turing Test, and yet, many try each year at the Loebner Prize competition. In 2012 Eugene Goostman—a chatbot with the personality of a 13-year-old boy, created by Vladimir Veselov of Raritan, New Jersey—won the contest by fooling its judges 29 percent of the time.

Should there come a day when a computer program does pass Turing’s test, the intelligence of the machine will still be disputed. Many AI researchers have challenged Turing’s assumption, claiming that clever use of language does not necessarily imply intelligence.

## Singularity

The **Singularity**, or more specifically, the technological Singularity, is the point in time at which computers exceed humans in intelligence, launching a new era of innovation.

### Why This Matters

Should it come to pass, a technological Singularity could completely change life as we know it. Those who subscribe to the theory believe that the Singularity will usher in an era of deeper understanding and rapid advancement. Others believe that the Singularity will never occur or that if machines become more intelligent than humans, they are liable to take over the world.

### Essential Information

The theory of a technological Singularity was originally proposed by mathematician and sci-fi author Vernor Vinge. Vinge believed that advances in AI and human biological enhancement would eventually lead to “superintelligences” with the ability to advance science and technology well beyond what is possible with the human brain alone. Since these superintelligences have knowledge beyond humans, it is impossible to predict what might transpire after the Singularity. In his book *The Singularity Is Near*, Ray Kurzweil takes an optimistic view of the near future and the impending Singularity. He classifies the days ahead as the “most transforming and thrilling period in history.” He goes on to say, “It will be an era in which the very nature of what it means to be human will be both enriched and challenged as our species breaks the shackles of its genetic legacy and achieves inconceivable heights of intelligence, material progress, and longevity.”

The rationale behind the theory of the Singularity is tied to Moore’s Law and other technological trends. For the past four decades, processing power has grown exponentially. Unless something arises to interrupt it, it will continue to grow to become more powerful than the human brain. Already, supercomputers have surpassed the human brain in pure processing power. The trick is getting them to process more like the human brain.

The Blue Brain project is a bold attempt to simulate a human brain at a molecular level in software running on one of the world’s fastest supercomputers, IBM’s Blue Gene. The project has succeeded in simulating the functioning brain of a mouse. Some speculate that we will have effective software models of the human brain in the next few decades. Kurzweil placed the date for the Singularity somewhere in the mid 2040s. He expects that shortly thereafter a single computer will become smarter than the entire human race. The concept of machines with intelligence that exceeds human intelligence is referred to as *strong AI*.

## AI Applications

**AI applications** are ways in which AI methodologies are applied to solve problems and provide services.

### Why This Matters

Research and innovation in artificial intelligence are impacting lives in subtle and not-so-subtle ways. From software that anticipates the user's needs to robots that create and perform music, artificial intelligence is being applied in many computer applications.

### Essential Information

Artificial intelligence has many and varied applications. AI techniques can be integrated into systems and applications to make them more intuitive. AI software is used to automate various types of decision-making logic. AI software can be connected to sensors and mechanical apparatus to create a variety of robots and other devices. Toyota and Audi have produced self-driving cars that utilize AI to detect and automatically respond to their surroundings (see image). Toyota says that the car can drive, on its own, through a fairly complex environment without a person touching the steering wheel or pedals. This section explores many other common AI applications.

### AI Applications Topics

- Robotics
- Computer Vision
- Natural Language Processing
- Pattern Recognition
- Intelligent Agent
- Artificial Creativity

## Robotics

**Robotics** involves developing mechanical or computer devices to perform tasks that require a high degree of precision or are tedious or hazardous for humans.

### Why This Matters

In recent years, robots have become a form of entertainment in toys for children and a necessity in many manufacturing processes. Contemporary robotics combines both high-precision machine capabilities and sophisticated AI controlling software.

## Essential Information

There are many applications of robots, and research into these unique devices continues. For many businesses, robots are used to do the three Ds: dull, dirty, and dangerous jobs. Manufacturers use industrial robots to assemble and paint products. Medical robots enable doctors to perform surgery via remote control. Sitting at a console, the surgeon can replace a heart valve or remove a tumor. Some surgical robots cost more than \$1 million and have multiple surgical arms and sophisticated vision systems.

Some robots can propel themselves by rolling, walking, hopping, flying, snaking, or swimming. Other robots are designed to interact with humans using speech recognition and gesture and facial expression interpretation. Increasingly, robots are being used to transport items in office buildings. Robots have become commonplace in combat zones, flying overhead and traversing mined roads to deactivate bombs. Some have predicted that robots will become common household appliances within the next decade.

Honda claims that its ASIMO is the world's most advanced humanoid robot. ASIMO can navigate a variety of terrains, walk up and down stairs, play sports, and serve drinks. Researchers at University of California in San Diego have developed an infant robot that realistically mimics the emotional expressions of a one-year-old child. Roboy, another advanced humanoid robot, is being engineered at the Artificial Intelligence Lab of the University of Zurich. Roboy utilizes "tendon-driven" joints, so it will move almost as elegantly as a human.

Since technologies have advanced to the point where the construction of useful humanoid robots is not only feasible but also affordable, many researchers and companies are investing in robotics research. Many predict that household robots will become commonplace over the next decade. In other cases robotics is used to augment human capabilities. A Pittsburgh woman who is paralyzed from the neck down has recently taken control of robotic arms that through a brain implant she controls with the fluidity of a natural arm.

## Computer Vision

**Computer vision** combines hardware (cameras and scanners) and AI software that permit computers to capture, store, and interpret visual images and pictures.

### Why This Matters

Computer vision enables software to react to visual input. This ability provides all sorts of opportunities for automation. No longer does the computer need to wait for manual input; it can be programmed to automatically react to movement or objects

in its environment. This is useful in all forms of robotics, in security systems, in games, and in a wide variety of applications that benefit from visual input.

### **Essential Information**

Although seeing is second nature for most humans, it is a complicated action to program into computers. To process input from video cameras or simply to analyze a photograph requires complicated AI techniques. Through those techniques, computers have learned to notice irregularities in video and still photos and to distinguish colors, motion, and depth. Using these skills, computers with vision capabilities can provide many useful services.

Computers are used to interpret medical images like X-rays and ultrasonic images. They are used in pattern recognition, such as face recognition in security systems. Computer vision is used in the military to guide missiles, and in space exploration to guide the Mars Rovers.

Microsoft brought computer vision into the living room with the Kinect Xbox 360 controller. The set-top box allows players to put away their handheld controllers and control game action with body action. Kinect applications have been developed to help stroke victims and children with autism, to assist doctors in the operating room, to create new forms of art, to assist the disabled, and to implement other valuable services.

Computer vision systems are also being developed to assist in human sight. Dr. William Dobelle designed a system that has brought a form of vision to totally blind individuals. The system combines a small video camera mounted in sunglasses, a powerful but small computer worn in a belt, and a brain implant that stimulates the visual cortex. By connecting an array of electrodes to the areas of the visual cortex, the system can provide vision with a grid of pixels. By enabling a video camera to control the intensity of power to the electrodes, one patient has been able to see well enough to drive a car.

## **Natural Language Processing**

**Natural language processing** uses AI techniques to enable computers to generate and understand natural human languages, such as English.

### **Why This Matters**

Natural language processing makes it possible to interact with computer systems using spoken words. Have you ever had an automated phone system ask you to reply to a question by speaking a response? Natural language processing has become popular in collecting user input over phone systems. It's also popular in mobile phones for automatic dialing and issuing commands. Natural language



processing is useful for individuals who cannot use a keyboard and mouse because they are disabled or because their hands are needed for other work. Increasingly, natural language processing is being used to dictate voice input to a computer rather than typing text or commands.

### Essential Information

One area of natural language processing that is evident in today's software and business systems is speech recognition. *Speech recognition* enables a computer to understand and react to spoken statements and commands. With speech recognition, it is possible to speak into a microphone connected to a computer, or into a mobile phone, and have the spoken words converted to commands or text displayed on the screen. Many mobile phones have the ability to recognize spoken commands, such as "Call Jon Alberts." The iPhone utilizes software named Siri to field all kinds of voice commands and questions in order to serve as a digital assistant and intelligent agent.

