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Computing Components:

Processors, Memory, the Cloud

Inside the Case

Whether you are a home user or a business user, you most likely will purchase a new computer or mobile device, or upgrade an existing computer at some time in the future. As a result, you should understand the purpose of each component in a computer or mobile device. Components are used for input, processing, output, storage, and communications. Many of these components are inside the case that contains and protect the electronics of the computer or mobile device from damage.

The Motherboard

The motherboard, also called a *system board*, is the main circuit board of the computer. Many electronic components, such as the processor and memory, attach to the motherboard; others are built into it.

On personal computers, the circuitry for the processor, memory, and other components reside on a computer chip(s). A computer **chip** is a small piece of semiconducting material, usually silicon, on which integrated circuits are etched. An *integrated circuit* contains many microscopic pathways capable of carrying electrical current. Each integrated circuit can contain millions of elements such as resistors, capacitors, and transistors. A *transistor,* for example, can act as an electronic switch that opens or closes the circuit for electrical charges. Today's computer chips contain millions or billions of transistors.

Most chips are no bigger than one-half inch square. Manufacturers package chips so that the chips can be attached to a circuit board, such as a motherboard.

Processors

The **processor,** also called the **central processing unit (CPU)**, interprets and carries out the basic instructions that operate a computer. The processor significantly impacts overall computing power and manages most of a computer's operations. On larger computers, such as mainframes and supercomputers, the various functions performed by the processor extend over many separate chips and often multiple circuit boards. On a personal computer, all functions of the processor usually are on a single chip. Some computer and chip manufactures use the term, *microprocessor,* to refer to a personal computer processor chip.

A single board computer has all components on one, small circuit board. These components might include the processor and memory. Single-board computers often are much less expensive than desktops and laptops.

Most processor chip manufacturers now offer multi-core processors. A processor core, or core, contains the circuitry necessary to execute instructions. The operating system views each processor core as a separate processor. A **multi-core processor** is a single chip with two or more separate processor cores. Multi-core processors are used in all sizes of computers.

Processors contain a *control unit* and an *arithmetic logic unit* (ALU). These two components work together to perform processing operations. When a user runs an application, its instructions transfer from a storage device to memory. Data needed by programs and applications enters memory from either an input device or a storage device. The control unit interprets and executes instructions in memory, and the arithmetic logic unit performs calculations on the data in memory. Resulting information is stored in memory, from which it can be sent to an output device or a storage device for future access, as needed.

Reflect

Are multi-core processors better than single-core processors?

Each processor core on a multi-core processor generally runs at a slower speed than a single-core processor, but multi-core processors typically increase overall performance. For example, although a dual-core processor does not double the processing speed of a single-core processor, it can approach those speeds. The performance increase is especially noticeable when users are running multiple programs simultaneously, such as antivirus software, word processing software, email program, browser, media player, and photo editing software. Multi-core processors also are more energy efficient than separate multiple processors, requiring lower levels of power consumption and emitting less heat inside the case.

The Control Unit

The **control unit** is the component of the processor that directs and coordinates most of the operations in the computer. That is, it interprets each instruction issued by a program or an application and then initiates the appropriate action to carry out the instructions. Types of internal components that the control unit directs include the *arithmetic logic unit, registers, and buses.*

The Arithmetic Logic Unit

The **arithmetic logic unit (ALU),** another component of the processor, performs arithmetic, comparison, and other operations.

Arithmetic operations include basic calculations, such as addition, subtraction, multiplication, and division. *Comparison operations* involve comparing one data item with another to determine whether the first item is greater than, equal to, or less than the other item. Depending on the result of the comparison, different actions may occur. For example, to determine if an employee should receive overtime pay, software instructs the ALU to compare the number of hours an employee worked during the week with the regular time hours allowed. If the hours worked exceed 40, software instructs the ALU to perform calculations that compute the overtime wage.

Machine Cycle

For every instruction, a processor repeats, a set of four basic operations, which comprise a *machine cycle*: (1) fetching (2) decoding (3) executing, and if necessary, (4) storing.

- *Fetching* is the process of obtaining a program or an application instruction or data item from memory
- *Decoding* refers to the process of translating the instruction into signals the computer can execute
- *Executing* is the process of carrying out the commands
- *Storing*, in this context, means writing the result to memory (not to a storage medium)

In some computers, the processor fetches, decodes, executes, and stores only one instruction at a time. With others, the processor fetches a second instruction before the first instruction completes its machine cycle, resulting in faster processing. Some use multiple processors simultaneously to increase processing times.

