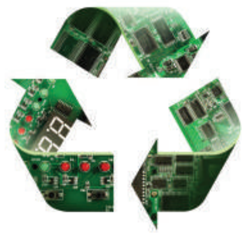
MERIT BADGE SERIES

DIGITAL TECHNOLOGY



BOY SCOUTS OF AMERICA®

STEM-Based

BOY SCOUTS OF AMERICA
MERIT BADGE SERIES

DIGITAL TECHNOLOGY

"Enhancing our youths' competitive edge through merit badges"

BOY SCOUTS OF AMERICA®

Note to the Counselor

The Digital Technology merit badge was designed to show the close relationship between humans and the technical world surrounding us. The fleur-de-lis in the center represents the Scout who, acting as the "brain" of a typical computing device, interfaces with the digital technology world through the means that those electronic devices can "understand"—electrons, bits of data, and specialized pathways for information. As we increasingly use digital technology in our everyday world, this relationship extends from the Scout to the digital devices.

Eventually, the machine becomes an extension of the Scout's will, carrying out what the Scout directs it to do. The challenge for the Scout and for every user of digital technology is to understand this boundary and relationship, to not lose one's own identity in the machine. We humans must remember that machines are simply an extension of—not a replacement for—the human mind.

The American Standard Code for Information Interchange, or ASCII, is used to transmit information between computers. To manage the alphabet, this binary system uses numbers 0 to 9 and special characters for 256 possible combinations with an eight-digit binary number. Those numbers would be 00000000, 00000001, 00000010, 00000011, 00000100, up to 11111111. In decimal it would be 0, 1, 2, 3, 4, and so on, up to 255. That's 256 combinations, including zero.

Where does that number come from? Computers at the most fundamental level handle circuits that are like "on" and "off" switches. In the decimal system, we typically use 10 symbols—numerals 0 to 9—and every digit uses a factor of 10. The binary system uses only two symbols—0 and 1—and a factor of 2. In the digital technology industry, these conditions are typically referred to as a binary number system with 1 for "on" and

35733
ISBN 978-0-8395-0000-0
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2024 Printing

0 for “off.” In decimal, the number 12 would be written as 12 = (1 X 10) + (2 X 1). In binary, it would be written as 1100 = (1 X 8) + (1 X 4) + (0 X 2) + (0 X 1).

This chart includes a “translation” of zero through 9, the entire alphabet (capital and lowercase letters), and a few other characters. See “Understanding Data and Files” for more information on ASCII translation.

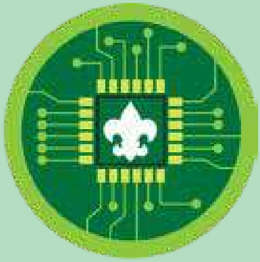
ASCII Code - Character to Binary

0	0011 0000	I	0100 1001	b	0110 0010	v	0111 0110
1	0011 0001	J	0100 1010	c	0110 0011	w	0111 0111
2	0011 0010	K	0100 1011	d	0110 0100	x	0111 1000
3	0011 0011	L	0100 1100	e	0110 0101	y	0111 1001
4	0011 0100	M	0100 1101	f	0110 0110	z	0111 1010
5	0011 0101	N	0100 1110	g	0110 0110		
6	0011 0110	O	0100 1111	h	0110 1000	:	0011 1010
7	0011 0110	P	0101 0000	i	0110 1001	;	0011 1011
8	0011 1000	Q	0101 0001	j	0110 1010	?	0011 1111
9	0011 1001	R	0101 0010	k	0110 1011	.	0010 1110
		S	0101 0011	l	0110 1100	,	0010 1111
		T	0101 0100	m	0110 1101	!	0010 0001
A	0100 0001	U	0101 0101	n	0110 1110	‘	0010 1100
B	0100 0010	V	0101 0110	o	0110 1111	“	0010 0010
C	0100 0011	W	0101 0111	p	0111 0000	(	0010 1000
D	0100 0100	X	0101 1000	q	0111 0001	)	0010 1001
E	0100 0101	Y	0101 1001	r	0111 0010	space	0010 0000
F	0100 0110	Z	0101 1010	s	0111 0011		
G	0100 0111			t	0111 0100		
H	0100 1000	a	0110 0001	u	0111 0101		

The original design for the Digital Technology merit badge contained a special ASCII encoding for “BSA.” However, due to constraints in the badge making process, this idea was abandoned. As a fun aside for Scouts, see if they can figure out the message. For the letters “B,” “S,” “A” in ASCII, here is the standard assignment:

B = 01000010 S = 01010011 A = 01000001

Starting from the tab in the top row to the far left, notice a trace that stops at a circle, which represents a zero. Going clockwise, the next trace twists and radiates outward. The next two end at circles. Then going down the right side of the yellow tabs, combinations of 1s and 0s are found. Eventually, if you go around the entire badge, you get the 1s and 0s to spell out “BSA” in ASCII format.



Requirements

Always check www.scouting.org for the latest requirements.

1. View the Personal Safety Awareness "Digital Safety" video (with your parent or guardian's permission).
2. Do the following:

   (a) Give a brief history of the changes in digital technology over time. Discuss with your counselor how digital technology in your lifetime compares with that of your parent's, grandparent's, or other adult's lifetime.

   (b) Describe what kinds of computers or devices you imagine might be available when you are an adult.
3. Do the following:

   (a) Explain to your counselor how text, sound, and pictures are digitized for storage.

   (b) Describe the difference between lossy and lossless data compression, and give an example where each might be used.

   (c) Describe two digital devices and how they are made more useful by their programming.

   (d) Discuss the similarities and differences between computers, mobile devices, and gaming consoles.

   (e) Explain what a computer network is and the difference between a local area network (LAN) versus a wide area network (WAN).
4. Do the following:

   (a) Explain what a program or software application or "app" is and how a computer uses a CPU and memory to execute it.

   (b) Name four software programs or mobile apps you or your family use, and explain how each one helps you.

   (c) Describe what malware is, and explain how to protect your digital devices and the information stored on them.

5. Do the following:

   (a) Describe at least two different ways data can be transferred through the internet.

   (b) Using an internet search engine (with your parent's permission), find ideas about how to conduct a troop court of honor or campfire program. Print out a copy of the ideas from at least three different websites. Share what you found with your counselor, and explain how you used the search engine to find this information.

   (c) Use a web browser to connect to an HTTPS (secure) website (with your parent's permission). Explain to your counselor how to tell whether the site's security certificate can be trusted, and what it means to use this kind of connection.

6. Do THREE of the following. For each project you complete, copy the files to a backup device and share the finished projects with your counselor.

   (a) Using a spreadsheet or database program, develop a food budget for a patrol weekend campout OR create a troop roster that includes the name, rank, patrol, and telephone number of each Scout. Show your counselor that you can sort the roster by each of the following categories: rank, patrol, and alphabetically by name.

   (b) Using a word processor, write a draft letter to the parents of your troop's Scouts, inviting them to a troop event.

   (c) Using a graphics program, design and draw a campsite plan for your troop OR create a flyer for an upcoming troop event, incorporating text and some type of visual such as a photograph or an illustration.

   (d) Using a presentation software program, develop a report about a topic approved by your counselor. For your presentation, create at least five slides, with each one incorporating text and some type of visual such as a . photograph or an illustration.

(e) Using a digital device, take a picture of a troop activity. Send or transfer this image to a device where it can be shared with your counselor.

(f) Make a digital recording of your voice, transfer the file to a different device, and have your counselor play back the recording.

(g) Create a blog and use it as an online journal of your Scouting activities, including group discussions and meetings, campouts, and other events. Include at least five entries and two photographs or illustrations.

Share your blog with your counselor. You need not post the blog to the internet; however, if you choose to go live with your blog, you must first share it with your parents AND counselor AND get their approval.

(h) Create a webpage for your troop, patrol, school, or place of worship. Include at least three articles and two photographs or illustrations. Include at least one link to a website of interest to your audience. You need not post the page to the internet; however, if you decide to do so, you must first share the webpage with your parents AND counselor AND get their approval.

7. Do the following:

(a) Explain to your counselor each of these protections and why they exist: copyright, patents, trademarks, trade secrets.

(b) Explain when it is permissible to accept a free copy of a program from a friend.

(c) Discuss with your counselor an article or (with your parent or guardian's permission) a report on the internet about a recent legal case involving an intellectual property dispute.

8. Do TWO of the following:

(a) Describe why it is important to properly dispose of digital technology. List at least three dangerous chemicals that could be used to create digital devices or used inside a digital device.

(b) Explain to your counselor what is required to become a certified recycler of digital technology hardware or devices.

(c) Do an internet search for an organization that collects discarded digital technology hardware or devices for repurposing or recycling. Find out what happens to that waste. Share with your counselor what you found.

(d) Visit a recycling center that disposes of digital technology hardware or devices. Find out what happens to that waste. Share what you learned with your counselor.

(e) Find a battery recycling center near you and find out what it does to recycle batteries. Share what you have learned with your counselor about the proper methods for recycling batteries.

9. Do ONE of the following:

(a) Investigate three career opportunities that involve digital technology. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

(b) Visit a business or an industrial facility that uses digital technology. Describe four ways digital technology is being used there. Share what you learned with your counselor.

Contents

Digital Technology All Around Us

Simply put, a computer chip is a machine that can perform simple commands: adding numbers, comparing values, moving data from one place to another, all at remarkable speeds. By performing many simple calculations exceedingly fast, computers can operate robots that build cars, send pictures and words to a video monitor or printer, run fast-paced video games, and send email messages around the world.

Digital technology devices use computer chips to perform specific functions. The range of devices that use computer chips is ever-growing. The remote control for your TV, the TV itself, mobile phones, game machines, tablet computers, digital cameras, and industrial robots all depend on digital signals from computer chips.

These devices do not think on their own. Software engineers write instructions for computers called *programs*. Software programs accomplish complex tasks by performing the computer's simple yes-or-no logic more than a billion times per second. Even though some digital devices seem to have intelligence, they are actually following the exact instructions they were given, extremely quickly.

Just how quickly does a computer chip work? Using a watch or clock to time yourself, count (by ones) as fast as you can in 10 seconds. How high did you get? 50? 70? 100? An average computer chip can count (by ones) to over 20 billion (20,000,000,000) in this same time. It is this mind-boggling speed of computer chips that has been harnessed in digital devices to do the incredible things they do.

Besides counting, digital devices can process information—troop rosters, for example, or the amount of water your family used at home last month, or the measurement of a car's speed. Many digital devices can also store information to be retrieved later.

Digital Technology Is Everywhere

Computer chips are found in almost all modern machines and electronic gadgets. Often you can't see the tiny computer processors built into the device and powered by a sometimes equally small battery. But these processors make possible digital technology devices like smartphones, garage door openers, DVD players, house thermostats, cameras, wristwatches, fuel-efficient vehicles, MP3 players, GPS units, and even recordable greeting cards.

Each global positioning system (GPS) satellite—an orbiting digital device in space—sends a constant stream of location data. This is interpreted by a handheld digital device (or smartphone) that converts the signals into an exact location on a map, which can tell hikers or drivers where they are.

Computers continue to be used in many more ways. A traveler's passport—the little booklet that identifies a person entering or leaving a country—now has an embedded computer chip. On the highway, a computerized tag attached to a car allows the driver to pay the toll while driving through a tollbooth without slowing down, and the car owner gets billed automatically.

Video games also use lots of computing power. These games once required a big desktop computer. But with the increased power and lower cost of computer chips, they now perform with ever-better quality on ever-smaller portable devices.

Digital devices don't just make our lives easier, safer, and more comfortable. They have become essential to business, industry, science, medicine, and communication: practically every part of society. For instance, stores can track product inventories with barcode scanners and keep just the right amount of products on their shelves. When you buy a shirt at a store, the computer at the register subtracts one shirt from the inventory list so the manager knows exactly when it's time to order more shirts. This saves money because it helps the store keep the right quantity of products on hand.

The worldwide network of computers known as the internet has revolutionized communication. Now, instead of waiting days or even weeks to receive a letter through the postal mail, people can use computers to send emails that zip around the world in seconds. Also, text messages and photos can be sent and received directly from a person's digital device. Vast databases of information are available through web browsers, mostly for free, allowing students and scientists to research from any location that has an internet connection. People can shop online for vast arrays of items.

The team that developed this pamphlet used online meeting tools, enabling people from all over the country to collaborate on the project.

In industry, digital devices have streamlined every step of the production process through computer-aided drafting, design, engineering, and manufacturing. Advanced software programs allow products to be conceived, designed, and tested virtually—that is, before they have taken physical form. In this way, a car designer can make a three-dimensional model of the car parts, “fit” them together, and test how well they work, all without tightening one bolt. When it’s time to manufacture the product, digital devices control the machines that fabricate and assemble the parts.

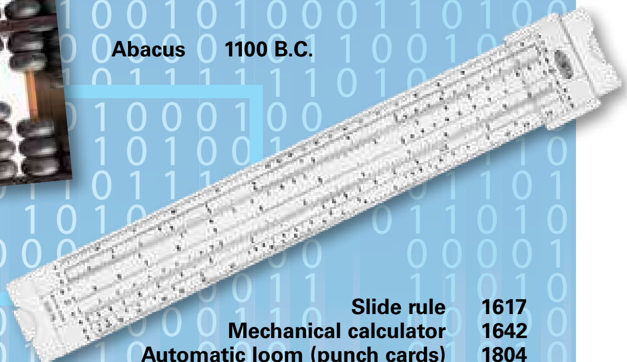
Using digital technology, phone companies keep track of millions of customers. They send each a detailed bill every month showing precisely which phone numbers were called, how many minutes customers talked on the phone, how much texting they did, and how much each transaction cost.

Digital technology is also common in the entertainment industry. One person using a synthesizer can make music that sounds like a whole orchestra playing. Animation workstations help artists create special effects in movies, such as making superheroes appear to jump from building to building. The video game industry is almost as big as the movie industry and it uses digital technology to produce these same special effects.