Current versions of many desktop and mobile operating systems have utilities that enable you to speak commands to the computer as well. Microsoft Word has a speech utility that enables you to dictate to the computer instead of typing. Dragon NaturallySpeaking is popular software for both PCs and cell phones, which allows users to dictate text as they would naturally speak. As with all dictation software, you must speak punctuation characters and commands to place the cursor in a new location. So, for example, you might dictate this statement, closing with "period – new line."

Speech recognition is not to be confused with voice recognition, which is a different technology used in the security field to identify an individual by the sound of his or her voice.

Speech recognition has utilized AI methodologies to overcome some difficult obstacles:

- **Speech segmentation:** If you listen to a person speak from a computer's perspective, you will notice that there is roughly the same length of pause between syllables in words as there is between words in a sentence (roughly none). How is the computer to determine where one word ends and the next begins?
- **Ambiguity:** There is no difference between the sound of the words "their," "there," and "they're." When spoken, how is the computer to know which one is intended?
- **Voice variety:** Everyone speaks differently. The English language has many regional and personal dialect variations. It is difficult for one program to understand both Arnold Schwarzenegger and Paris Hilton.

Using AI, speech recognition software "learns" a dictionary of words to determine how to parse a sentence into individual words. It must also learn grammatical rules

in order to overcome the problem of ambiguity. In addition, it must have some insight into human thinking to understand a sentence such as “Time flies like an arrow.” Finally, speech recognition must be able to learn the individual speaking quirks of the user. For this reason, speech recognition software gets better the longer it is trained to an individual user.

## Pattern Recognition

**Pattern recognition** is an area of AI that develops systems that are trained to recognize patterns in data.

### Why This Matters

Many useful applications are based on computers’ ability to recognize patterns in data. Pattern recognition is used to find exceptions to trends in data for businesses in a process called data mining. Such discoveries can help in discovering fraud or other unusual business activities. Pattern recognition is also useful for training AI computer vision systems to recognize faces, handwriting, or other visual patterns.

### Essential Information

Speech recognition, handwriting recognition, and face recognition all fall under the AI category of pattern recognition. *Handwriting recognition* uses AI techniques in software that can translate handwritten characters or words into computer-readable data. In its handwriting recognition software, Microsoft uses AI technology that allows tablet PC users to write out full words and sentences anywhere on the touch-sensitive screen with printed or cursive characters.

While Microsoft continues to pursue stylus input and handwriting recognition for its tablet PCs, other tablets, including the iPad, have opted for a soft keyboard for text entry. When Steve Jobs introduced the iPhone, he demonstrated how convenient it was to enter data directly with fingers on the display. It is likely that manufacturers will continue to experiment with many styles of user input for mobile computing, many of which rely on AI.

For governments and other organizations concerned with security, facial recognition is a hot area of AI research. Facial recognition uses cameras and AI software to identify individuals by unique facial characteristics. Facial recognition is used in authentication—verifying a person’s identity before allowing access to secure areas or systems—and in surveillance. The Australian SmartGate system uses facial-scan technology to compare the traveler’s face against the scan encoded in a microchip contained in the traveler’s ePassport.

Facial recognition is also being incorporated into marketing. Facebook’s Facedeals service utilizes cameras in stores to identify Facebook users when they are out and

about shopping. Once visitors are identified, Facebook partners can offer them special deals based on their Facebook profiles. The use of cameras in public places is almost always associated with privacy concerns. Some people do not like their public movements tracked—by governments or businesses (see video).

Facial recognition is catching on as a handy tool for organizing photos as well. Apple's iPhoto, Facebook, and other photo software uses facial recognition technology to automatically recognize and tag friends in digital photos. The tool is trained to recognize individuals with the help of the user who corrects the software when it incorrectly identifies a face. Over time the facial recognition gets more competent and can call up all the photos that include a specified person.

## Intelligent Agent

An **intelligent agent**, *digital assistant*, or *bot*, consists of programs and a knowledge base used to perform a specific task for a person, a process, or another program.

### Why This Matters

Intelligent agents can automate tasks and save human users time and effort. They can search for interesting items on the web or field basic questions from customers. They may be programmed to carry out any number of software tasks with varying degrees of artificial intelligence. They often include a human persona and animated avatar form.

### Essential Information

There are different types of intelligent agents, or bots, trained to carry out a variety of tasks. A bot may search for useful information on the web or in databases or interact with individuals on the web, a PC, or a smart phone to answer questions or carry out tasks.

Like an agent who searches for the best endorsement deals for a top athlete, an intelligent agent may search to find the best price, the best schedule, or the best solution to a problem. Often used to search the vast resources of the Internet, intelligent agents can help people find information on an important topic, find the best employment opportunities, or find the best price for a new digital camera. What once took days when done manually now takes hours or minutes. Intelligent agents have been used by the U.S. Army to route security clearance information for soldiers to the correct departments and individuals. Intelligent agents can also be used to make travel arrangements, monitor incoming e-mail for viruses or spam, and coordinate the meetings and schedules of busy executives. Some companies use intelligent agents to find the best job candidates by searching millions of resumes in a database by title, company, and other factors.

Apple's Siri interface ushered in the era of the personal digital assistant for the iPhone. Using natural language processing, Siri allows iPhone users to ask questions or issue commands by speaking into the handset. Siri accepts commands such as "Remind me to pick up milk on my way home" and questions like "Any good burger joints around here?" Siri responds to commands and questions with a human-like voice. Siri works its magic by sending a query to an Apple server, where AI software dissects the request, runs it through the most appropriate online service, and responds with a solution. The result is the first convincing digital personal assistant application. Microsoft, Google, Amazon, and others are hot on the heels of Apple with similar applications.

Other intelligent agents are programmed with topic-specific information and trained to carry on text or voice conversations with visitors to your website. SitePal provides a catalog of intelligent agent avatars that can be programmed to greet visitors as they open a website. Intelligent agents can be programmed to answer frequently asked questions and even open webpages of interest to the visitor. The application of natural language processing is necessary to interpret questions typed by the person interacting with the intelligent agent. AI techniques are also necessary in determining the correct response.

## **Artificial Creativity**

**Artificial creativity** is a branch of AI that works to program computers to express themselves through art, music, poetry, and other outlets.

### **Why This Matters**

Some AI software has become quite talented at creating works of art. The most useful output, however, is the insight it gives us into the workings of human creativity.

### **Essential Information**

Artificial intelligence is enabling computer software to become creative. A number of researchers are working to provide computers with the ability to create visual art, music, poetry, and other forms of creative expression.

Harold Cohen was an English painter with an established international reputation before he joined and eventually directed the Center for Research in Computing and the Arts (CRCA) at the University of California, San Diego. The mission of the CRCA is to facilitate the invention of new art forms that arise out of the developments of digital technologies. Harold Cohen created an AI artist named AARON, which independently paints large, impressive works of art with a paintbrush and canvas.

AI expert Ray Kurzweil has created an AI program he calls the Cybernetic Poet, which can create poetry in the style of human poets. The software “reads” poem samples from one or more human poets and then creates one of its own in the same style. Here is a haiku written by the Cybernetic Poet after reading the poetry of John Keats and Wendy Dennis:

*You broke my soul  
The juice of eternity,  
The spirit of my lips.*

British jazz saxophonist Paul Hodgson has written a music program called Improviser that can create songs on a synthesizer in styles ranging from that of Bach to jazz-great Charlie Parker. The software has earned the respect of many musicians.

Research in computer-designed art has caused controversy and debate. When a computer creates artwork that is beautiful or stirring, with only vague instructions from the AI programmer, does the art originate in the programmer or the machine? AI art impacts many of the core philosophical debates surrounding strong AI.