Registers

A processor contains small, high –speed storage locations, call *registers*, that temporarily hold data and instructions. Registers are part of the processor, not part of memory or a permanent storage device. Processors have many different types of registers, each with a specific storage function. Register functions include storing the location from where an instruction was fetched, storing an instruction while the control unit decodes it, storing data while the ALU calculates it, and storing the results of a calculation.

The System Clock

The processor relies on a small quartz crystal circuit called the **system clock** to control the timing of all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components of the system unit.

Each tick equates to a c*lock cycle.* Processors today typically are *superscalar,* which means they can execute more than one instruction per clock cycle.

The pace of the system clock, called the **clock speed,** is measured by the number of ticks per second. Current personal computer processors have clock speeds n the gigahertz range. Giga is a prefix that stands for billion, and a *hertz* is one cycle per second. Thus, one **gigahertz (GHS)** equals one billion ticks of the system clock per second. A computer that operates at 3 GHz has 3 billion (giga) clock cycles in one second (hertz).

The faster the clock speed, the more instructions the processor can execute per second. The speed of the system clock is just one factor that influences a computers' performance.

Personal Computer and Mobile Device Processors

The leading manufacturers of personal computer processor chips are Intel and AMD. AMD manufactures *Intel-compatible processors*, which have an internal design similar to Intel processors, perform the same functions, and can be as powerful, but often are less expensive. These manufacturers often identify their processor chips by a model name or model number.

In the past, chip manufactures listed a processor's clock speed in marketing literature and advertisement. Clock speed is only one factor that impacts processing speed in today's computers. To help consumers evaluate various processors, manufacturers such as Intl and AMD now use a numbering scheme that more accurately reflects the generation and processing speed of their chips.

Processor chips include technologies to improve processing performance such as for media and 3-D graphics. Some also include technology to track computer hardware and software, diagnose and resolve computer problems, and secure computers from outside threats. Processors for mobile computers also include technology to optimize and extend battery life and integrate wireless capabilities. Smaller mobile devices often use more compact processors that consume less power, yet offer high performance.

Reflect

How to Select the Right Processor

It is important to select a computer with a processor that will meet your needs. Some processors are designed for home users, some are designed for power users, and others are designed for mobile users. Performing basic research before you buy a new computer can help you buy the most appropriate processor. Here are steps to take:

1. **Determine your needs**
   Think about how you will use your computer and the programs and applications you plan to run. If you will be using your computer for basic tasks, such a web browsing or checking email, you may require a less expensive processor than a user who will be running many programs and applications simultaneously.
2. **Determine our current processor.**
   If you are replacing your existing computer with a new computer, determine the processor in your existing computer so that you can make sure the new processor is better and faster than the one that is currently in use.
3. **Research processor models.**
   While shopping for computes in your price range, pay attention to the types of processors they include. Visit the processor manufacture's website and verify that the processor will meet your computing needs . Reviewing the minimum system requirements on the programs and apps you wish to run may help you determine the processor you need. Choose a processor that exceeds the minimum system requirements of the programs and apps you wish to run, but remember that it is not always necessary to purchase the most expensive computer with the fastest processor.

Processor Cooling

Processor chips for laptops, desktops, and servers can generate quite a bit of heat, which could cause the chip to malfunction or fail. Although the power supply on some computers contains a main fan to generate airflow, today's personal computer processors often require additional cooling. Some computer cases locate additional fans near certain components, such as a processor to provide additional cooling. Heat sinks, liquid cooling technologies, and cooling mats often are used to help further dissipate processor heat.

A *heat sink* is a small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components, such as a processor. Many heat sinks have fans to help distribute air dissipated by the heat sink. Some heat sinks are packaged as part of a processor chip. Others are installed on the top or the side of the chip.

Some computers use liquid cooling technology to reduce the temperature of a processor. *Liquid coloring technology* uses a continuous flow of fluid(s), such as water and glycol, in a process that transfers the heated fluid away from the processor to a radiator-type grill, which cools the liquid, and then returns the cooled fluid to the processor.

Laptop users sometimes use a cooling pad to help further reduce the heat generated by their computer. A *cooling pad* rests below a laptop and protects the computer from overheating and also the user's lap for excessive heat. Some cooling pads contain a small fan to transfer heat away from the laptop. These types of cooling pads often draw power from a USB port. Instead of using power, other pads absorb heat through a conductive material inside the pad.