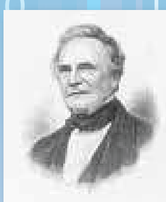
Digital technology has also changed photography. Not long ago, most cameras used rolls of light-sensitive film to capture pictures. If a picture was blurry or if someone blinked, you would not know until the photo was developed. Now with smartphones and digital cameras, you can take lots of pictures, delete the ones you don't like, and print only the good ones. Digital technology also makes it possible to alter a digital photo and add special effects.

With digital technology being used all around us, it's good to be aware that anything you say and do could turn up in unexpected places—even posted online by complete strangers.

Abacus 1100 B.C.



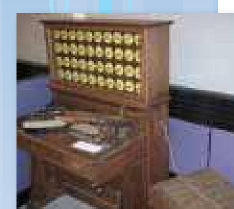
Slide rule 1617
Mechanical calculator 1642
Automatic loom (punch cards) 1804



Charles Babbage

Babbage's computer 1830s
Boolean logic 1850s

Hollerith's electric tabulator 1880s
Analog computer 1927
ENIAC 1946
EDVAC 1951



Hollerith's electric tabulator

Transistor 1947

UNIVAC 1951
Integrated circuit late 1950s
Microprocessor 1971
Altair 8800 1975
Apple II® 1977
IBM PC 1981

Macintosh® 1984

History of Digital Devices

The modern computer reflects the ingenuity of many inventors, mathematicians, and philosophers working over a period of centuries, often improving on the work of others who came before them.

Today, we use handheld electronic calculators at home, school, and work. But another calculating aid, the abacus, has been around since about 1100 B.C. and is still used in some parts of the world. An abacus consists of a wooden frame with beads that slide along rods. By assigning a value to the beads and sliding them up and down the rods, users can add, subtract, multiply, and divide.

Early Math Aids

In 1617, Scottish mathematician **John Napier** invented an aid to calculation—the concept of logarithms, which simplify the task of multiplying and dividing into a form of addition and subtraction. He inscribed his logarithms on a set of calculating rods he called "Napier's bones." Soon after, English clergyman **William Oughtred** invented a device based on Napier's logarithms: the slide rule. It remained in use for the next 350 years, until the electronic calculator was invented. Like the earlier inventions, however, the slide rule was only an aid to calculation, not a true calculator.

William Oughtred

Blaise Pascal

First Calculator

The first practical mechanical calculator was invented by a French mathematician. In 1642, while still a teenager, **Blaise Pascal** invented an adding machine called the Pascaline, which worked with wheels and gears. His father, a tax collector, used the Pascaline to add up how much money people owed the government—something modern computers still do today. In 1670, a German named **Gottfried von Leibniz** improved on Pascal's invention, developing a calculator that not only could add and subtract, but also could multiply and divide.

The First Computer

In 1804, a French weaver named **Joseph-Marie Jacquard** invented an automatic loom, or weaving machine, controlled by sets of instructions coded into punched cards. Different cards held instructions for different patterns to be woven into fabrics. The idea of using coded instructions readable by a machine became the basis of computer programs, years later.

In the 1830s, English mathematician **Charles Babbage** designed plans for the analytical engine. His machine, intended to automatically produce mathematical tables for navigation at sea, consisted of four main parts, all found on today's computers:

- An input device to read instructions from punched cards
- A memory to store the instructions and results
- A processor, which Babbage called a mill
- An output device to print the tables of numbers

Augusta Ada King, who wrote a program for the analytical engine, is considered to be the world's first computer programmer.

Babbage's analytical engine could be programmed to perform different tasks. That feature also made it like a modern computer—although the analytical engine was completely mechanical and powered by steam, not electricity. Unfortunately, Babbage was never able to complete the machine or test it. A model of his earlier design, the difference engine, was finally built at London's Science Museum for display in 1991. It had 4,000 parts and weighed three tons.

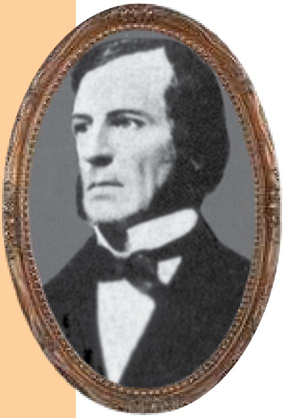
For more about computer programs, see the *Programming* merit badge pamphlet.

Boolean Logic

In the 1840s and 1850s, English mathematician and philosopher **George Boole** developed a kind of logic that allows thoughts to be expressed in mathlike terms. The basic forms of Boolean logic (also called Boolean algebra) are the AND, OR, and NOT operations.

- An AND operation is one in which two or more conditions must be true to achieve a result. For example, before you can safely cross a street intersection, the walk sign must be lit AND cross traffic must be stopped.
- In an OR operation, the result will happen if either condition is met: If it is cold outside OR if it is raining, you will put on a jacket before leaving home.
- With a NOT operation, a result happens when a particular condition is not met: You will go to school today if today does NOT fall on the weekend.

Years after Boole died, computer designers arranged electric switches to perform these operations in what became known as logic circuits, allowing digital computers to mimic human thought processes. Later still, Boolean logic would be used in internet search engines and in specialized computer languages used to manage data in databases.



George Boole

Edison's Vacuum Tube
In 1883, a few years after Thomas Edison invented the electric lightbulb, he noticed something peculiar about how electricity flowed inside it. To protect the brightly glowing filament, air had been removed from the bulb, creating a vacuum tube. Surprisingly, if he placed a metal plate inside the bulb, electricity would flow across the vacuum from the filament to the plate. Edison patented the discovery of how electrons flowed across a vacuum, now known as the Edison Effect, though he made little use of it.

Thomas Edison

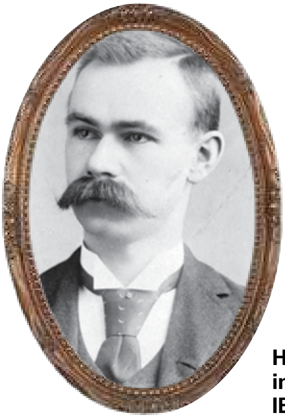
In 1906, American inventor Lee de Forest discovered that placing three electrodes inside the bulb created an amplifier. Besides making radio and television possible, this vacuum tube could also serve as an extremely fast on-and-off switch. This discovery would prove crucial in the development of digital computers.

Special-Purpose Calculators

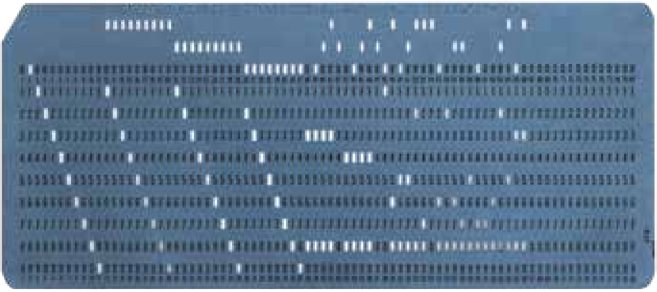
Every 10 years, the U.S. government conducts a census, or study, to collect information about everyone who lives in the country. By 1880, the population was so large—over 49 million—that the task took seven years to complete.

To speed things up for the 1890 census, the government turned to American inventor **Herman Hollerith.** His electric tabulating machine automatically recorded punched cards prepared for every individual. The cards held information that could be presented in different ways—for example, to find out how many married people lived in Tennessee, or how many owned farms smaller than 3 acres. This machine was the beginning of automated data processing.

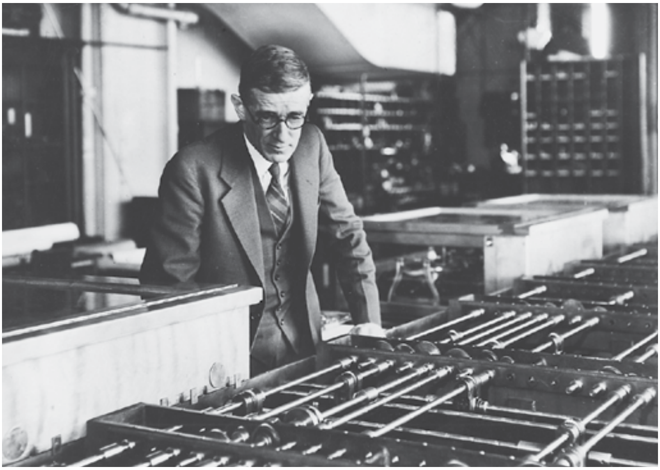
Soon, other companies were formed to build special-purpose calculating machines to help businesses. Eventually, universities joined in, finding scientific and military uses for the technology. These machines were one of a kind, and each had its peculiarities.



Herman Hollerith, the father of automated data processing, formed a company that would later become the giant IBM corporation.



Hollerith punched card



Massachusetts Institute of Technology engineer Vannevar Bush invented the differential analyzer, an electromechanical analog computer, in 1927.

At Harvard University, professor **Howard Aiken** worked on the Mark I computer using electromagnetic relays as switches. At the University of Pennsylvania, **John William Mauchly** and **J. Presper Eckert Jr.** designed the EDVAC and the ENIAC, using vacuum tubes as switches, which worked a thousand times faster than the relays in the Mark I.

Grace Hopper coined the term "bug" for a computer fault. The original bug was a moth that created a hardware problem in the Mark I. Hopper was the first person to "debug" a computer.

The U.S. military used first-generation digital computers like this ENIAC to calculate trajectories of artillery shells and to help build weapons.

The military used these first-generation digital computers to calculate weapon trajectories and help build atomic bombs. Each of these computers weighed tons, filled an entire room, and consumed enough electricity to light up a small town. They also required thousands of vacuum tubes, which tended to overheat and burn out, needing to be replaced often.

The "Universal" Computer

The first commercially built computer was Mauchly's and Eckert's UNIVAC. It was designed to be a general-purpose, or "universal," computer that would serve scientists, business people, and engineers alike.

The UNIVAC was a stored-program computer, meaning the program didn't have to be fed into the computer as it was running. Another innovation in the UNIVAC was its ability to take input from data on magnetic tape, rather than from punched cards. This ability made it faster and easier to operate.

Customers for the new computer—which cost about $1 million in the early 1950s—included the U.S. Census Bureau, the Air Force, and insurance companies.

The Transistor—A Major Breakthrough

In 1947, engineers **John Bardeen, Walter Brattain,** and **William Shockley** at Bell Laboratories ushered in the second generation of computers by inventing the transistor. Like a vacuum tube, the transistor had three terminals. It could function as an amplifier and a switch, but it was much smaller, used far less power, and performed thousands of times faster. Early transistors were also used in consumer products, most notably the portable transistor radio.

Silicon, the most widely used semiconductor material, is used to make silicon chips.

The Integrated Circuit—An Even Bigger Breakthrough

A major limitation of transistors was that they had to be connected to other electronic components (resistors, capacitors, and diodes) to form circuits. An early computer could have tens of thousands of transistors and other components that required tens of thousands of hand-soldered connections.

This problem was solved in the late 1950s when **Jack Kilby** of Texas Instruments, and a few months later, **Robert Noyce** of Fairchild Semiconductor, thought of the integrated circuit. The concept was simple: Instead of connecting components after they were made, manufacture them all on the same chip of silicon, with built-in connections. The integrated circuit, also called the microchip, revolutionized computing. It also made possible such products as the handheld calculator and the digital wristwatch.

The Apollo space program of the 1960s, with a mission to put an American on the moon by the end of the decade, was an early user of integrated circuits.

Integrated circuits were also used in so-called minicomputers, which, though smaller than the big mainframes of the day, still cost tens of thousands of dollars each.

The Microprocessor

In 1971, engineers at Intel Corporation, founded by Noyce, advanced the integrated circuit to a new level: They designed the first microprocessor, putting all the circuits needed for a computer's central processing unit (its "brain," which could run coded instructions) onto a single chip. This invention made the personal computer possible.

Altair 8800

Personal Computers

The Altair 8800 was an early model personal computer sold in 1975 as a mail-order kit for hobbyists to build themselves. That year, boyhood chums **Bill Gates** and **Paul Allen,** along with **Monte Davidoff,** wrote a programming language called BASIC that would run on the Altair. For a fee, they licensed the program to the computer maker and formed their own company, Microsoft®.

Meanwhile, two other young friends, **Steve Wozniak** and **Steve Jobs,** were busy working on the Apple II, a personal computer released in 1977 by their new company, Apple®. Unlike most early computers, the Apple II® had color graphics. This asset made it good for games, and it became extremely popular with home users.

The year before the release of their Apple II® computer, Wozniak and Jobs had worked together making a video game for Atari, a company founded by Nolan Bushnell. Atari had already become successful by selling a console that played one video game—called "Pong"—in arcade and home versions. Pong was the beginning of the multibillion-dollar video game industry.

In 1979, **Daniel Bricklin** and **Robert Frankston** created a software program for the Apple II called VisiCalc, short for "visible calculator." The program automatically calculated rows and columns of numbers arranged in a form known as a spreadsheet. This program, which was not available for mainframe computers, helped start a trend of companies installing personal computers in the workplace.

Two years later, IBM introduced its PC (or personal computer) based on the Intel 8088 microprocessor. The PC ran its own version of VisiCalc as well as other software programs, including a word processor. IBM contracted with Microsoft to supply a form of BASIC for the new computer, as well as an operating system, the program that gets the computer up and running, and then interacts with application programs.

The original IBM PC cost $3,000 when it debuted in 1981—around $7,500 in 2012, adjusted for inflation. Today's desktop computers, thousands of times more powerful, can be purchased for only a few hundred dollars.

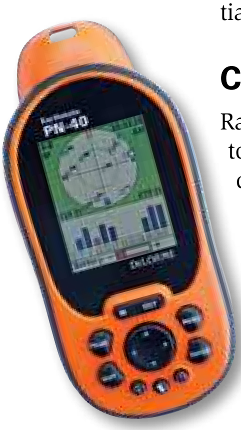
Microsoft later created a similar operating system, MS-DOS, for use on computers made by many different companies. The IBM PC and other computers using the MS-DOS platform dominated the business and home computer markets, helping make Microsoft one of the world's largest corporations.