## **Windows 7**

### **Lesson Topics**

1. Navigating in Windows 7
2. Windows 7 File Management

### **Overview**

Microsoft Windows is the dominant operating system on personal computers around the world, and Windows 7 is the most recent version of the Microsoft Windows operating system.

The operating system is the most important software on a computer. The operating system acts as an interface between application software and the hardware and allows users to manage files and applications. Roughly 90 percent of personal computers use Microsoft Windows operating systems. You will encounter Windows operating systems such as Windows 7 on residential, business, and educational computer systems worldwide. Being comfortable in the Windows environment is key to becoming computer literate. This includes being able to navigate around the components of the operating system, adjust system settings, manipulate software applications, and manage files.

Windows 7 was released in 2009. There are several versions of Windows 7 including Home, Premium, Professional, and Ultimate. Depending on which version you are using, some features may differ. But the features covered in this lesson are pertinent to all.

## **Windows 7 Lesson 1: Navigating in Windows 7**

### **Lesson Topics**

1. Windows 7 Layout
2. Programs and Windows
3. The Windows 7 Taskbar
4. Gadgets
5. The Control Panel
6. Appearance and Personalization
7. Help and Support

### **Overview**

Navigating in Windows 7 requires a familiarity with all Windows 7 features including the user interface, customizing and personalizing the Windows

environment, changing system settings, searching for files and folders, and getting help.

Windows is the dominant operating system in the world, used throughout business and in educational institutions. Having a firm understanding of how to navigate and use Windows 7 is essential to gain computer literacy and be productive in today's technology-centric environment. This lesson teaches you how to navigate and perform basic functions in Windows 7. It covers the "ABCs" of becoming computer competent in Windows 7.

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## 1. Windows 7 Layout

### **Skills Covered**

Windows 7 consists of three main areas: the Start menu, the taskbar and the desktop. Each area can be customized and configured for personal use.

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## 2. Programs and Windows

### **Skills Covered**

Software applications, or programs, can be launched in Windows 7 using shortcut icons on the desktop or taskbar, or by finding the program in the Start menu. Multiple programs can run simultaneously. Windows 7 provides numerous ways to preview and manipulate windows, including several that are brand new to Windows. Understanding how to run software and manipulate windows is an essential skill for computer users.

---

## 3. The Windows 7 Taskbar

### **Skills Covered**

The Windows 7 taskbar runs across the bottom of the display and is always visible unless customized to be hidden. The taskbar is used to manage running programs and windows, launch frequently used programs, access the Start menu, and view programs running in the background. Understanding the taskbar is essential to working effectively in Windows.

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#### 4. Gadgets

##### **Skills Covered**

Gadgets are small useful programs that run on your desktop. There are gadgets available to display time, display the weather, view photos in a slideshow, track stocks or sports teams, follow your friends on Facebook, and thousands of other uses. Gadgets are free and useful and can be added to the desktop wherever the user desires.

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#### 5. The Control Panel

##### **Skills Covered**

The Control Panel is where all the settings and configurations for your computer are located. In the Control Panel you can create user accounts, set parental controls, make Internet and network connections, set Windows security, uninstall programs, and much more.

---

#### 6. Appearance and Personalization

##### **Skills Covered**

Windows 7 is highly configurable and can easily be customized for a personal computing experience. For example, the desktop background can be changed, the Start button icon can be swapped with a more personal image, and Folder Options can be set for preferred behavior.

---

#### 7. Help and Support

##### **Skills Covered**

Help and Support is a resource for finding answers about Windows 7, from the most basic questions to complicated troubleshooting. If a question cannot be answered from the Windows 7 help files on your computer, Help and Support can search Windows Online Help and Support pages. In Help and Support, you can also find very useful video demos of common tasks in Windows 7.

## **Windows 7 Lesson 2: Windows 7 File Management**

### **Lesson Topics**

1. Files, Folders, and Libraries



2. Creating and Moving Files and Folders
3. Copying, Renaming, and Deleting
4. File Preview and Open With
5. Saving Files

## Overview

File management refers to the important practice of creating and manipulating files, and organizing files in folders on a computer system. Knowing how to organize files into folders and subfolders is essential to keeping your digital life in order. Although the Windows 7 search function is excellent for finding individual files or folders, finding related information is beyond the scope of the search feature. Organizing your files in a hierarchy of folders and subfolders will help you quickly find the information you need.

---

### 1. Files, Folders, and Libraries

#### Skills Covered

Using the analogy of a filing cabinet, the files and folders on your computer are the digital equivalents of paper documents and folders in filing cabinet drawers. Windows 7 has a new organizational feature called Libraries that allows you to collect folders and files from various locations on your computer or on your network into one place.

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### 2. Creating and Moving Files and Folders

#### Skills Covered

Folders typically hold related files. Files can be moved (dragged) from one folder into another folder. Files can be created and saved in an appropriate folder, or they can be placed into a new folder after they are saved.

---

### 3. Copying, Renaming, and Deleting

#### Skills Covered

Files and folders can be duplicated by copying and pasting. Copying a file or folder does not affect the original but makes an identical digital copy. When a file or folder is deleted, it is not truly gone until the Recycle Bin is emptied. Cutting a file or folder removes it from the current location and places it on the Clipboard (in memory) so that it can be pasted in another location. Cutting and pasting a file or folder achieves the same effect as dragging—the original is moved from its current position to a new location. After you have saved a file, you can easily rename it.

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#### 4. File Preview and Open With

##### **Skills Covered**

A file's content can be scanned with the Windows 7 Preview Pane without opening the file. But when a file is to be opened, you can select the program you want to use to open the file using the Open With option.

---

#### 5. Saving Files

##### **Skills Covered**

Files can be saved into existing folders or they can be placed into a new folder at the time they are saved.

## Windows 8

### Lesson Topics

1. Navigating
2. File Management

### Overview

Microsoft Windows is the dominant operating system on personal computers around the world; Windows 8 is the most recent version.

The operating system is the most important software on a computer. The operating system acts as an interface between application software and the hardware and allows users to manage files and applications. Roughly 90 percent of personal computers use Microsoft Windows operating systems. You will encounter Windows operating systems such as Windows 8 on residential, business, and educational computer systems worldwide. Being comfortable in the Windows environment is key to becoming computer literate. This includes being able to navigate around the components of the operating system, adjust system settings, manipulate software applications, and manage files.

Windows 8 was released in 2012. There are several versions of Windows 8. Depending on which version you are using, some features may differ. However, the features covered in this lesson are relevant to all versions of Windows 8.

## Navigating

### Lesson Topics

1. Windows 8 Layout
2. Working with Apps
3. Charms & Settings
4. Internet Explorer 10
5. Windows 8 Shortcuts
6. Getting Help

### Overview

Navigating in Windows 8 requires a familiarity with all Windows 8 features including the user interface, customizing and personalizing the Windows Start Screen, changing system settings, using Internet Explorer browser, using shortcuts, and getting help.

Windows is the dominant operating system in the world, used throughout business and educational institutions. Having a firm understanding of how to navigate and

use Windows 8 is essential to gain computer literacy and be productive in today's technology-centric environment. Since Windows 8 is designed for both touch screen and keyboard interaction, working with the operating system requires familiarity with both approaches. These video lessons introduce keyboard and click-based functions, so if you have a tablet or other touch-based device, take some time outside of these lessons to learn the equivalent tap or swipe commands.

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## 1. Windows 8 Layout

### **Skills Covered:**

Windows 8 has a completely new look and feel, beginning with the Start Screen. The Start Button is gone! Wondering how you shut down Windows 8?

---

## 2. Working with Apps

### **Skills Covered:**

Software programs, or apps, can be launched in Windows 8 using tiles on the Start Screen. Multiple apps can run simultaneously. Windows 8 provides numerous ways to launch and manipulate windows, including several that are new to Windows. Understanding how to run apps and manipulate windows is an essential skill for computer users.

---

## 3. Charms & Settings

### **Skills Covered:**

The Charms bar is accessed on the right side of the Start Screen. Charms provide quick links to popular functions within Windows 8 and its apps. This lesson introduces the five new charms: Settings, Devices, Start, Share and Search.

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## 4. Internet Explorer 10

### **Skills Covered:**

Internet Explorer 10 has been completely redesigned for touch-based devices. Tabs are gone, but it's easier than ever to pin any Web page to the Windows 8 Start Screen.

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## 5. Windows 8 Shortcuts

### **Skills Covered:**

If you have a touch-based device, you'll quickly learn which tap and swipe gestures access and launch content. Since many computer users still rely on keyboard and mouse functionality, it's useful to know some keyboard shortcuts to navigate within Windows 8.

---

## 6. Getting Help

### **Skills Covered:**

Windows 8 makes it easy to find online help and support, starting with the new Search charm in the Charms bar.

## **File Management**

### **Lesson Topics**

1. Windows Explorer Ribbon
2. File History
3. Using Search
4. Working with Folders and Files
5. Using OneDrive

### **Overview**

File management refers to the important practice of creating and manipulating files, and organizing files in folders on a computer system. Knowing how to organize files into folders and subfolders is essential to keeping your digital life in order. Although the Windows 8 search function is excellent for finding individual files or folders, finding related information is beyond the scope of the search feature. Organizing your files in a hierarchy of folders and subfolders will help you quickly find the information you need.

---

## 1. Windows Explorer Ribbon

### **Skills Covered:**

Using the analogy of a filing cabinet, the files and folders on your computer are the digital equivalents of paper documents and folders in filing cabinet drawers. In Windows 8, the former File Explorer is now called "Windows Explorer." Opening Windows Explorer provides access to a ribbon with tabs for File, Home, Share and

View. There's also a Quick Access Toolbar you can easily customize to better suit the way you work with files and folders.

---

## 2. File History

### **Skills Covered:**

Windows 8 comes with a feature called "File History" that makes it easy to back up to a second drive location, including USB and external hard drives. You also have advanced settings to control the frequency of backups.

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## 3. Using Search

### **Skills Covered:**

The Windows 8 Search charm makes it easy to search for apps, settings and files on your computer. You can also use this charm to perform a contextual search within open apps, including those connected to the Internet.

---

## 4. Working with Folders and Files

### **Skills Covered:**

Windows Explorer and the Desktop view within Windows 8 make it easy to work with folders and files. This lesson explores ways to work with folders, including how to move, copy, rename, delete, share, pin, and recover deleted folders.

---

## 5. Using OneDrive

### **Skills Covered:**

Windows 8 makes it easier than ever to use Microsoft's OneDrive cloud-based storage solution. Learn how your live.com account gives you free access to the cloud so you can save and retrieve your files from anywhere with an Internet connection.

## Mac OS X

### Lesson Topics

- Mac OS X Layout
- Mac OS X Tools
- Mac OS X File Management

### Overview

Mac OS X (Mac Operating System 10), the second most popular operating system for personal computers, was developed by Apple Inc. in 2002 and, like Microsoft Windows, has received several updates since.

The operating system is the most important software on a computer. The operating system acts as an interface between application software and the hardware and also provides file and application management capabilities to the user. There are a wide range of useful functions provided by the operating system.

Roughly 9% of personal computers are Apple Macs running Mac OS X. Over the past few years, Mac has grown in popularity and is expected to continue expanding its market share. Mac OS X Leopard was released in 2007, followed by Snow Leopard in 2009, which introduced refinements to the system. The tutorials provided here are applicable to both Leopard and Snow Leopard.

Although Apple's Mac OS X utilizes a different style of user interface than Microsoft Windows, the two share all of the most important functions of an operating system and it is relatively easy to switch from one to the other. The ability to work on both Windows and Mac computers is valuable in professional environments where both platforms are represented.

## Mac OS X Layout

### Lesson Topics

1. The Desktop
2. The Menu Bar
3. The Finder
4. The Dock

### Overview

Mac OS X has a very different look and feel than Windows operating systems, but fundamentally it performs very similar functions. Learning the layout of Mac OS X will make any Windows or novice computer user much more comfortable with

using Mac OS X. This lesson introduces the layout of Mac OS X and teaches you some basics about working on an Apple computer running Mac OS X.

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## 1. The Desktop

### **Skills Covered**

Mac OS X has a very different look and feel than Windows operating systems, but fundamentally it performs very similar functions. Learning the layout of Mac OS X will make any Windows or novice computer user much more comfortable with using Mac OS X. This lesson introduces the layout of Mac OS X and teaches you some basics about working on an Apple computer running Mac OS X.

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## 2. The Menu Bar

### **Skills Covered**

The Menu Bar is the semi-transparent bar that spans the top of the screen and holds the menu options for the active application.

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## 3. The Finder

### **Skills Covered**

The Finder is the “handle” that opens the digital filing cabinet of your computer. From the Finder you can access everything stored on your machine.

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## 4. The Dock

### **Skills Covered**

The Dock is the bar of icons at the bottom or side of the screen. It holds links to commonly used and currently running applications, minimized windows, stacks of files, the Finder, and the Trash.

## **Mac OS X Tools**

### **Lesson Topics**

1. System Preferences
2. Customize and Personalize



3. Exposé, the Dashboard, and Spaces
4. Search
5. Help

## Overview

Mac OS X includes many tools that enable you to configure and customize your system, search for documents, get help, and more. Knowing how to use the built-in tools available in Mac OS X can make the user experience much smoother and more efficient, not to mention a lot more enjoyable. There are many available tools in Mac OS X, but you don't have to use them all. They are all optional, so only use the ones that make your Mac experience better.

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### 1. System Preferences

#### Skills Covered

System Preferences is where all the settings and configurations for your computer are located. In System Preferences you can create user accounts, set parental controls, make Internet and network connections, set security controls, and much more.

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### 2. Customize and Personalize

#### Skills Covered

Mac OS X is highly configurable and can easily be customized for your personal computing experience. For example, the appearance of buttons, windows, menus, the Desktop, and the screen saver can all be changed, as well as settings for the Dock, Exposé, and Spaces.

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### 3. Exposé, Dashboard, and Spaces

#### Skills Covered

Exposé reveals all the open applications and windows currently on the Desktop. It is ideal for getting a bird's-eye view of everything and finding the window you want. The Dashboard holds mini-applications and puts useful information at your fingertips, and Spaces reveals multiple desktops to organize an overcrowded screen.

---

## 4. Search

### Skills Covered

The Mac OS X Spotlight feature can search for file or folder names, or it can search for content. Entering text into Spotlight will initiate a search of the entire hard drive, or you can refine your search using the search bar in the Spotlight window. Preferences for Spotlight can be set in the Spotlight category of System Preferences. If you need to find something on your computer, let Spotlight search for it.

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## 5. Help

### Skills Covered

Help is a resource for finding answers about Mac OS X, from the most basic questions to complicated troubleshooting. Help includes support articles that Apple Support has filed to answer questions on many topics.

## Mac OS X File Management

### Lesson Topics

1. File and Folder Organization
2. Creating and Moving
3. Copying, Renaming, and Deleting
4. Quick Look and Open With
5. Saving Files

### Overview

File management refers to the important practice of creating, and manipulating files, and organizing files in folders on a computer system. Knowing how to organize files into folders and subfolders is essential to keeping your digital life in order. Although the Mac OS X Spotlight search function is excellent for finding individual files or folders, finding related information is beyond the scope of the search feature. Organizing your files in a hierarchy of folders and subfolders will help you quickly find the information you need.

It is useful to think of a computer as a digital filing cabinet. With this in mind, it is easy to understand how files are organized in folders and subfolders. The “handle” that opens your digital filing cabinet is the Finder.

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## 1. File and Folder Organization

### **Skills Covered**

Using the analogy of a filing cabinet, the files and folders on your computer are the digital equivalents of paper documents and folders in filing cabinet drawers.

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## 2. Creating and Moving

### **Skills Covered**

Folders typically hold related files. Files can be moved (dragged) from one folder into another folder, and from Finder window to Finder window. Files can be created and saved in an appropriate folder, or they can be placed into a new folder after they are saved.