Apple's Macintosh® computer also had great influence on the industry. Introduced in 1984, the Mac's operating system featured several innovations that made computers easier to use, many of which had been developed years earlier by researchers working for Xerox. These innovations included a handheld pointing device, or mouse; the use of little pictures called icons to represent programs and files on the computer screen; and a system of pull-down menus and movable screen displays called windows.

Apple II®

Despite the Macintosh innovations, the PC grew ever more popular, in part because IBM allowed other companies to sell less expensive "clones" of its PC design, while Apple did not. By 1990, Microsoft managed to incorporate many user-friendly advantages of the Macintosh into the latest version of its operating system, called Windows®.

Computers continue to drop in price and grow in power, much as they have throughout their history. In 1971, a microprocessor held 2,250 transistors; by 1993, it was 3.1 million. In early 2008, Intel® announced the creation of the first microprocessor to hold two billion transistors. Experts say this exponential growth in computing power cannot continue indefinitely.



Computers in Your Hand

Rapid increases in computing power have allowed computers to get ever smaller and faster. The early years of the 21st century saw an explosion in handheld computing devices—not only calculators, but also GPS units, which people now commonly use to find their way while driving; and personal digital assistants (PDAs), small computers that could fit in a pocket and be used as portable media players, electronic address books, mobile phones, and web browsers.

Likewise, enhanced cell phones, called "smartphones," do many tasks beyond making phone calls. This includes taking pictures, doing calculations, browsing the internet, texting, using apps, playing games, utilizing social media, and storing information.

New software programs are continually introduced to take advantage of the increased power and to expand the ways in which we use computers.

Another category of handheld computer is the personal translator. These small, inexpensive devices act like a "speaking dictionary," so you can hear how to pronounce words and phrases in various languages and see how they are spelled on a display screen.

In recent years, tablet computers have become popular handheld devices. Tablets are generally larger than a smartphone. A tablet's touchscreen allows the user to operate the device with finger or stylus gestures. Some models have detachable physical keyboards, but a tablet computer is generally self-contained like a smartphone, with an on-screen "virtual" keyboard for typing and on-screen icons for accessing the many software applications that run on these versatile devices.

A Quick Response (QR) code is a two-dimensional bar code that is widely used to cause a webpage to download to the user's smartphone when scanned with a mobile tagging application (app).

The Web Is Born

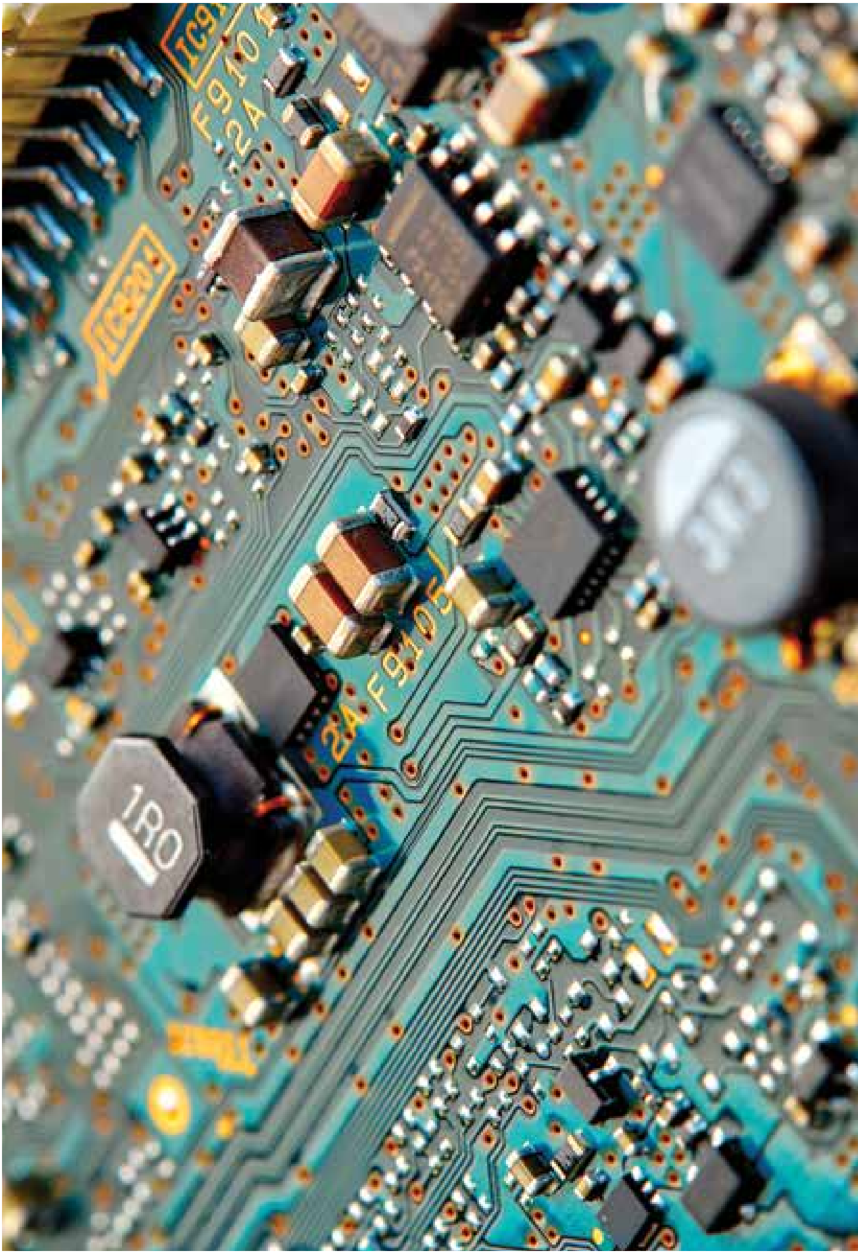
The 1990s brought another significant revolution: the rapid expansion of the internet and the World Wide Web, linking computers around the globe and changing the way people communicate and do business. Today, many activities we used to do in person can be done by connecting our digital devices to distant computers called *servers* or via *Wi-Fi* (a wireless network access point). By connecting to a server at a bank, for example, we can transfer money from one account to another or pay bills; by connecting to the server at a library, we can renew a book we checked out; by connecting to a server at an online store, we can order all manner of products and even rent movies. Students now check assignments due and turn in homework online through a website kept by their schools or teachers. There are online colleges that grant degrees for work done through the internet.

See "The Internet and the World Wide Web" later in this pamphlet for more about online communications.

Cloud Computing

What do you get when you combine advances in software with advances in internet connectivity? One result is cloud computing. The term refers to the "cloud" of powerful computers (servers) scattered throughout the internet. Increasingly, these servers provide "temporary" software that exists on a distant "cloud" and is loaded into a computer's web browser only temporarily, while being used.

You can visit a site, upload photographs, and edit them (say, making them sharper or more colorful) without actually downloading any software. An auxiliary program that temporarily loads into the web browser makes this possible.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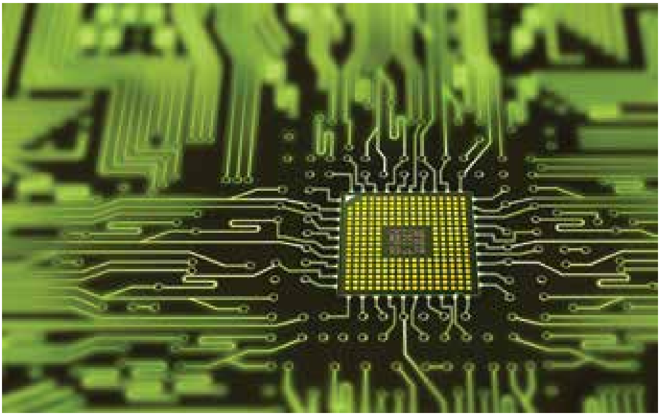
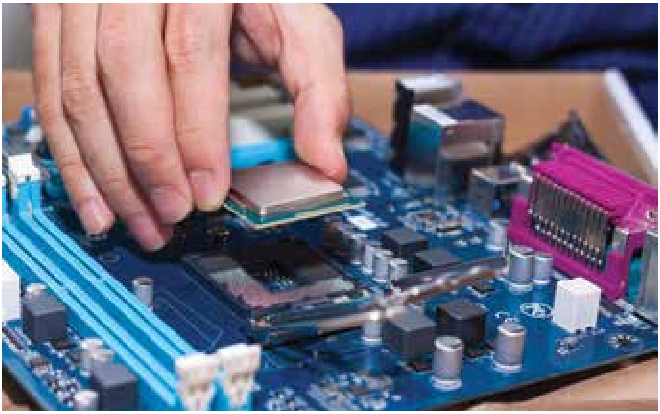
Performance of Digital Devices

Every digital device—from large multiuser computing systems to a handheld mobile device—has a central processor and memory. These fundamental building blocks determine the system performance and ultimately what kind of experience awaits the device's user.



Central Processor

The "brain" of a digital device is the central processing unit (CPU). This part has four main functions: It fetches instructions from memory, decodes those instructions, executes the instructions, and places the result back in memory. All of these functions are typically contained in a single chip mounted on a circuit board. The CPU has many different circuits all working together to process and move the data around.



Some CPUs contain multiples of these processors in a single part. A "quad-core" CPU has four CPUs on a single device. If a program is written to take advantage of the four processors, they can share the workload and complete tasks sooner.

In 1971, Intel's first processor had 2,300 transistors in it. Today's processors have more than 1 billion (that's 1,000,000,000!). The transistor has gotten ever smaller over the years, and processors are doing more in less space, allowing huge computing power to be put into small devices like smartphones and tablets.

The speed of early processors was measured in kilohertz (kHz): 1,000 cycles per second. Today's processors are measured in gigahertz (GHz) in billions of cycles per second. To get an idea of how much faster today's processors are, think of sprinting coast-to-coast across America in no more time than it would take you to walk across your bedroom.

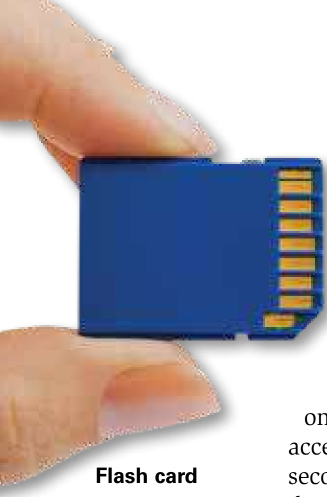
Between 1993 and 1999, processor speeds increased tenfold. Since then, processor speeds have not even doubled. The reason for the declining rate of increase lies in the physical limitation of the silicon being used to make semiconductors.

Most digital devices have coprocessors to help the CPU with specialized functions such as graphics and sound capabilities. This further improves the system performance. Collectively, the various components that perform critical functions are known as the chipset.

Memory

The CPU and memory work closely together. Everything the CPU does comes from memory and ends up in memory. The two main types of memory are ROM (read-only memory) and RAM (random-access memory). ROM is permanent memory that remains in place even when the device is turned off. Information stored in ROM is "maintained" in BIOS (Basic Input–Output System), a small program that starts—or boots—the digital device, checks its components, and launches the operating system.

RAM is temporary memory. When you launch an application program, it is loaded into RAM. Information that you put into the device during a particular work session is stored in RAM. RAM remembers this information only while the computer is turned on. If you turn off the computer, everything in RAM is lost.



Flash card

Flash memory is a type of memory that retains data after the device is turned off but can be used like RAM. Flash memory chips are found in digital cameras, handheld computers, cell phones, USB drives, and other devices.

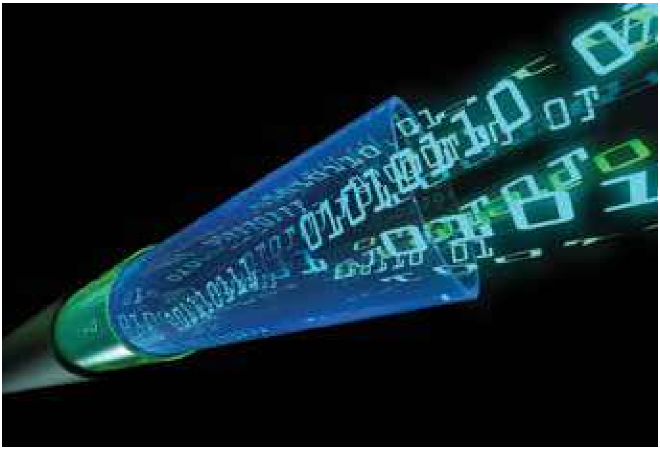
The speed of a digital device depends largely on how fast the CPU can store information into memory and retrieve information from it. In the 1960s, memory could be accessed only once every 10,000 nanoseconds (that's every 0.00001 seconds). Today, memory can be accessed every 60 nanoseconds (or once every 0.00000006 seconds), which means memory speed has improved more than 10,000 percent.