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## 3. Copying, Renaming, and Deleting

### **Skills Covered**

Files and folders can be duplicated by copying and pasting. Copying a file or folder does not affect the original, but makes an identical digital copy. When a file or folder is deleted, it is not truly gone until the Trash is emptied. Cutting a file or folder removes it from the current location and places it on the Clipboard (in memory) so that it can be pasted in another location. Cutting and pasting a file or folder achieves the same effect as dragging—the original is moved from its current position to a new location. Renaming a file simply changes its file name but does not affect the contents of the file.

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## 4. Quick Look and Open With

### **Skills Covered**

A file's content can be scanned with Quick Look in the Finder without opening the file. But when a file is to be opened, you can select the program with which to open the file using the Open With option.

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## 5. Saving Files

### **Skills Covered**

Files can be saved into existing folders, or they can be placed into a new folder at the time they are saved.

## **Office 2013 - Common Application Components**

### **Lesson Topics**

1. Launching Applications
2. Application Components
3. Ribbons & Tabs
4. Getting Help

## **Word 2013**

### **Lesson Topics**

1. Overview of Word Processing
2. Document Formatting Techniques
3. Academic Publishing Tools

### **Overview**

Microsoft Word® 2013 is a word processing application that is ideal for creating, editing, formatting and sharing professional-looking documents using styles and themes, graphics, tables and figures, citations, and many more publishing tools.

Knowing how to use this program or a comparable full-featured word-processing program is an indispensable skill in both the classroom and nearly all professions. Today's employers consistently cite written communication skill as one of the key skills most lacking in college graduates. By learning how to harness the power of word processing software now, you will set yourself apart from your peers and increase your chances for professional recognition and success.

### **Overview of Word Processing – Lesson Topics**

1. Word Processing Tools and Features
2. Word Processing Case Study
3. Well-formed Documents
4. Word Processing Uses

### **Document Formatting Techniques – Lesson Topics**

1. Creating and Editing Documents
2. Applying Styles
3. Working with Themes
4. Headers and Footers
5. Tabs and Indents
6. Setting Document Margins
7. Working with Columns
8. Inserting Page and Section Breaks

**Academic Publishing Tools – Lesson Topics**

1. Inserting Figures with Captions
2. Thesaurus, Define Tool and Document Statistics
3. Footnotes and Endnotes
4. Symbols and Equations
5. Citations and Bibliography
6. Table of Contents
7. Integration: Inserting Spreadsheet Data

## **Excel 2013**

### **Lesson Topics**

1. Overview of Spreadsheets
2. Cells and Cell Data
3. Formulas
4. Functions
5. Formatting Spreadsheets
6. Spreadsheet Graphics
7. Advanced Spreadsheet Tools

### **Overview**

Microsoft Excel® 2013 is a spreadsheet application that is ideal for collecting, analyzing, reporting and sharing both qualitative and quantitative data and information. Everything from personal household budgets to large corporate financial plans are created and used in Excel every day around the world. The software makes it easy to create graphics for quick visualization of historical data patterns, current organizational activity and future data trend predictions, making it the “go-to” program for serious business professionals.

Most corporate recruiters favor job candidates with a solid background in quantitative analysis and decision making. By learning how to use Excel now, you’ll add a valuable skillset to your list of qualifications while demonstrating your readiness for the challenges of a professional work environment.

### **Overview of Spreadsheets - Lesson Topics**

1. Spreadsheet Tools and Features
2. Spreadsheet Case Study
3. Well-formed Spreadsheets
4. Spreadsheet Uses

### **Overview**

On the list of skills most desired by corporate recruiters is the ability to analyze data, solve problems and make decisions using quantitative tools. In upcoming Excel video lessons, you’ll learn what types of situations are best suited for using spreadsheets, and how to structure your own spreadsheets for easier and faster data analysis when changes are required.

## **Cells and Cell Data - Lesson Topics**

1. Creating and Editing Spreadsheets
2. Selecting Objects
3. Entering and Editing Data
4. Adjusting Rows and Columns
5. Grouping Rows and Columns
6. Copying Cell Data
7. Using the Fill Handle and Flash Fill
8. Inserting and Deleting

### **Overview**

There's a phrase commonly used by computing professionals that says, "Garbage in, garbage out." What it means is that bad data and poorly-structured formulas going into a spreadsheet will only result in bad information and unusable results coming out. The video lessons on this page are designed to help you understand how to enter data into a spreadsheet, copy cell data quickly, and do a better job of creating accurate and efficient formulas to work with data so you don't experience "garbage in, garbage out."

## **Formulas - Lesson Topics**

1. Using Arithmetic Formulas
2. Formula Auditing
3. Using Named Ranges

### **Overview**

The video lessons on this page are designed to strengthen your ability to understand arithmetic formulas and to successfully de-bug them to remove errors when they don't provide correct results. You'll also see how to name a range of cells, and then use that named range as a reference in cell formulas and functions. It's one thing to know how to set up a formula, but quite another to figure out how to fix one with errors in it. Being able to do this efficiently is a great problem-solving skill to possess.

## **Functions - Lesson Topics**

1. Using Functions
2. Copying Functions
3. 3-D References
4. Absolute References
5. Using Logical Functions (IF)



6. Advanced Functions (VLOOKUP)
7. Advanced Functions (PMT)
8. Function and Formula Troubleshooting

## **Overview**

You'll gain a better understanding of the difference between a relative cell reference and an absolute cell reference. This knowledge is critical if you're going to create formulas and functions that will be copied within a spreadsheet. When a spreadsheet has multiple pages that reference data and formulas across those sheets, your new knowledge of how to create 3-D references will prove invaluable.

## **Formatting Spreadsheets - Lesson Topics**

1. Number Formats
2. Aligning Cell Contents
3. Sorting and Filtering Data
4. Working with Tables
5. Applying Borders and Shading
6. Applying Conditional Formatting

## **Spreadsheet Graphics - Lesson Topics**

1. Creating Charts
2. Chart Types
3. Creating Sparklines
4. Inserting Pictures
5. Integration: Inserting Graphics from PowerPoint
6. Adjusting Page Layout
7. Printing Spreadsheets

## **Overview**

When it comes to reading Excel spreadsheet data, the phrase, "A picture is worth a thousand words," could not be truer. Spreadsheets often contain vast quantities of numeric and text data that can be difficult to quickly sort through in search of patterns or answers to questions about the data. Creating charts based upon those data is the simple solution, and can make the daunting task of interpreting the data a simple matter of reading a chart or graph to discover the answers the visual data representations hold. Even if you have created charts before in Excel, there are new tools and techniques in the latest version that are sure to spark your creativity.

## **Advanced Spreadsheet Tools - Lesson Topics**

1. PivotTables, PivotCharts and the Slicer
2. Using Data Tools and Quick Analysis
3. Using Add-Ins

### **Overview**

Excel is an extremely versatile quantitative analysis application. In addition to the fundamental skills demonstrated here in Emerge, there are more advanced features and tools available to help you take data-intensive worksheets and summarize them into meaningful form for a wide variety of readers, perform sensitivity and what-if analyses on data, and apply add-in tools to extend the statistical analysis and reporting abilities of the software.

These features include PivotTables, PivotCharts, a filtering tool called “The Slicer,” and add-in programs such as the Excel Analysis ToolPak and Solver.

## **PowerPoint 2013**

### **Lesson Topics**

1. Overview of PowerPoint
2. Working with Slides and Text
3. Using Graphics Objects
4. Formatting a Slide Show
5. Presenting and Publishing

### **Overview**

Microsoft PowerPoint® 2013 is a presentation software application that is ideal for creating, editing, formatting, and sharing professional-looking presentations that include text, graphics, videos, music, and much more!

The program has features that let you easily import text and graphics from other Office programs. With its presenting and broadcasting options, you can easily make your presentations available online in real-time. There also are updated tools for dressing up slides with embedded videos and music, transitions, and customizable animations that give any presentation professional appeal.

### **Overview of PowerPoint - Lesson Topics**

1. PowerPoint Tools and Features
2. PowerPoint Case Study
3. Effective PowerPoint Presentations
4. PowerPoint Presentation Uses

### **Working with Slides and Text - Lesson Topics**

1. Creating and Editing Presentations
2. Integration: Creating a Presentation from a Word Outline
3. Working with Slides
4. Entering and Formatting Text and Hyperlinks
5. Inserting Symbols and Equations
6. Presentation Views
7. Using the Ruler and Gridlines

### **Using Graphics Objects - Lesson Topics**

1. Inserting Graphics
2. Adjusting Object Properties
3. Layering and Grouping Objects
4. Animating Objects

5. Working with Tables and SmartArt
6. Inserting Video and Music
7. Integration: Inserting a Spreadsheet Table

### **Formatting a Slide Show - Lesson Topics**

1. Slide Header and Footer
2. Inserting Date & Time and Slide Numbers
3. Working with a Slide Master
4. Working with Slide Design
5. Working with Slide Transitions
6. Setting Up a Slide Show

### **Presenting and Publishing - Lesson Topics**

1. Presenting with a Slide Show
2. Printing Slides
3. Publishing a Presentation
4. Presenting Online

## **Access 2013**

### **Lesson Topics**

1. Overview of Databases
2. Database Tables
3. Datasheets and Forms
4. Queries and Reports

### **Overview**

Microsoft Access® 2013 is a database application that is ideal for gathering and understanding data that's been collected on just about anything – from customers and employees, to inventory, services, and events. Marketing managers use databases to better understand how products and services are selling, and who's buying those products and services. Human resource managers use databases to track employees, benefits, and training activities. Accounting, financial and operations managers use databases to manage inventory, track investments, and prepare and share reports on all aspects of business operations to both internal and external stakeholders. And information systems managers help develop and maintain those databases while also using them to track computer equipment, manage system user information, and much more.

While you may not become a database developer in your career, you will certainly be a user of databases, both personally and on the job. By gaining a fundamental understanding of how databases work, you'll be better prepared to take advantage of your company's own database systems, perform at a higher level in your career, and set yourself apart as a data-driven and analytical professional.

### **Overview of Databases - Lesson Topics**

1. Database Management Tools and Features
2. Database Case Study
3. Effective Database Management
4. Database Uses
5. Creating and Saving Databases

### **Overview**

Access is Microsoft's relational database management program. It's designed to help users create databases – collections of data – for later retrieval, manipulation and reporting of that data to support problem-solving and decision making activities. To use a database, though, you don't have to be its creator. In fact, most of the time we aren't even aware that it's a database we are using when we search for something

online, ask a store clerk to check the status of an out-of-stock item, use library resources to find books, or buy an airline ticket.

### **Database Tables - Lesson Topics**

1. Creating a Table in Datasheet View
2. Creating a Table in Design View
3. Primary Keys
4. Adding Fields Using the Data Type Gallery
5. Integration: Working with Spreadsheet Data
6. Integration: Importing Data from Another Access Database
7. Integration: Importing Data from a Text File
8. Table Relationships

### **Overview**

Before you can use a database for problem-solving and decision making, the database needs to be populated with data. The data in any database also have to be arranged in a logical manner to make it easy to add, change, delete and create information based on the data.

### **Datasheets and Forms - Lesson Topics**

1. Entering Data in Datasheets
2. Subdatasheets & Lookup Fields
3. Sort & Filter
4. Calculating
5. Using Forms
6. Designing Forms
7. Creating a Form with a Subform

### **Overview**

The data in an Access database are organized into tables which are joined together through key fields. Data may be entered into a database directly into tables or through forms that you can create to simplify and control the data entry process. Additionally, Access provides tools for sorting, filtering, and performing calculations on the data that make the task of extracting and reporting that data later much easier.

**Queries and Reports - Lesson Topics**

1. Simple Queries
2. Querying Joined Tables
3. Calculating Values
4. Reports

**Overview**

The real value of a database is found in the user's ability to query its contents to get answers to questions about the data held in the system's tables. When data are collected in a database's tables, it's understood that those data will someday be needed to answer specific questions. Otherwise, why go to the trouble of collecting it in the first place?

## **Office 2013 - Other Office 2013 Applications**

### **Lesson Topics**

1. Outlook
2. OneNote
3. Office Web Apps

### **Overview**

In addition to Word, Excel, PowerPoint and Access, Microsoft Office® 2013 includes Outlook and OneNote. Outlook is a popular and sophisticated e-mail program used by millions of people worldwide to communicate, maintain contacts, manage calendars and meetings, track to-do lists, and even connect to each other via social networks.

Microsoft calls OneNote a “digital notebook” that can be used to collect and store just about anything, from random screenshots and web clippings, to documents, photos, videos, notes and illustrations. The notebooks can be easily shared with others, and when materials are collected from online sites, the original source is collected with the content to make it easy to retrieve and cite the author or creator of the materials gathered.

On the web, Microsoft now makes basic versions of its popular Word, Excel, and PowerPoint programs available through its live.com web site. The latest release of Office makes it clear that, no matter where you work, there is a software solution to help you efficiently and effectively get your work done.



## Office® for Mac 2011 – Common Office 2011 Components

### Lesson Topics

1. Launching Applications
2. Application Components
3. Ribbons & Tabs
4. Getting Help

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#### 1. Launching Applications

##### Skills Covered

Launching applications in Microsoft Office for Mac 2011, adding applications to the dock, removing applications from the dock, and closing an application.

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#### 2. Application Components

##### Skills Covered

Locating the Standard toolbar, displaying ScreenTips, minimizing, zooming and maximizing the application window, maximizing and expanding the Ribbon, locating the Zoom slider, locating the View buttons, and locating the status bar.

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#### 3. Ribbons & Tabs

##### Skills Covered

Navigating the Ribbon, navigating the Menu bar, and using the File menu.

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#### 4. Getting Help

##### Skills Covered

Using ScreenTips to get help on a topic and looking up information in Help.

## **Word 2011**

### **Lesson Topics**

1. Overview of Word Processing
2. Document Formatting Techniques
3. Academic Publishing Tools

### **Overview**

Microsoft Word® for Mac 2011 is a word processing application that is ideal for creating, editing, formatting, and sharing professional-looking documents using styles and themes, graphics, tables and figures, citations, and many more publishing tools.

Knowing how to use this program or a comparable full-featured word-processing program is an indispensable skill in the classroom and nearly all professions. Today's employers consistently cite written communication skill as one of the key skills most lacking in college graduates. By learning how to harness the power of word processing software now, you will set yourself apart from your peers and increase your chances for professional recognition and success.

### **Overview of Word Processing - Lesson Topics**

1. Word Processing Tools and Features
2. Word Processing Case Study
3. Well-formed Documents
4. Word Processing Uses

### **Document Formatting Techniques - Lesson Topics**

1. Creating and Editing Documents
2. Applying Styles
3. Working with Themes
4. Headers and Footers
5. Tabs and Indents
6. Setting Document Margins
7. Working with Columns
8. Inserting Page and Section Breaks

### **Academic Publishing Tools - Lesson Topics**

1. Inserting Figures with Captions
2. Thesaurus, Research Tools, and Document Statistics
3. Footnotes and Endnotes
4. Symbols and Equations
5. Citations and a Bibliography
6. Table of Contents
7. Integration: Inserting Spreadsheet Data

## **Excel 2011**

### **Lesson Topics**

1. Overview of Spreadsheets
2. Cells and Cell Data
3. Formulas
4. Functions
5. Formatting Spreadsheets
6. Spreadsheet Graphics
7. Advanced Spreadsheet Tools

### **Overview**

Microsoft Excel® 2011 is a spreadsheet application that is ideal for collecting, analyzing, reporting, and sharing both qualitative and quantitative data and information. Everything from personal household budgets to large corporate financial plans are created and used in Excel every day around the world. The software makes it easy to create graphics for quick visualization of historical data patterns, current organizational activity, and future data trend predictions, making it the “go-to” program for serious business professionals.