Storing Files in a Flash

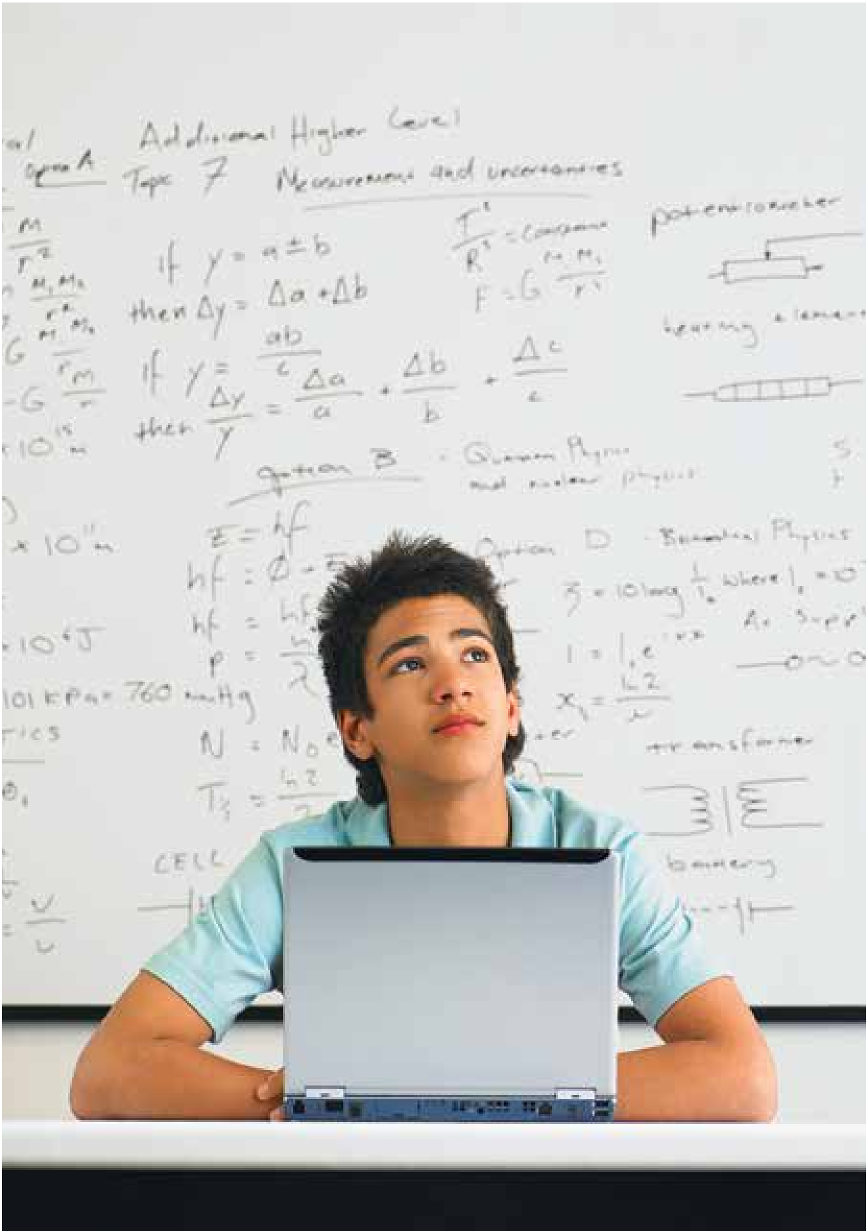
The portable USB flash drive (or thumb drive) is a handy little pocket device that allows you to easily transport files and take files anywhere you go. Just plug it into your computer's USB port and it will pop up on the screen as a portable or removable device.

Digital Device Performance

Simply having a fast processor does not guarantee a fast device. The memory needs to be fast enough to keep up with the processor, and they must be connected to each other in a way that ensures data flows freely between them. Think of driving a high-performance racing car through a crowded city. That super-fast car is slowed by stoplights, pedestrians, and other traffic. Similarly with processors and memory, if the processor can't access the memory because other devices like graphics cards also try to use the same "highway" called the data *bus,* then having a fast processor is of little advantage. Devices can be rated by the speed of this highway.



Some devices use multiple buses to improve the flow of data between the processor and memory to improve system performance.

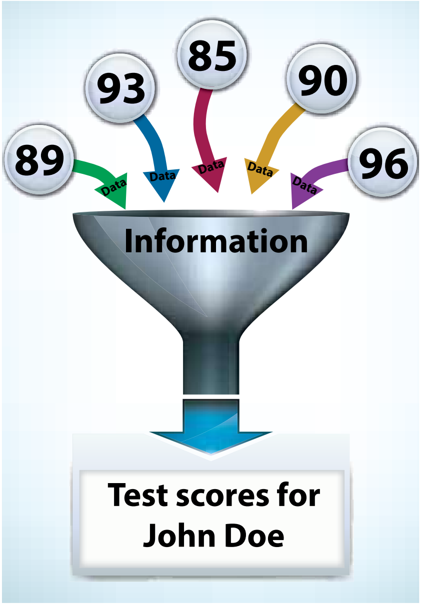

Additional Higher Level
Topic 7 Measurement and uncertainties
potentiometer
Option B
Option D
transformer
CELL
battery

Understanding Data and Files

Data and *information* are two terms commonly used to mean the same thing. However, each term has its own definition. "Data" refers to symbols—letters, numbers, and other characters—that may or may not have meaning. "Information" is data placed into a context that gives them meaning. For instance, a data set may include 89, 93, 85, 90, and 96. Alone, these numbers are data with little meaning. But if it is revealed that these numbers were the high temperatures of several consecutive days or a student's test scores in a course, then the data become information. Digital devices store data and can help organize data into context to make usable information.

Almost all data is stored in the form of *files*. The many different types of files include number, text, picture, sound, and video files. The type, or format, of the file is identified by the suffix, or extension—usually several letters long—that follows a dot after the file name. For example, in the file name *badger patrol.txt,* the ".txt" indicates a text file.

Software programs are set up to properly interpret specific types of files. Most programs can use multiple file formats. However, the types of files a program can interpret are typically limited to the program's function; for instance, audio players can process only sound files and not spreadsheet files.



What Extension, Please?

When creating a file name, using the correct extension is important, particularly if the file will be emailed to another computer or viewed on a webpage. If the servers that display webpages or help send email can't read those extensions, they can't tell the receiving device what sort of file it is receiving, and the recipient won't be able to process the file.

There are thousands of different types of files and file extensions. Some can be read only by a specific brand of device or software program. However, many popular file formats can now be read on any operating system as long as the digital device is running the required software.

On many devices and in operating systems, these extensions are not displayed as commonly as they once were. In many cases, file types are distinguishable by the different icons.

Extension	File Type
Text files	
.txt	ASCII text
.doc or .docx	Microsoft Word® (word processing)
Document Files	
.pdf	Portable document format for files compatible with the Adobe Acrobat® Reader; can include text and images
Image files	
.jpg	Popular for saving photographs; adjustable compression ratio to achieve exact desired file size
.gif	Nonphotographic images such as icons, buttons, drawings, and figures
.png	Image format with better color reproduction than .gif
.bmp	Short for bitmap, a standard Windows® graphics format
.tif	Offers a lossless way to compress graphics; produces much larger file than .jpg
Presentation files	
.ppt or .pptx	Microsoft PowerPoint®, a slide-based presentation program
Spreadsheet files	
.xls or .xlsx	Microsoft Excel®, a spreadsheet program
Sound files	
.mp3	High compression of sound data with only a slight loss in quality
.aiff, .au	Macintosh®-platform sound file
.wav	Windows®-platform sound file
.aac, .wma	High compression; even better quality than .mp3 file
Video files	
.avi	Windows® video file
.mov, .mpg, .mpeg	Movie file in Mac® or Windows® platform
Web files	
.htm, .html	Hypertext markup language
.asp, .aspx	Active server page (.aspx is used for dynamic pages)
.php	Dynamic webpages
.css	Cascading style sheet

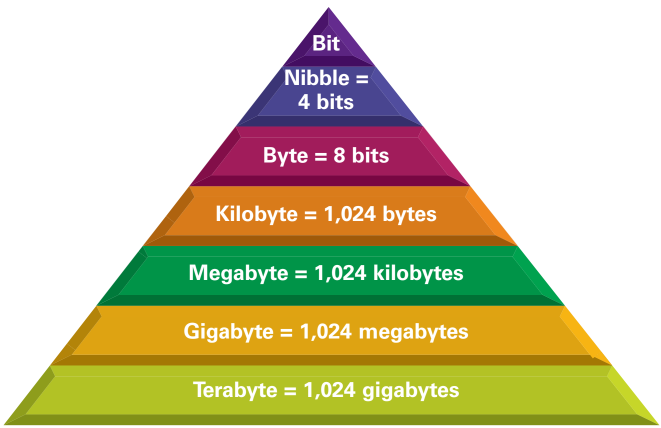
Storing Data

Let's look at some main types of data and how they are stored on digital devices.

For more about machine languages, see the *Programming* merit badge pamphlet.

Numbers

Think of a digital device as a collection of billions of circuits, each with just two positions, off and on. These two positions are represented by the numerals 0 and 1, which make up the binary number system. All data is stored on a digital device as groups of 0s and 1s. Each individual numeral is called a *bit*, short for binary digit. Bits are arranged in sets of eight bits, which is called a *byte*. The byte is a fundamental unit of data storage.



This binary code translates to "Boy Scouts of America."

Binary numbers do not look much like the decimal numbers we are used to seeing. For example, written as a binary number, the decimal numeral 101 is 01100101. Binary numbers make up machine code, the low-level language that digital devices translate all data into before performing operations on it.

Text

Text is stored using a special code corresponding to the numbers between 0 and 255. The code is called ASCII (American Standard Code for Information Interchange). Similar to the way it stores decimal numbers, the device represents each text character as a single byte of information. For example, the letter A is assigned the number 65 in ASCII code, which is 01000001 in binary form. ASCII text is stored without any formatting, such as indentations or boldface.

> An ASCII text file is often referred to as a plain text file and can be read by almost any word-processing program. Depending on the program, you can add formatting and save the text in another format.

Pictures

Pictures are stored as a series of small dots called *pixels*. A monitor might display, for example, 1,024 x 768 pixels; each horizontal row contains 1,024 pixels, and there are 768 rows stacked vertically. In a black-and-white monitor, each pixel requires only one bit of information, telling it to display either 1 (black) or 0 (white). A grayscale monitor designates up to 256 different shades of gray between black and white for each pixel.

A device screen that is in color displays pixels with three color components—red, green, and blue. Different colors, displayed in various shades and strengths, produce the desired final color. Eight bits of information per pixel will produce 256 different colors on the screen; 16 bits will produce 32,767 colors; and 24 bits will produce 16.7 million colors—the maximum number the human eye can see, sometimes called true color.

When digital cameras take pictures, the resolution, or number of pixels, is important for the quality of the picture. Each pixel is a dot that has information about the picture in that location.

A television (old analog or today's digital) also has pixels. For example, a high definition television labeled 1080i indicates that the picture is 1920 pixels wide by 1080 pixels tall. That means each picture has about 2.1 million pixels. This is also known as 2.1 mega-pixels.

Figure 1 is a "high" resolution picture of 1.4 mega-pixels. Figure 2 is a "low" resolution picture of only 30 thousand pixels. Because Figure 2 has much less information about the image, it looks less crisp and clear.

In Figure 3, we magnify a small section from the left-hand side of Figure 1. Some detail is still there, but individual pixels are starting to be noticed. This is sometimes called pixelation. In Figure 4, we magnify Figure 2. The individual pixels are clearly seen. Depending on the photographer, a high or low resolution picture would be important.

Figure 1, pixels, hi-res

Figure 2, pixels, lo-res

Figure 3, pixels, detail from Figure 1

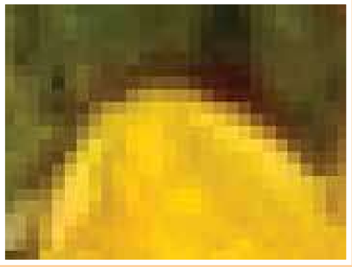


Figure 4, pixels, detail from Figure 2

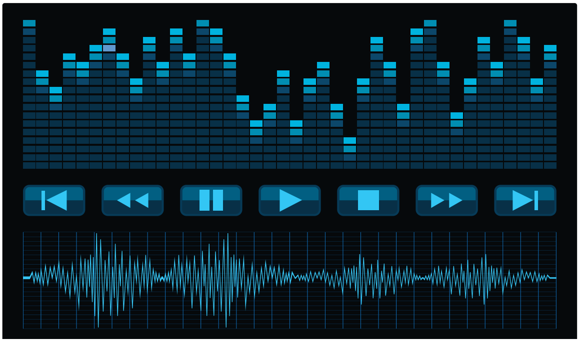
Compression

Picture and image files are stored in many different formats. Some formats use specialized mathematical formulas to compress the picture. The file takes up less disk space and is easier to email or display on the web, but some of the original data is lost, causing the expanded picture to be more blurry than the original. This is called *lossy* compression. Another type of compression, called *lossless,* can temporarily shrink a file by removing parts that are repeated and then, later, restore the file to its full size. Lossless compression is often used with text files and database files. Lossless compression is also used when you want to retain the original picture size and quality.

Sound

Sound is made up of vibrations that travel through the air by passing from one molecule to the next. These vibrations are called *waves*. If you could see them, they would look like the waves at the beach. The height, or *amplitude,* of the wave determines the volume or loudness. How close together the waves are determines the *frequency*, or pitch—whether it's a bird's whistle or a boom of a bass drum and how that sounds to your ear.

A digital device "hears" through a microphone or media player, via an *analog* signal consisting of these sound waves.



The device's audio circuitry feeds this signal through an analog-to-digital converter chip that converts the signal into bits that the computer can read and save as a digital file: basically a long list of 1's and 0's. When you replay the file, the data is sent back through a digital-to-analog chip, which rebuilds the shape of the wave and sends that information to the speakers, which vibrate the air, re-creating the original sound wave that you can hear.

Video

Faster microprocessors have made it possible for devices to display video. Digital video is projected much like traditional film in that digitally encoded pictures are flashed up on the screen in rapid succession to give the appearance of movement. However, storing all the digital pictures needed to make up one digital video requires enormous amounts of storage space. To reduce the amount of storage needed, video files use a type of digital compression where the first picture is stored in the video file and then only the changes to that picture are stored as the second picture. The third picture is made up of only the changes made by the combination of the first and second picture. Each succeeding picture is made up of the changes made from the previous composite image. This process continues for the entire movie. By using the image displayed on the screen and only storing the changes to the current display, the video file is able to eliminate lots of redundant information and compress the video to a manageable size.

```
// Example F to C in Java
// This file must be named FahrenheitToCelsius.java
import java.util.Scanner;
public class FahrenheitToCelsius {
  public static final double LOW_TEMP_F_WARNING=0;
  public static final double HIGH_TEMP_F_WARNING=100;
  public static final int    MAX_LOOP=5;
  public static void main(String[] args) {
    Scanner scanFaren = new Scanner(System.in);
    double Farenheit = 0;
    double Celsius = 0;
    for(int i=0; i<MAX_LOOP; i++){
    System.out.print("\nEnter a temperature in Fahrenheit: ");
      if(scanFaren.hasNextDouble()) {
          Farenheit=scanFaren.nextDouble();
          Celsius = ( Farenheit- 32 )*5 /9;
      }else{
      System.out.println("data entry error – program terminated\n");
      System.exit(-1); }
     System.out.println("The temperature in Celsius is: "+Celsius);

     // Check for high temperature and issue a warning if necessary
     if(Farenheit > HIGH_TEMP_F_WARNING){
       System.out.print("Remember to hydrate\n");}
     // Check for low temperature and issue a warning if necessary
     if(Farenheit < LOW_TEMP_F_WARNING ){
       System.out.print("Remember to pack Long underwear\n");}
    }
    System.exit(-1);
  }
}
```

JAVA
Temperature Example

```
Example Output:

Enter a temperature in Fahrenheit: 76.0
The temperature in Celsius is: 24.444444444444443
Enter a temperature in Fahrenheit: 102.
The temperature in Celsius is: 38.888888888888886
Remember to hydrate
Enter a temperature in Fahrenheit: -2.
The temperature in Celsius is: -18.88888888888889
Remember to pack Long underwear
Enter a temperature in Fahrenheit:
```

Java is one of the most popular programming languages in the world because it is free and runs on many different platforms, a quality referred to as "Write Once, Run Anywhere." Java is easy to learn if you are already familiar with another text-based language.

Computer Software

Software, a set of instructions organized into a program, is what makes hardware work. The central processing unit (CPU) uses this list of instructions to move and manipulate data in the digital device.

The three main categories of programs are operating systems, application programs, and programming languages. Operating systems control the basic operations of the computer and set up the environment for the applications to run. Application programs allow users to do specific tasks with their digital devices, such as write letters or touch up photographs. Programming languages are used to write other programs; for example, application programs.

Operating Systems

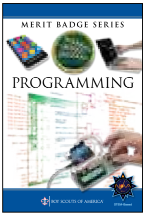
Operating system (OS) software is the foundation software on which all other programs run. This set of programs controls all of the digital device's basic operations. This includes accepting input, displaying output on the monitor or graphic display, keeping track of files and directories on the hard drive or other internal storage, and controlling peripheral devices such as disk burners, printers, scanners, speakers, and the mouse.

Because of the work done by the OS, programmers who create application software do not have to write code (instructions) into their applications to control these basic functions.

Hardware is the physical, electronic, and electrical devices that make up a computing device, such as the CPU, disk drive, keyboard, and monitor.

Likewise, the OS adapts to upgrades to a computer's hardware (for example, installing more RAM), automatically updating settings in the rest of the system. Another task of the OS is to serve as a kind of traffic cop, allocating processing power and memory space among the various programs that might be running at once while holding back some resources for use by the OS itself.

Common operating systems are the Microsoft® Windows® series, the Macintosh® series, Android™ OS, and the UNIX® family of operating systems, which includes freeware and inexpensive versions of what is known as Linux®.



For more about machine languages, see the *Programming* merit badge pamphlet.

Applications

As digital devices become more powerful, and as people think up new ways that computers can help us at school, work, and home, new application programs are continually being written. There is no limit to how many applications can exist. The following are some of the most popular types of application programs, but there are many others adapted to particular needs in science, business, industry, and personal use.

Spreadsheet

A spreadsheet performs arithmetic on numbers, which are arranged in rows and columns. The rows and columns intersect to form boxes, called *cells*. A *formula* is a function performed on numbers in particular cells—for example, adding the number in cell A1 to the number in cell A2, and having the sum appear in cell A3.

The benefit of a spreadsheet is that if you change a number in one cell, the program immediately recalculates the totals in the other cells that are affected by the change. This allows you to perform "what if?" operations. For example, you can figure out how many more Scouts could go to summer camp if the troop raised an additional $300 or $400 at car washes.

Besides numbers, you can also type words in a spreadsheet, such as headings, names, and explanatory notes. Spreadsheets are useful for various types of reports, including fundraising reports, fitness logs, sports team records, travel budgets, currency conversions, and worksheets for car loans.

Database Manager (DBM) Program

Database manager (DBM) programs are used for organizing, storing, and keeping track of a set of information called a database. The data are organized in lines called records, with each record consisting of a number of fields. For each new record, the same set of fields is stored, with different contents in each field.

A troop attendance database could be set up with a record for each Scout in the troop. Each record would consist of fields for the Scout's name, patrol, rank, troop meeting attendance, campout attendance, and other events. An entry of "present" or "absent" could be made in the appropriate field of each Scout's record after each activity. The Scoutmaster could easily see who attended a particular event. The DBM program could also calculate the percentage of participation for each activity.

A DBM program can perform sorting and searches of the database information and produce neatly printed reports with graphs and charts.

Word Processing Program

Word-processing software programs are tools that make writing—and formatting text—easier. Once words are typed into a document, they can easily be rearranged and corrected. Software may allow you to change the size and style (together, called the font) of the letters, as well as the color. You can easily align paragraphs to the left, right, or center; add bullets or underlining; adjust the amount of indentation at the beginning of a paragraph; and alter the width of margins.

Some programs let you add tables and graphics and will automatically number pages. You can check the spelling, make different versions of documents without completely retyping them, and print out your work.

With the "mail merge" command, you can insert names and addresses from a database program into a form letter to send out personalized letters to a large group—to every Scout in your troop, for example.

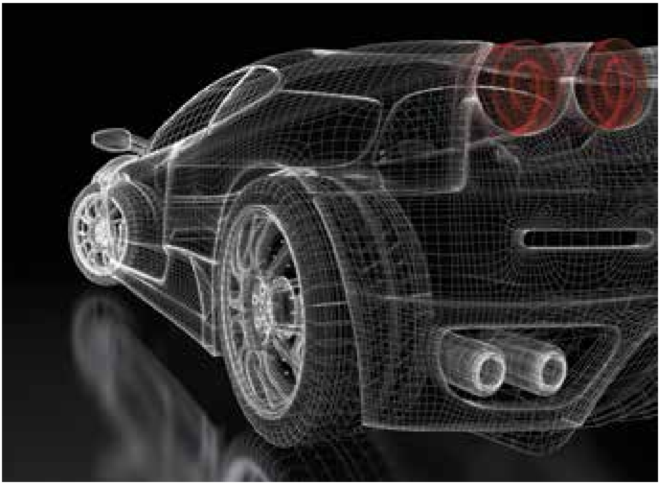
Presentation Program

A popular aid for public speaking, a presentation program lets you create screens or slides that list important points of your speech, as well as pictures, charts, graphs, and even sounds and animation. Slides you create can be projected onto a screen in front of your audience, and can be advanced from one slide to the next while you speak. Also, the text and graphics portion of your presentation can be printed and distributed as handouts for your audience.

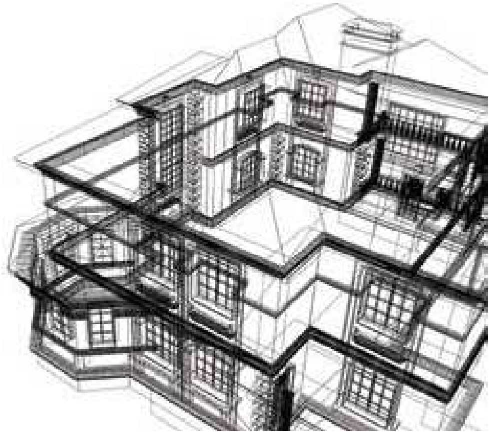
Desktop Publishing and Graphic Design Software

Desktop publishing programs allow you to design (or lay out) a page with various elements, including words, pictures, and drawings. The programs have special tools for formatting text, such as setting a headline in big, bold type; sizing images to fit the layout; and adding color backgrounds, shading, boxes, lines, and other design elements. Using a desktop publishing program, you can design a newsletter, a poster, or even a book.

Graphics and design programs allow you to create and edit pictures or drawings. Paint or draw programs let you create images in two dimensions. Other programs allow you to draw in two or three dimensions and create sophisticated models.



Computer-Aided Drafting (CAD) Programs



CAD architecture software allows the user to create a floor plan like this that can be printed and shared.

Three-dimensional CAD programs can be used to create *wireframes*, or outlines of objects, and solid models, which can show texture, light, and shadows. Automotive engineers use CAD programs to design automobiles, down to each individual part. Other engineers use CAD software to design circuit boards, bridges, or buildings.

CAD software is also used by architects to design rooms or entire buildings. A designer usually starts drawing the walls of the structure by dragging the cursor across the screen with the mouse, and the program automatically adds dimensions. You can place furniture in a room—using pull-down menus for couches, tables, etc.—and input exact measurements to match your own furniture.

Photo and Video Programs

Using photo-editing software, you can enhance digital pictures by cropping, sharpening, adjusting brightness and contrast, deepening color saturation, correcting color hues, and otherwise improving your pictures. You can then print the touched-up photos and save them as digital files.

Photo files can be saved at various resolution and compression levels, depending on how you will use an image. For printing, you want as high a resolution and as low a compression as possible, resulting in a large file size and sharp prints. For sending a photograph via email or displaying a photo on a website, you want low resolution and high compression, which produces a small file size that will quickly download to a viewer's computer.

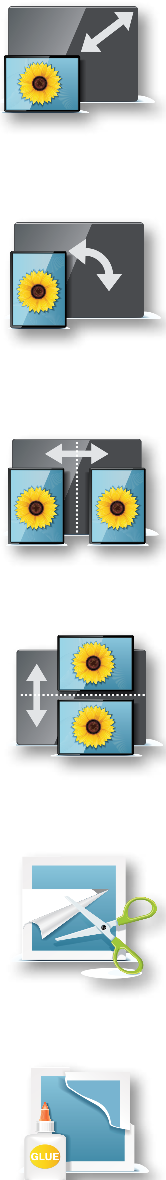


Photo album programs help you organize your picture collection electronically on a hard drive or compact disc (CD or DVD). This software may also let you create slideshows of your pictures that can be stored on a CD or DVD for playback on a computer or TV.

Video editing programs turn a computer into a digital movie studio, allowing you to edit and enhance video footage taken from a digital device. The basic functions of these editing programs include cutting and rearranging video sections; adding transition effects such as fades and wipes between scenes; and adding titles and text, background music, and narration.

Most digital cameras come bundled with image editors.

Webpage Editors

Webpage editors are programs that help you create websites without having to write HTML, the best-known markup language used on the World Wide Web. Typically, these programs help you design your page—positioning text and graphics—by selecting commands from toolbars and icons. The editing program automatically creates the underlying code needed. Most webpage editors also allow you to add advanced features such as animation and scrolling text. The programs offer some help in publishing the webpages you have created onto the internet.

See "The Internet and the World Wide Web" later in this pamphlet.

Financial Programs

Financial programs help users keep track of money. In their simplest form, they are like a checkbook that does all the addition and subtraction for you. Financial software has additional features that allow you to generate reports, helping you track how you spend your money by categorizing expenses (entertainment, phone, school, and so on). A program can also help you create a budget so that you won't overspend in particular categories. This kind of software can be linked to bank accounts over the internet so a check register can be automatically updated, and funds can be transferred between checking and savings accounts.

Media Players

Media players help organize music. You can use these programs to convert music from audio compact discs into files that can be stored digitally. You can also add songs that you have purchased. These programs let you create playlists of your favorite songs, "burn" songs onto CDs, and download your music files into portable music players.

It is important to remember that copyrighted song files cannot legally be shared over the internet. See "Intellectual Property" later in this pamphlet.

The Internet and the World Wide Web

Two or more computers working together can do far more than a single computer. When computers are linked, their connection is called a *network*. It might be a local area network (LAN) contained within a single building; or a wide area network (WAN) covering a large region of the country.

These small and midsized networks, in turn, are linked to form a much larger system that spans Earth. That system is called the internet. The internet, simply stated, is a network of networks. When connected to the internet, any digital device can communicate with any other digital device around the globe that is also connected to the internet.

The amazing thing about the internet is that it does not rely on any one central computer to operate, nor even a central network. No one organization controls it. Instead, the internet operates across numerous high-speed networks maintained by various internet service providers (ISPs) and private networks operated by different companies.

Origins of the Internet

The internet's origin can be traced to ARPANET, a small network launched in 1969 by the U.S. Department of Defense. ARPANET linked computers at various universities around the country. In 1974, researchers **Robert Kahn** and **Vinton Cerf** developed a way to join ARPANET with other similar networks. The networks were joined in 1983, and the internet was born.

At first, all networks were connected to the internet through a "backbone" network. ARPANET was the first backbone. Then came a high-speed network of supercomputers organized by the National Science Foundation. That backbone, in turn, was replaced by private high-speed networks.

For years, only universities, military agencies, and defense contractors used the internet. But as private companies were allowed to join the internet, and as local area networks started getting connected, it became possible for people everywhere to use the internet, as well.

The supercomputer is the fastest type of computer made. This is Titan, one of the world's largest supercomputers.

World Wide Web

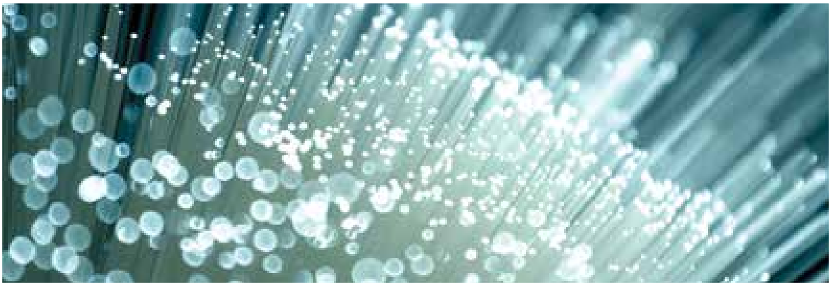
As the internet grew, a better way was needed to access and display the vast stores of information it held. That better way was the World Wide Web, developed in 1990 by **Tim Berners-Lee**, a British physicist and software consultant at CERN, the European particle physics laboratory. The web—consisting of documents called webpages—would eventually bring graphics, pictures, sound, animation, and video to the internet. However, its true brilliance was in the simple system of organization it provided.