Most corporate recruiters favor job candidates with a solid background in quantitative analysis and decision making. By learning how to use Excel now, you’ll add a valuable skill set to your list of qualifications while demonstrating your readiness for the challenges of a professional work environment.

### **Overview of Spreadsheets - Lesson Topics**

1. Spreadsheet Tools and Features
2. Spreadsheet Case Study
3. Well-formed Spreadsheets
4. Spreadsheet Uses

### **Cells and Cell Data - Lesson Topics**

1. Creating and Editing Spreadsheets
2. Selecting Objects
3. Entering and Editing Data
4. Adjusting Rows and Columns
5. Grouping Rows and Columns
6. Copying Cell Data
7. Using the Fill Handle
8. Inserting and Deleting

**Formulas - Lesson Topics**

1. Using Arithmetic Formulas
2. Formula Auditing
3. Using Named Ranges

**Functions - Lesson Topics**

1. Using Functions
2. Copying Functions
3. 3-D References
4. Absolute References
5. Using Logical Functions (IF)
6. Advanced Functions (VLOOKUP)
7. Advanced Functions (PMT)
8. Function and Formula Troubleshooting

**Formatting Spreadsheets - Lesson Topics**

1. Number Formats
2. Aligning Cell Contents
3. Sorting and Filtering Data
4. Working with Tables
5. Applying Borders and Shading
6. Applying Conditional Formatting

**Spreadsheet Graphics - Lesson Topics**

1. Creating Charts
2. Chart Types
3. Creating Sparklines
4. Inserting Pictures
5. Integration: Inserting Graphics from PowerPoint
6. Adjusting Page Layout
7. Printing Spreadsheets

**Advanced Spreadsheet Tools - Lesson Topics**

1. Pivot Tables
2. Using Data Tools
3. Using Add-ins

## **PowerPoint 2011**

### **Lesson Topics**

1. Overview of PowerPoint
2. Working with Slides and Text
3. Using Graphics Objects
4. Formatting a Slide Show
5. Presenting and Publishing

### **Overview**

Microsoft PowerPoint® 2011 is a presentation software application that is ideal for creating, editing, formatting, and sharing professional-looking presentations that include text, graphics, videos, music, and much more!

The program has features that let you easily import text and graphics from other Office programs. With its presenting and broadcasting options, you can easily make your presentations available online in real time. There also are updated tools for dressing up slides with embedded videos and music, transitions, and customizable animations that give any presentation professional appeal.

### **Overview of PowerPoint - Lesson Topics**

1. PowerPoint Tools and Features
2. PowerPoint Case Study
3. Effective PowerPoint Presentations
4. PowerPoint Presentation Uses

### **Working with Slides and Text - Lesson Topics**

1. Creating and Editing Presentations
2. Integration: Creating a Presentation from a Word Outline
3. Working with Slides
4. Entering and Formatting Text and Hyperlinks
5. Inserting Symbols and Equations
6. Presentation Views
7. Using the Ruler and Guides

**Using Graphics Objects- Lesson Topics**

1. Inserting Graphics
2. Adjusting Object Properties
3. Layering and Grouping Objects
4. Animating Objects
5. Working with Tables and SmartArt
6. Inserting Video and Music
7. Integration: Inserting a Spreadsheet Table

**Formatting a Slide Show - Lesson Topics**

1. Slide Header and Footer
2. Inserting Date & Time and Slide Numbers
3. Working with a Slide Master
4. Working with Slide Design
5. Working with Slide Transitions
6. Setting Up a Slide Show

**Presenting and Publishing - Lesson Topics**

1. Presenting with a Slide Show
2. Printing Slides
3. Publishing a Presentation

## **Other Office 2011 Applications**

### **Lesson Topics**

1. Outlook

### **Overview**

In addition to Word, Excel, PowerPoint and Access, Microsoft Office® 2011 includes Outlook. Outlook is a sophisticated e-mail program used by over 500 million people worldwide to communicate, maintain contacts, manage calendars and meetings, track to-do lists, and even connect to each other via social networks.

### **Outlook - Lesson Topics**

1. E-Mail
2. Calendaring & Tasks

### **Overview**

Microsoft Outlook 2011 is more than just an e-mail management program. With over 500 million Office users globally, this application offers communication tools that range from message organization and search to calendaring, meeting scheduling, connection with social networks, and more.

## Google Docs

### Lesson Topics

1. Navigating in Google Docs
2. Word Processing
3. Spreadsheets Part 1
4. Spreadsheets Part 2
5. Presentations

### Overview

Google was one of the first companies to provide a full suite of productivity software applications online. While not nearly as powerful as installed software like Microsoft Office, Google Docs provides most features and tools that people use when creating word processing documents, spreadsheets, and presentations. Google Docs provides the additional benefit of storing your work in “the cloud,” that is, on Internet servers, where it can be accessed from any Internet-connected computer. This makes it an ideal tool for collaborating on documents with others over the Internet.

### Navigating in Google Docs - Lesson Topics

1. Creating Documents and Folders
2. Uploading Files
3. Sharing Documents
4. Managing Documents
5. Searching for Documents

### Overview

Navigating in the Google Docs interface allows you to create or upload word processing, spreadsheet, presentation, and other documents, and to edit, organize, and share them, all in an easy-to-use online environment.

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#### *1. Creating Documents and Folders*

### Skills Covered

When you first open Google Docs, you are presented with a page that lists your Google Docs along with several options and menus. Creating a new document is as simple as clicking “Create” and choosing from several common types of documents. You also have the option of creating a new “Collection” for organizing your documents, and choosing from hundreds of different templates.

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## *2. Uploading Files*

### **Skills Covered**

Google Docs allows you to upload existing files from your local computer. To upload a file to Google Docs, click the Upload button, located just to the right of the Create button. Next, locate the file to upload by clicking “Files...,” browse your computer for the files you want and select them, and click Open.

---

## *3. Sharing Documents*

### **Skills Covered**

Because Google Docs is an online suite of applications, it is very easy to share docs with others. You are given the option to allow certain users to either be able to make changes to documents, or only look at them.

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## *4. Managing Documents*

### **Skills Covered**

The Google Docs homepage by default lists all items in order of the last modified. There are several ways of organizing and viewing your docs. You can change their listing order with the drop-down Sort menu. You can also organize your files into collections, preview files, download files, or unsubscribe to files.

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## *5. Searching for Documents*

### **Skills Covered**

There are several listing options in the navigation menu to help you find a doc. If you are looking for a specific document and can't seem to find it using these different listing options, you can use the Google Docs built-in search.

## **Word Processing - Lesson Topics**

1. Document View and Styles
2. Paragraph Formatting
3. Table of Contents, Bookmarks, and Links
4. Inserting Pictures
5. Tables, Tools, and Sharing
6. Printing, Saving, and Closing

## Overview

Knowing how to use Google Docs for research papers is very useful skill for students. Today, educators are concerned not only with quality content, but also with quality presentation. Google Docs is an ideal application for creating professional-looking research papers if you know how to use it to its full potential—and that is exactly what you will learn in this lesson.

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### *1. Document View and Styles*

#### **Skills Covered**

Documents in Google Documents can be viewed as a regular Web page or changed to look more like a traditional word-processed document. The overall page style can also be set to adjust line spacing, font, background, and more.

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### *2. Paragraph Formatting*

#### **Skills Covered**

The contents of the document can be transformed into a professional-looking publication with appropriate page breaks, headings, subheadings, headers, footers, and other formatting

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### *3. Table of Contents, Bookmarks, and Links*

#### **Skills Covered**

A professional research paper is not complete without a table of contents (TOC). Google Documents can automatically create a table of contents if the headings are formatted correctly. Each heading in the TOC is automatically hyperlinked to the corresponding section in the paper for easy navigation.