Billions of webpages are indexed on the World Wide Web—and an endless number of pages is possible.

One of Berners-Lee's two main innovations was the *uniform resource locator* (URL), a form of address that can be used on any webpage or other file on the internet. His other important invention was *hypertext markup language* (HTML), a form of computer language for creating webpages that link to other webpages through clickable hypertext. A word in hypertext can be linked by way of a hidden URL to any other page, or part of a page, or file. Simply by clicking your cursor on the linked word, you can jump to some other location on the internet, even if it is stored on a computer far from the page where you started.

The Incredible Optical Fiber

Optic and photonic devices help make today's internet work. Lasers, fiber optics, photonic switches, and photonic displays allow digital devices anywhere in the world to connect to each other, exchange information, and visually display that information. All information, like movies, phone calls, and emails, are converted into binary data, or ones and zeros, similar to the dots and dashes of Morse code on a telegraph line.



Today, those ones and zeros of information known as "bits" are generated as pulses of light by turning a laser on and off. A small number of the bits are grouped together in what is called a packet with its own address or header, just like an old-fashioned letter, so they can get to the right place. These packets of light pulse and then travel along a strand of glass called an optical fiber.

An optical fiber is about the same size (approximately 100 micrometers, or millionths of a meter) as a hair on your head. It can transmit as much information as more than 30 feet (10 meters) in diameter of copper telephone cables. A single fiber can carry more than 1 million phone calls at the same time.

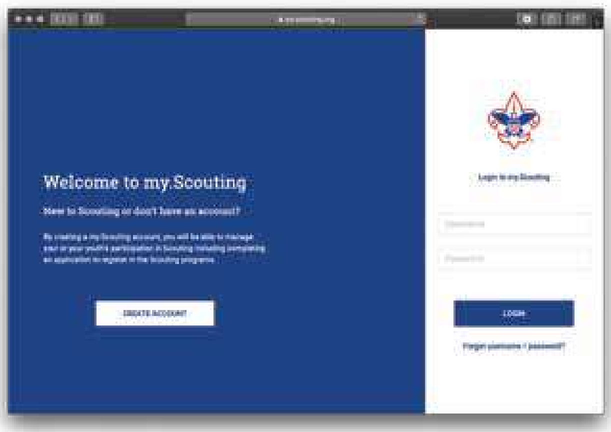
There are optical switches on the internet that get those packets from your computer to your friend's computer, if it is an email, or from a special computer called a server, if it is a movie, video, website, etc. Near the end of the journey, the light pulses are converted back to electrical ones and zeros. Those electrical "bits" drive special photonic display devices (LEDs or LCDs) so you can see the information.

In summary, the vast amount of information on the internet is available at your fingertips because optical fibers carry millions of times more bits of data over thousands of times greater distances than the copper cables they replaced. The only thing preventing you from getting even more information faster is the copper wire connecting you to the photonic internet.

Web Browsers and Helper Software

To view webpages, you need a software program called a web browser. As webpages add video, sound, and animation, additional software is needed to enable the browsers to use these multimedia elements. A helper software program "inserted" into a browser is referred to as a *plug-in*. When videos are uploaded to a popular website (YouTube, for example), the video files—no matter what format they were created with—are converted into Flash files, which are compressed (made smaller) for easy loading onto a webpage.

Widely used plug-ins include Adobe® Flash® and Adobe® Acrobat®, which allow webpages to display videos and PDF files. Most browser creators allow users to view and manage plug-ins or add-ins through the browser's Tools menu.



Another kind of helper software used in web browsers is called a *cookie*. A cookie is a small data file transferred to your computer from a website. The cookie, which can contain information about you, such as your user name, language preferences, or shopping preferences, stays on your computer and is loaded into your web browser the next time you visit the site. Cookies are retrieved from your computer each time you visit a website to allow your visits to have consistency.

Third-party cookies are another type of cookie that can be placed on your computer. Typically these cookies are placed on a computer to track internet usage to be used in advertising and statistical analysis. All browsers allow you to manage and remove cookies that are stored on your computer.

Protocols and Domains

Every device connected to the internet can be identified by its unique internet protocol (IP) address. Every computer connected to the internet has an IP address, either a permanent one or a different one that is assigned to the computer each time it connects. A typical IP address looks like this: 23.67.61.152. This is the same as typing *www.scouting.org* into a web browser. Finding devices by their IP addresses was difficult, so in 1983, the University of Wisconsin created the domain name system (DNS), which allows people to find a computer on the internet by a unique name connected to the IP address. (These names form part of the website's URL.)

Domain names, such as "www.scouting.org," always have two or more parts separated by dots. The part of the name farthest to the right is the *top-level domain*—.com, .net, .org, .gov, .edu. The part to the left of the top-level domain ("scouting" in this example) is the *host name*. The top-level domain alone can tell you something about the website.

- .com, .net, and .org—for general use
- .gov—reserved for governmental agencies
- .edu—for educational institutions, such as schools and colleges

Once a particular domain name, such as www.scouting.org, has been registered, no one else can use it. A nonprofit group called ICANN (Internet Corporation for Assigned Names and Numbers) maintains the internet domain name system. ICANN regulates the buying and selling of domain names, which is handled by various private companies.

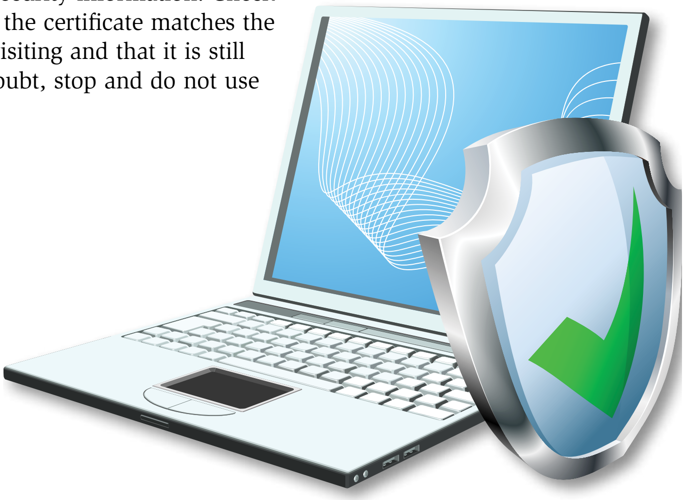
Different countries have their own top-level domains. For example, .uk stands for United Kingdom, .au for Australia, .jp for Japan, .ru for Russia, and .ca for Canada. Websites with those letters at the end are likely to be based in those countries.

Internet Security

When most users type in a web address, they usually start with the "www" part of the URL. But in front of that is an important part which tells the browser how to communicate the information: *http* (plain text) or *https* (encrypted). HTTP, which stands for *hypertext transfer protocol*, is a set of standards governing the exchange of data as text. This is the most common type of request sent through the internet.

HTTPS, which stands for *hypertext transfer protocol secure*, adds an additional layer to HTTP by encrypting the information with Secure Sockets Layers (SSL) and adding more security around a web request using security certificates. You will typically see *https* used whenever you are asked to log in to a website or send personal information.

Before sending personal information to a website that is requesting it, you should check that the site has appropriate security and a valid security certificate. web browsers (Internet Explorer, Firefox, and others) know how to trust HTTPS websites and typically represent secure websites with a lock icon in the URL address bar. You can click on the lock to see information on the website and security information. Check that the name on the certificate matches the website you are visiting and that it is still valid. When in doubt, stop and do not use the website.



Instant Messaging, Texting, and Video Chatting

Digital technology has made possible new forms of communication. You know that email allows you to send a written message to any other email user in the world who has an email account that is connected to the internet. Another form of digital communication is instant messaging (IM), by which people can communicate in real time, using digital devices. IM also lets users see whether a particular person is online and connected to make an instant-messaging exchange possible.

Another kind of instant messaging is text messaging, usually done through a cell phone, which contains computer chips. Texting is good for quick communication at times when phone calls might be disruptive or impractical, or when a person isn't available to take your call. Text messages can also be sent to order products or services, but you must be careful not to receive unwanted charges on your cell-phone bill this way.

Video chatting allows you and a friend to talk to and see each other, turning your digital device into a sort of video telephone. You can use your computer or other device with a camera attached to stream the video and audio back and forth. Another way to do this is through your cell phone or mobile device using specialized streaming software.

Search Engines

The internet contains billions of pages of content. To find the information you need among all these pages, you use a search engine. Search engines use programs called *crawlers* to explore the web and build indexes of webpages.

To use a search engine, you simply type in your search term ("court of honor," for example), wait a moment, and then see a list of webpages pop up that contain the term you submitted. You can click on any of the listed pages that you want to view.

Stay Safe Online

Learn about internet safety by viewing the Digital Safety video that is required for Scout rank. Together with NetSmartz.org, the BSA created this video to help educate Scouts about being safer online, cyberbullying, and internet scams, and to promote community awareness of internet safety issues. Before reviewing this video, Scouts should complete the exercises in the "How to Protect Your Children from Child Abuse: A Parent's Guide" pamphlet with their parent or guardian. This pamphlet can be found in the front of the *Scouts BSA Handbook*. Find the video at www.scouting.org/training/youth-protection/scouts-bsa

Tips for Online Safety

On the internet, you can have fun, play games, and take care of business. You can find help with your hobbies and interests, learn all sorts of things, click your way to a wide world of instant information, and even read books. Along with the convenience of the internet, however, comes some risk.

A computer can catch a malware infection from an email message, websites, downloaded programs, or infected disks.

Protect Yourself

When you are online, be careful to guard your privacy and protect yourself from potentially harmful situations. The following tips will help you stay safe. Your parent, merit badge counselor, or Scout leader may talk with you about other rules for internet safety. This information is covered in the Cyber Chip. To review, here are a few tips for keeping yourself safe and being a good online Scout.

1. Follow your family's rules for going online. Respect any limits on how long and how often you are allowed to be online and what sites you can visit. Do not visit areas that are off-limits. Just as there are places you don't go to in real life, there are places to avoid on the internet.
2. Protect your privacy. Never exchange emails or give out personal information such as your phone number, your address, your last name, where you go to school, or where your parents work, without first asking your parent's permission. Do not send anyone your picture or any photographs unless you have your parent's permission.

3. Do not open emails or files you receive from people you don't know or trust. If you get something suspicious, trash it just as you would any other junk mail. It may contain a virus that can harm your computer just by opening the email.
4. If you receive or discover information that makes you uncomfortable, leave it and tell your parent. Never respond to any message that is disturbing or hurtful.
5. Never agree to get together with someone you "meet" online. Tell your parents if someone you don't know tries to arrange a meeting with you.
6. Never share your internet passwords with anyone (even if they sound "official") other than your parents or other responsible adults in your family.
7. Don't believe everything you see or read online. Along with some great information, the internet has lots of junk. Learn to separate the useful from the worthless. Talk with your parents or merit badge counselor about ways to tell the difference.

Protect Your Computer and Other Digital Devices

Besides taking precautions to protect your personal safety online, you should protect your computer and other digital devices from a number of online dangers, including malware and theft of files. This applies not only to your home computer but also to any device that can be connected to the internet such as cell phones and internet-connected video game consoles.

Malware is a term covering several types of harmful files, including viruses (software codes designed to harm your computer in some way, such as by destroying files or causing your computer to malfunction); worms (files that infect your computer and send out copies of themselves from your computer over the network); and trojan horses (programs that appear to do something useful but actually are harmful). Another form of malware is spyware. Such programs, often attached to some useful software, "spy" on you, tracking your movements on the web. Spyware can also install secret programs on your computer.

Keep Your Digital Devices Healthy

The following tips will help you keep your computer and other digital tools safe. Your parent, counselor, or librarian may talk with you about other rules for avoiding viruses.

1. Look carefully at the return address of all email messages you receive, especially those that arrive with attachments. Download a file only from someone you trust; even then, be suspicious. Sometimes a virus can be sent from a friend's computer without the person's knowledge if the computer is infected. Be particularly wary of a file attachment with a name ending with ".exe," which indicates an "executable" program file that may harm your system.
2. Install antivirus software on your computer and keep it updated. The software can be set to automatically look for viruses on your hard drive, to scan disks and files that you put into your computer, and to scan email attachments that you receive.
3. Do not open email that appears to be spam, or junk mail, which may only be trying to sell you something but could also introduce a virus into your computer or other device.
4. Back up your important files regularly onto optical storage media (CDs, DVDs), flash drives, or extra hard drives. (There are also online backup services available for a yearly fee.) It is prudent to make your backup redundant; that is, back up to more than one type of media. Be sure to scan your backup media for malware, too.
5. Buy software only from trusted sources. Unauthorized copies of software programs often contain viruses and should be avoided.
6. For added protection, use a firewall, which can consist of software, hardware, or both, to keep intruders from looking at and possibly stealing private information stored on your hard drive, such as passwords or credit card numbers. Using a firewall is particularly wise if you have a broadband connection to the internet. The latest versions of Windows® and Macintosh® operating systems have built-in firewalls that you can activate to protect your computer online.
7. Keep your digital device software up-to-date. Software creators often release updates as they fix issues with their software that can lead to security problems. You can help protect your devices by keeping up to date with these releases. Never update your computer or other device without your parent's permission.

Digital Technology at Work

Today, digital-technology skills are useful in almost every profession. As technology has become cheaper and more powerful, it has spread into practically all aspects of business including agriculture, medicine, landscape design, and aerospace. Almost all industries use digital technology for at least one part of their operations. Employees use computers to perform various tasks. Companies use websites and social media to communicate with customers. Technology has become an integral piece of business.