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### *4. Inserting Pictures*

#### **Skills Covered**

Pictures are easily inserted into Google Documents by uploading them from your computer, pasting a link to an image already online, searching for an image using Google Image Search, choosing an image from my Picasa Web Album, or searching for a Stock photo.

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### *5. Tables, Tools, and Sharing*

#### **Skills Covered**

As in most word processors, in Google Documents you can create, insert, and edit tables. Google Documents also offers a number of useful tools such as a spelling checker, word count, lookup references, and revision history for tracking when, what, and who made changes to the document. Finally, docs can be shared with others, e-mailed as attachments, or published to the Web or a blog.

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### *6. Printing, Saving, and Closing*

#### **Skills Covered**

Setting up a document to print couldn't be easier with Google Documents' Print settings. When printed, the doc is transformed into a PDF file that is sent to the local printer. Google Docs automatically saves your documents, so there is no Save or Close option in the File menu.

### **Spreadsheets Part 1 - Lesson Topics**

1. Basic Features
2. Working with Data in Cells
3. Formatting and Printing
4. Functions and Formulas
5. Graphics

#### **Overview**

Google Spreadsheets is an ideal tool for creating all kinds of spreadsheets, from simple shopping lists to complicated business accounting ledgers. Knowing how to create and use a spreadsheet is an invaluable skill. Like other spreadsheets, Google Spreadsheets enables you to perform logical and mathematical calculations on cell data using formulas, easing the burden of tedious repetition and boosting productivity. Unlike most other spreadsheet applications, Google Spreadsheets files are stored online so you can easily share them and collaborate with others.

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### *1. Basic Features*

#### **Skills Covered**

Spreadsheets are made up of rows and columns; the intersection of a row and a column is called a cell. Cells can be referred to by labels, and functions and formulas

can be used to operate on certain cells to produce calculated results. Labels, data, functions, and formulas form the basic skeletal structure of spreadsheets.

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## *2. Working with Data in Cells*

### **Skills Covered**

Entering and editing data into Google Spreadsheets is as simple as clicking the cell and typing in the formula bar, or double-clicking the cell and entering data directly. Cell data can be copied or moved using the same techniques as in Excel.

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## *3. Formatting and Printing*

### **Skills Covered**

Common formatting commands for cells and data are also located on the on the tool bar. They include formatting values as currency, percentages, and other number formats. There are also buttons for formatting font and cell attributes like background color and borders. Printing in Google Spreadsheets is similar to printing in Excel, but with fewer options.

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## *4. Functions and Formulas*

### **Skills Covered**

Google Spreadsheets supports hundreds of built-in functions like SUM, AVERAGE, MAX, and MIN. To insert a function type and equals sign and the functions name or select it from the Function options in the Insert menu or toolbar.

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## *5. Graphics*

### **Skills Covered**

From the Insert Image dialog box you can choose from a number of different ways of choosing the image to be inserted, including uploading from your computer, pasting an image URL of an image already online, or searching for an image online.

## **Spreadsheets Part 2 - Lesson Topics**

1. Revision History
2. Gadgets

3. Drawings
4. Scripts
5. Forms
6. Collaborating on Spreadsheets

## Overview

Google Spreadsheets is an ideal tool for creating all kinds of spreadsheets, from simple shopping lists to complicated business accounting ledgers. Knowing how to create and use a spreadsheet is an invaluable skill. Like other spreadsheets, Google Spreadsheets enables you to perform logical and mathematical calculations on cell data using formulas, easing the burden of tedious repetition and boosting productivity. Unlike most other spreadsheet applications, Google Spreadsheets files are stored online so you can easily share them and collaborate with others.

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### *1. Revision History*

#### **Skills Covered**

One of the best features of Google Spreadsheets is Revision history. Every time the spreadsheet autosaves a copy is archived in the Revision history. To view the revision history of the spreadsheet, go to the File menu and click “See revision history.”

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### *2. Gadgets*

#### **Skills Covered**

A spreadsheet gadget is a small program that interacts with the content of a spreadsheet much like the way a chart does, but more powerfully. To insert a gadget go to the Insert menu and click Gadget.

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### *3. Drawings*

#### **Skills Covered**

By going to the Insert menu and clicking Drawing, you will launch an embedded Google Drawings window. Google Drawings is an application in the Google Docs lineup used for making drawings, and in this instance inserting them into your spreadsheet.

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#### *4. Scripts*

##### **Skills Covered**

Google Apps Script is a powerful and flexible scripting environment that lets you automate actions across your spreadsheets. You can create your own scripts or access hundreds of already-created useful scripts from the script gallery.

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#### *5. Forms*

##### **Skills Covered**

Google Spreadsheets work hand in hand with Google Forms. To create a Form click the Insert menu and then click Form. Forms, or web forms, are elements on a web page or email that allow users to enter data and submit it to a server for processing. In this case Google Docs is your server and the collected data is stored in your spreadsheet.

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#### *6. Collaborating on Spreadsheets*

##### **Skills Covered**

The Share menu can be used to collaborate and work on a spreadsheet with others in real-time. If multiple users are working on a common spreadsheet, a notification will appear letting you know someone else is viewing the document. As your collaborator moves around the spreadsheet and makes edits to the cells the movements will be highlighted by a pink colored box.

#### **Presentations - Lesson Topics**

1. Basic Features
2. Inserting and Formatting Text
3. Inserting Graphics and Video
4. Formatting Graphics Objects
5. Working with Tables
6. Collaborating on Presentations
7. Viewing Presentations
8. Publishing, Downloading, and Printing

##### **Overview**

Creating and presenting presentations is a required skill for any professional whose job includes communicating ideas with others. Whether used for teaching, presenting reports, or defending a thesis, at some point in your career you will be

required to use presentation software. Google Presentations provides a convenient tool for generating presentations online and sharing them with others on the Web.

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### *1. Basic Features*

#### **Skills Covered**

When creating a presentation, you should take some care to establish the mood and feel of the design at the outset. Google Presentations provides many themes and templates to apply to your presentation for an immediate professional look. Slides need to be adjusted before being turned into a final presentation. Slide layouts should be applied when they are inserted and slide positions finalized in the slide window.

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### *2. Inserting and Formatting Text*

#### **Skills Covered**

Entering and formatting text in Google Presentations is as easy as it is in Google Documents. Fonts, colors, styles, and sizes of selected text are all quickly adjusted in the toolbar.

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### *3. Inserting Graphics and Video*

#### **Skills Covered**

There are several ways to insert graphics into a presentation. Whether uploaded from your computer or found on the Web, it only takes a few clicks to add graphics to the slide. It is also easy to move and resize graphics. Background images can be adjusted to match the design of the presentation depending on what is needed. YouTube videos can also be added to slides, ready to play when a slide is displayed.

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### *4. Formatting Graphics Objects*

#### **Skills Covered**

Graphics objects' fill and outline colors, orientation, and size, are fully adjustable in Google Presentations. Additionally, clicking "Add animation" adds an animation to the selected object.

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### *5. Working with Tables*

#### **Skills Covered**

Tables are useful for displaying structured data in a presentation. You can insert a table into a presentation via the Insert menu or the Table menu.

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### *6. Collaborating on Presentations*

#### **Skills Covered**

Using the Share button, you can invite other users to collaborate on a Google Presentations. When other users are editing the presentation you will be notified with a status message stating the number of other viewers viewing the document. As edits are made, the presentation will be automatically refreshed on each user's screen to reflect the updates.

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### *7. Viewing Presentations*

#### **Skills Covered**

To view a presentation from the beginning, go to the View menu and click "Start presentation" or click the "Start presentation" button next to the Comments and Share buttons. The presentation will be displayed in a full-screen window.

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### *8. Publishing, Downloading and Printing*

#### **Skills Covered**

Saving a presentation is automatically done as soon as you start editing. You will be notified of the document's saved status with a message displayed in the menu bar. You can easily publish a presentation online by going to the File menu and clicking Publish to the Web, or viewed offline by downloading it as a Microsoft PowerPoint file, PDF, or text file.