Basic application programs—word processing, spreadsheets, etc.—are used throughout the economy. But beyond that, each industry uses specialized software, and often specialized technology, tailored for the specific needs of the trade.

- Graphic designers and special-effects creators use computers to produce special film sequences for movies and television commercials.
- Air-traffic controllers who guide commercial airplanes use sophisticated systems to help them do their jobs.
- Music publishers record and edit music digitally.
- Newspaper and magazine publishers use computers to edit and design print products and online publications.
- Professional translators use digital devices to automatically translate writing from one language into another.
- Doctors store and retrieve digital medical records of their patients and access medical information that can help diagnose and treat illness.
- Hospitals use software-controlled robots for surgery and digital techniques for medical images.

Computer-driven robots are used in manufacturing, where they provide precise control of sophisticated equipment.

- Architects use software, such as CAD, to help them design buildings.
- Retail workers such as cashiers and stockers use digital devices to track the store's inventory both into the store and then out through the registers.

The list of career uses for digital technology can be endless. When exploring any career field that interests you, look at how that field uses digital technology to enhance and simplify the work.

Video Games: More Than Just Fun

The video game business, which today employs thousands of people, did not exist before digital technology was invented. In only a few decades, the business has grown from a small niche market to a major industry. In 2012, more than 214 million video games were sold in the United States, or more than two games for every household in America. Globally, the video game industry sells more than 500 million games annually.

In the early days of video games, in the late 1970s and early 1980s, many games were developed by one or two people working alone on their computers. Graphics were simple. Game play was crude and unsophisticated. Today, however, video games are often large-scale productions involving entire teams of individuals working on different parts of the game.

Positions in the video game industry include lead programmers, special-effects programmers, audio programmers, sound engineers, composers, art directors, game designers, level designers, screenwriters, project managers, and game testers. Developing a game can take months or years of work and cost millions of dollars, but the profits of a successful game can be huge.

Recently, sales of video games reached over $10 billion per year in the United States alone. If games played on social media and mobile apps are added, this figure rises to $15.9 billion. Electronic games are played in 65 percent of American households. Responding to the demand, more than 200 colleges, universities, and design schools now offer courses or degree programs in game development and digital media.

Preparing for Your Visit

As you prepare to visit a business or an industrial facility that uses digital technology, consider a grocery store, school, manufacturing facility, office, or even your local library. Here are some things to investigate on your visit.

1. What types of digital technology are used—scanners, printers, smartphones, tablets, price-check stations, and so on.

2. What types of software programs are most useful to the organization—inventory, office applications, or mobile apps, etc.

3. Whether any specialized software had to be written to meet the organization's particular needs.

4. What kind of digital technology skills the organization seeks in newly hired employees.

5. How the internet has changed the way the organization operates. Ask whether the organization has a website and how many employees it takes to maintain the site. Ask if the organization participates in social media and whether it maintains a blog.

Recycling E-Waste

New and exciting digital technology emerges every day to capture our imaginations and improve our lives. Digital technology is changing so rapidly that yesterday's wonder gizmo is today's outdated trash, filling landfills with e-waste. Most discarded digital technology is loaded with toxic chemicals like lead, bromine, cadmium, chlorine, and mercury.

According to the Environmental Protection Agency, Americans throw away 125 million phones each year, creating 65,000 tons of waste. When digital technology is dumped in landfills, dangerous chemicals can leak into groundwater. When incinerated, the toxic chemicals contaminate the air. More than half the states have banned electronics from landfills.

Manufacturers recognize the environmental issues and are shifting to manufacturing processes that minimize the use of hazardous chemicals, including:

- Reducing or eliminating lead solder
- Using less hazardous resins in plastics
- Using mercury-free flat-panel liquid crystal displays (LCD) and arsenic-free glass
- Using bromine-free and chlorine-free printed circuit board laminates
- Moving to less toxic and reactive phosphorous-based flame-retardant chemicals

Because many recyclers are not equipped to responsibly recycle electronics, it is important to help ensure proper disposal of e-waste and use a certified recycler. Certified electronics recyclers meet high standards for data privacy, environmental responsibility, and employee health.

You can learn about certified recyclers by visiting the Environmental Protection Agency's website; see the resources section.

Batteries

Batteries are a special concern since every mobile device uses some kind of battery. While today's household batteries—the common AA, AAA, C, and D cell alkaline batteries—are not thought to pose a significant hazard because they contain much less mercury than they used to, it is still best to recycle them and not discard them in the trash. Batteries are not biodegradable, and some of their properties can contaminate groundwater.

Rechargeable batteries are a significant problem, because they are used in almost every mobile device in the market. These contain toxic metals and can be hazardous in landfills and incinerator emissions.

For more information about recycling batteries, see the resources section.

When recycling batteries, it is important to cover the contacts with electrical tape to prevent a short, which could start a fire.

The battery industry sponsors the Rechargeable Battery Recycling Corporation (RBRC), which is dedicated to the collection and disposal of rechargeable batteries. Many home improvement stores participate in this program. You can probably find a participating store in your community.

WHAT HAPPENS TO MY DATA?

A proper recycling center will remove all data before reusing your old digital technology. But why depend on others to do it? Always follow the manufacturer's guidelines to remove personal data from your device so thieves can't use your data. Not deleting your data is like throwing important papers in the trash without first shredding them. Note that simply reformatting or resetting your old device may leave your data subject to recovery. Be sure to use an application which "sanitizes" data completely.

How Can I Help?

Do your part to reduce e-waste by following the four R's of digital-device disposal:

Reuse. The best form of recycling is to donate your old digital technology to a good cause. A quick internet search will identify charities that will take and refurbish your old technology for people who can't afford brand-new products, or for residents of third-world countries where digital technology is not readily available.

Recycle. According to the EPA, for every million cell phones we recycle, 35,000 pounds of copper, 772 pounds of silver, 75 pounds of gold, and 33 pounds of palladium can be recovered. Many companies will responsibly recycle digital e-waste for you; make sure you use a certified recycler.

Refurbish. Several companies buy old digital technology, refurbish it, and then resell it. This is another form of recycling that helps everyone involved. Many refurbishers will buy old technology even if it doesn't work properly and use certain parts to fix other devices. See the resources section at the end of this pamphlet for more information.

Reduce. The best way to reduce the amount of e-waste is to simply use less stuff. Do you really need three or four devices that play music, or could you get by with one or two? Do you really need the latest cell phone, or could you wait a year or two?

How Scouts Can Be Involved
Why not start your own recycling effort in your community? Think about how you can educate your community about e-waste and set up drop boxes for digital technology that you could then send to recycling and reuse centers. You might even sell the devices you collect to a refurbishing company and use the proceeds for your troop.


Intellectual
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exclude
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compared
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period
based
used
rivals
simultaneously
one
law
applied
temporary
use
include
industrial
cost
works
problems
copied
copyrights
monopolies
IP
enjoyed
specific
meant
trade-off
production
trademarks
make
benefits
legal
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non-rival
costs
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incentive
produced
example
ideas
person
term
encouraging
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commercial
variety
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establishment
depend
formula
therefore
creations
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Intellectual Property

Ideas are referred to as *intellectual property*. Intellectual property laws are set up to protect unique and original ideas by establishing and defining the rights of those who create, own, and use them. The laws seek to balance the benefits of copying, sharing, and spreading ideas while making it worthwhile for people to produce new ideas.

Digital technology has made it much easier for people to copy, share, and spread ideas, whether or not they own the ideas. Technology allows people to mash up songs and videos, manipulate images, and duplicate and use apps on different devices. Creatively, this enables people with artistic skills to put new spins on existing ideas. When it comes to innovation, people can spend more time adjusting, enhancing, and tweaking ideas without the need to start from scratch.

There is a downside to copying, sharing, and spreading ideas—especially the ideas of others. Allowing people who create ideas to enjoy the recognition and to profit from their hard work is important in motivating people to produce new ideas and materials.

In the United States, everyone is entitled to intellectual property rights. For example, a record company has the right to protect and profit from a song that it produces and releases, just as an individual has the right to protect and profit from a song that he or she writes and performs. A record company may have the right to use a portion of another company's or artist's song in one of their songs, just as an individual may also use a portion of another person's or company's song. It all depends on the intellectual property laws and how they apply.

Laws help protect intellectual property. Every Scout needs to make sure to respect those laws and the intellectual property created by others.

A Scout Is Trustworthy
Scouting promotes hard work, creativity, and innovation, and acting in an honest and respectful fashion. Scouts should strive to create new ideas and use existing ideas in a manner that respects the hard work and the desires of the creators and owners of those ideas.

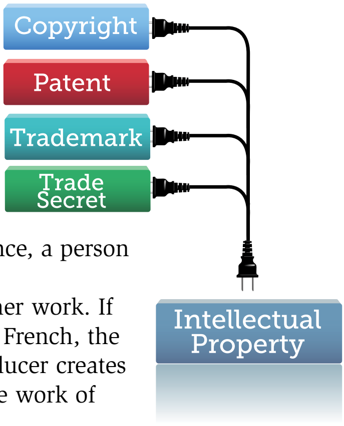
Intellectual Property Protections

Intellectual property, or IP, refers to creations that cannot be touched or held, such as ideas, plans, and designs. The major types of intellectual property protection include *copyright*, *patents*, *trade secrets*, and *trademarks*. Each type protects different aspects of ideas and has its own rules. The information below provides an overview.

Copyright

Copyright law protects the creative, original expression of an idea, not the idea itself. Examples of copyrighted works include books, magazine articles, movies, music, plays, sculptures, paintings, software, and photos. Under copyright law, protected items are called "works of authorship," and their creators are called "authors." Copyright law gives the copyright owner a set of exclusive rights to:

- Reproduce the work.
- Make "derivative works" of the original work.
- Distribute copies of the work.
- Publicly perform the work.
- Publicly display a work.
- Perform an audio recording via a digital audio transmission.



Keep in mind that copyright protects a set of legal rights; it does not cover ownership of copies of the works themselves. Just because a reader owns a single copy of a book or movie on DVD does not mean the reader can legally make copies of those works. However, although the copyright owner has the right to publish, reproduce, and distribute a work, people are entitled to resell items they have legally purchased. For instance, a person can sell his or her books.

A "derivative work" is a work based on another work. If someone translates an English-language book into French, the French version is a derivative work. Also, if a producer creates a movie based on a book, the movie is a derivative work of the book.

Copying another person's ideas may or may not infringe upon or violate the person's intellectual property rights. Under certain circumstances and limitations, the legal doctrine known as "fair use" enables people to use a limited portion of copyrighted works without obtaining permission.

The length of copyright protection can vary. Typically it is the lifespan of the author plus 70 years, but under certain conditions it can be longer. The Library of Congress has tools that can help determine whether copyright protection on a work is still in force.

Works no longer protected by copyright are in the *public domain*. Anyone can use such works without obtaining permission or approval from the rights holder. For instance, Sir Arthur Conan Doyle's novels about Sherlock Holmes have entered into the public domain, allowing people to make new movies and television shows featuring Holmes or a Holmes-like character. These new creations have their own copyright protections.

Look at the copyright notice on page 2 of this merit badge pamphlet. The information follows the copyright symbol: © (a circled capital C). What does the information tell you? Also look at the acknowledgments in the back of the pamphlet. What images in this publication are copyrighted? All merit badge pamphlets comply with intellectual property laws.

One major restriction imposed by copyright law is that you cannot make illegal copies of protected works. Trading in illegal copies of copyrighted works is called *piracy*.

Unfortunately, digital technology makes it easy to produce exact digital copies of certain kinds of intellectual property, including copyrighted software programs, games, music, photographs, books or articles, and movies. Worsening the problem is the illegal sharing of these pirated copies over the internet through the use of file-sharing networks. These networks make piracy easy and seemingly secret.

Not all copying is illegal. When you buy recorded music, you usually are allowed to copy it for your personal use. However, it is illegal to give copies of music or software to your friends. If you do, you are committing a crime. If you download pirated files into your computer, you also run the risk of downloading a virus that can harm your computer and data files.

Copying songs and books like this merit badge pamphlet is like stealing anything else, and it is wrong. You would not shoplift a CD at the music store or sneak in at a concert to listen for free. Similarly, you should not make copies of songs, books, and other copyrighted materials for friends.

Patent

A *patent,* issued by the U.S. government, grants certain exclusive rights in an invention for a limited term, typically 14 to 20 years. Patent law gives the inventor the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States. In exchange for these exclusive rights, the inventor must publicly disclose the invention. After the patent expires, anyone is free to use the invention.

In the United States, an inventor must file a patent application with the U.S. Patent and Trademark Office. The government will grant a patent only after an examiner has looked at the application and is satisfied that it meets the requirements. For more about patents and the rights of inventors, see the *Inventing* merit badge pamphlet.

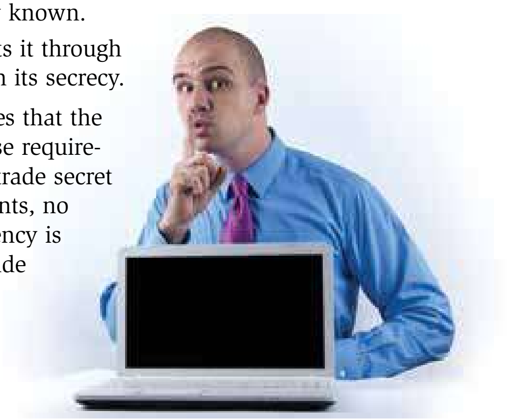
Foreign governments also issue patents that provide protection within their countries.

Trade Secrets

Unlike copyright and patent law, trade secrets are covered by state law. In most states, the four requirements for trade secret protection are:

- The confidential information provides a competitive edge for a business.
- The information has value.
- The information is not generally known.
- The information's owner protects it through reasonable measures to maintain its secrecy.

As long as the business ensures that the information continues to meet these requirements, the business can maintain trade secret protection indefinitely. Unlike patents, no registration with a government agency is necessary to obtain or maintain trade secret protection.



The trademark symbol ™ may be used with any mark. But the registered trademark symbol ® may only be used by the owner of a mark following registration with the U.S. Patent and Trademark Office.

Trademarks

A trademark (identified with a ™ or ®) is any word, name, logo, symbol, or device, or a combination of them, used to identify and distinguish the goods or products of a business. Some famous trademarks are Coca-Cola®, McDonald's®, and Apple®. You are also likely familiar with the trademarked logos of well-known companies, such as the golden arches of the McDonald's® restaurant chain. Unlike copyrights and patents, trademark rights continue indefinitely as long as the owner continues to use the mark.

In the United States, it is possible to obtain limited protection of a mark without registration. As soon as a business starts using the mark, the business obtains some protection of the mark as an unregistered trademark. Registration of a mark with the U.S. Patent and Trademark Office gives the mark's owner additional benefits. Businesses can also obtain trademark registrations from foreign governments.

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Piracy

The unauthorized use of another person's intellectual property is called *piracy.* As an example, software piracy is a costly, worldwide problem. According to the Business Software Alliance's 2011 Global Software Piracy Study: "[T]he global piracy rate hovered at 42 percent in 2011 while a steadily expanding marketplace in the developing world drove the commercial value of software theft to $63.4 billion." It is *not* a victimless crime.

The Federal Bureau of Investigation is charged by the U.S. government to investigate piracy and intellectual property theft. This includes ideas, inventions, and creative expressions, such as trade secrets, music, movies, and software. The FBI's Anti-Piracy Warning Seal is used to help "detect and deter criminal violations of U.S. intellectual property laws by educating the public about the existence of these laws and the authority of the FBI to enforce them." **You have probably seen this seal alongside the following text:**

> *The unauthorized reproduction or distribution of a copyrighted work is illegal. Criminal copyright infringement, including infringement without monetary gain, is investigated by the FBI and is punishable by fines and federal imprisonment.*

Glossary

analog. Describes a device or information that is continually variable, like a clock or a sound wave. The opposite of digital.

binary. A numbering system that uses only two digits. In digital technology, the two digits are 1 and 0, which represent turning an electronic circuit on and off.

bitmap. A grid on a computer screen made up of individual dots or pixels. The file name extension is ".bmp" and is a standard image format for personal computers.

browser. A program that lets users find and explore information on the World Wide Web, including text, graphics, sound, and video.

cloud computing. Applications and data storage, management, and processing offered over the internet, on shared computing resources rather than individual personal devices.

compression. Shrinking a file. Compression can be lossless (preserving all the data in a file) or lossy, (some data is deleted).

cookie. A small file downloaded from a website to your computer to store information about your activity at the site, such as what items you placed in your "shopping cart" at a store website.

digitize. To change something such as a picture or a sound into a form that a computer can understand.

download. Transferring information "down" from someone else's computer to one's own computer, by way of a local area network connection or the internet.

driver. A small computer program that allows the computer to communicate with a peripheral device, such as a printer or scanner.

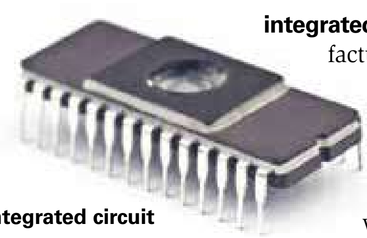
field. Part of a database in which a specific type of information is stored, such as telephone numbers.

firewall. Software or hardware that protects a computer or a private network of computers from other computers on the internet.

freeware. Software that is not copyrighted and can be used and copied by anyone. Also known as public-domain software.

hard drive. A rigid disk consisting of several platters that store information in magnetic form, usually installed inside a computer.

HTML (hypertext markup language). The basic language for displaying text and pictures on websites and linking webpages together.


Integrated circuit

integrated circuit. A group of related circuits all manufactured together on a single chip.

local area network. A computer network within a single office, building, or other site.

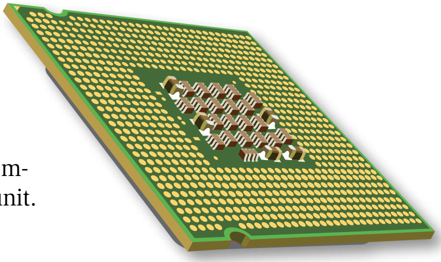
lossless/lossy. Compression can be lossless (preserving all the data in a file) or lossy, in which some data is deleted.

machine code. A programming language made up of sets of binary codes that a computer uses to pass instructions back and forth among its parts. Sometimes called low-level code.

malware. Damaging or "malicious" software intended to disrupt a network or a single computer. Types of malware include viruses, worms, and trojan horses.

memory. Where a computer stores information, for example, in RAM or ROM, or on compact discs or hard drives.

microchip. Integrated circuit.



Microprocessor

microprocessor. The “brain” of a microcomputer, or personal computer.

motherboard. The main circuit board of a computer, which contains the central processing unit.

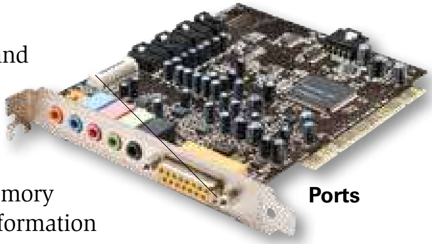
network. A group of connected computers.

operating system. Software that allows the computer to perform basic functions.

output device. Any device such as a monitor, printer, or sound card that allows information to be sent out from a computer.

pixel. Short for picture element. A single dot on a computer screen.

port. A place on a computer where accessories and peripherals can be plugged in and connected.



Ports

protocol. The rules computers use to communicate with each other.

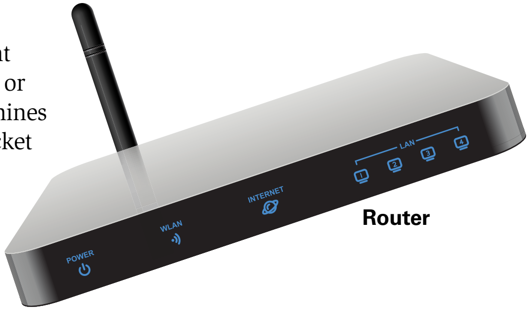
RAM (random-access memory). Temporary memory that the computer uses to store programs and information until the computer is turned off.

read. To retrieve information or a program from storage and put it into the computer’s internal memory. The opposite of write.

resolution. Describes how much detail is used to print an image (in dots per inch, or DPI) or display it on a computer monitor (in number of pixels wide by number of pixels high).

ROM (read-only memory). Permanent, unchangeable memory used to store basic instructions the computer needs in order to operate.

router. A device or software that serves as a bridge between two or more networks. A router determines the best route for sending a packet of data to its destination.



Router

security certificate. A digital certificate that authenticates business websites and secures email messages, allowing users to verify the identity of the company or person with whom they are doing business.

server. A computer on a network that manages shared resources, such as files or webpages.

shareware. Software that a user pays for after trying it and deciding to use it.

sound digitizer. A circuit that converts sound into digital form.

trojan horse. A virus or harmful computer program disguised to look like a useful program, such as a screensaver.

uniform resource locator (URL). A location or address identifying where documents can be found on the internet; also known as a web address.

upload. To transfer information from one's own computer "up" to someone else's computer via a local area network or the internet.

USB (universal serial bus) port. The device used to connect all such peripheral devices.

Wi-Fi (wireless fidelity). A method of connecting computers on a network with radio signals rather than wires.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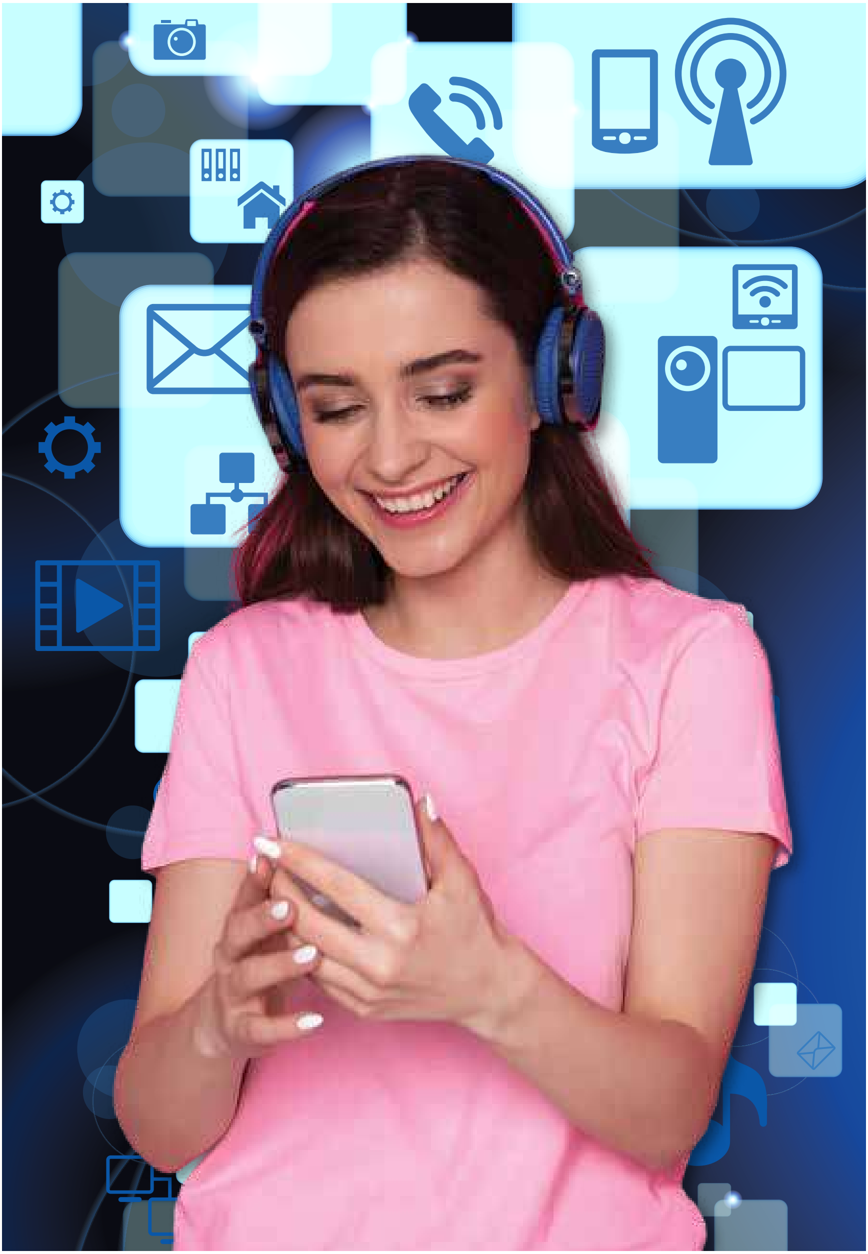

Digital Technology Resources

Scouting Literature

Drafting, Electricity, Electronics, Engineering, Game Design, Graphic Arts, Inventing, Photography, Programming, and *Robotics* merit badge pamphlets

With your parent's permission, visit the Boy Scouts of America's official retail website, www.scoutshop.org, for a complete listing of all merit badge pamphlets and other helpful Scouting materials and supplies.

Organizations and Websites

American Society for Engineering Education
www.asee.org

Computer and Information Technology Occupations
Occupational Outlook Handbook:
www.bls.gov/ooh/computer-and-information-technology/home.htm

Computer History Museum
www.computerhistory.org

Entertainment Software Association
www.theesa.com

Environmental Protection Agency
www.epa.gov

IEEE (Institute of Electrical and Electronics Engineers)
www.ieee.org

IEEE Computer Society
www.computer.org

International Game Developers Association
www.igda.org

International Intellectual Property Alliance
www.iipa.org

Library of Congress
www.loc.gov

Recording Industry Association of America
www.riaa.com

U.S. Patent and Trademark Office
www.uspto.gov

World Wide Web Consortium
www.w3.org

E-Waste Resources

Call2Recycle
www.call2recycle.org

Earth911
earth911.com

Terracycle
www.terracycle.com/en-US

Acknowledgments

The Boy Scouts of America gratefully acknowledges the team that helped update this edition of *Digital Technology,* which replaces the *Computers* merit badge pamphlet:

Celeste Rance—Digital Technology merit badge lead; coauthor, *Programming* merit badge pamphlet; software development manager, Pearson

Rick Folea—Eagle Scout; Programming merit badge lead; coauthor, *Robotics* merit badge pamphlet; AutomationDirect.com

Laszlo Hideg—Ph.D., P.E.—Transmission Algorithms and Control, GM Powertrain; coauthor, *Robotics* and *Programming* merit badge pamphlets; FIRST® Robotics competition judge and volunteer

Steve Petersen—Eagle Scout; BSA Cyber Chip codeveloper; web development professional

Robert J. Caruso, CISSP—Information security architect, Battelle Memorial Institute; inventor and software product developer; U.S. CyberPatriot mentor and lifelong Scouter; coauthor, *Programming* merit badge pamphlet; BSA Cyber Chip codeveloper

Steve Wincor—Chief systems architect, Lockheed Martin; BSA Nova Awards mentor; coauthor, *Programming* merit badge pamphlet; BSA Cyber Chip codeveloper

Dr. Philip Stahl, Ph.D.—Eagle Scout; senior optical physicist, NASA; 2014 president, SPIE (Society of Photo-Optical Instrumentation Engineers)

Thanks also to Eagle Scout Christopher Hideg for his assistance with sidebars for this merit badge pamphlet.

We appreciate Scott Stuckey for writing the previous edition of the *Computers* merit badge pamphlet, upon some of which this new pamphlet is based. Mr. Stuckey is a former editor of *Scout Life* magazine.

The BSA is grateful to the Components, Packaging, and Manufacturing Technology Society of the Institute of Electrical and Electronics Engineers, in particular longtime national Scout jamboree staff member Ralph W. Russell II, IEEE Precollege Education Coordinating Committee, for their assistance with previous editions of the *Computers* merit badge pamphlet that formed the basis for much of this revised edition.

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Brian Payne—page 12 *(youth)*

Notes

Notes

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