The Internet of Things

The *Internet of Things (IoT)* describes a computing environment where everyday objects, or things, are connected to the internet. Sensors connected to these objects may gather, share, transmit, and receive data bout the objects with other devices or servers online. Users can access the data or control individual objects using web or mobile apps.

Cloud Computing

Cloud computing refers to an environment of servers that house and provide access to resources users access via the Internet. Home and business users choose cloud computing for a variety of reasons:

- **Accessibility**: Data and/or applications are available worldwide from any computer or device with an Internet connection.
- **Cost savings**: The expense of software and high-end hardware, such as fast processors and high-capacity memory and storage devices, shifts away from the user.
- **Space savings**: Floor space required for servers, storages devices, and other hardware shifts away from the user.
- **Scalability**: Provides the flexibility to increase or decrease computing requirements as needed.

Cloud computing consist of a front end and a back end, connected to each other through a network. The front end includes the hardware and software with which a user interacts to access the cloud or a user might access a resource on the cloud through a browser on a laptop. The back end consists of the servers and storage devices that manage and store the resources access by users.

Cloud Computing Services

Cloud computing allows companies to outsource, or contract to third-party providers, elements of their information technology infrastructure. They pay only for the computing power, storage, bandwidth, and access to applications that they actual use. As a result, companies need not make large investment in equipment or the staff to support it.

Infrastructure as a Service (Iaas)

IaaS uses software to emulate hardware capabilities, enabling companies to scale, or adjust up or down, storage, processing power, or bandwidth as needed. For example, retailers may need to increase these capabilities to accommodate additional traffic to their website during busy holiday shopping seasons. When the season ends, retailers easily can reduce these settings. Two specific instances of IaaS are *storage as a service* and *desktop as a service*:

- **Storage as a Service:** cloud storage providers offer file management service such as storing files online, system backup, and archiving earlier versions of files. Cloud storage is especially useful to tablet and smartphone users, because it enables them to access their files from all of their devices.
- **Desktop as a Service**: some companies specify the applications, security settings, and computing resources available to employees on their desktop computers. These images, or configurations, provide a common desktop work environment available to employees across an entire organization. Because the desktop and its

applications appear to be installed on the user's own computer, desktop as a service is also known as a *virtual desktop*.

Software as a Service (SaaS)

SaaS describes a computing environment where an Internet server hosts and deploys applications. Editing documents or photos, sending email messages, and managing finances are common consumer tasks of SaaS applications. A pioneering provider of SaaS applications for companies is *Salesforce* which offers customer relationship management (CRM) software. Salesforce users subscribe to modules to handle tasks such as sales and marketing campaigns and customer services.

Data as a Service

Government agencies, companies, and social media sites make data available for developers to incorporate in applications or to use when making business decisions and plans. DaaS allows uses and applications to access a company's data. *Mashups* are applications that incorporate data from multiple providers into a new application. Displaying homes or crime statistics on a map are examples of mashups that require data from real estate, police records, and mapping providers.

Platform as a Service

Application developers need to maintain computers running specific hardware, operating systems, development tools, databases, and other software. PaaS allows developers to create, test, and run their solutions on a cloud platform without having to purchase or configure the underlying hardware and software.

Data Representation

To understand how a computer processes data, you should know how a computer represents data. People communicate through speech by combining words into sentences. Human speech is **analog** because it uses continuous (wave form) signals that vary in strength and quality. Most computers are **digital**. They recognize only two discrete states: **on and off**, The two digits, 0 and 1, easily can represent these two states. The digit 0 represents the electronic state of off (absence of an electronic charge). The digit 1 represents the electronic state of on (presence of an electronic charge).

Bits and Bytes

When people count, they use the 10 digits in the decimal system (0 through 9). The computer, by contrast, uses a binary system because it recognizes only two states. The **binary system** is a number system that has just two unique digits, 0 and 1, called bits. A **bit** (short for *binary digit)* is the smallest unit of data the computer can process. By itself, a bit is not very informative.

When 8 bits are grouped together as a unit, they form a **byte**. A byte provides enough different combinations of 0s and 1s to represent 256 different characters. These characters include numbers, uppercase and lowercase letters of the alphabet, punctuation marks, and other keyboard symbols, such as an asterisk (*), ampersand (&), and dollar sign ($).

Coding Schemes

The combinations of 0s and 1s that represent uppercase and lowercase letters, numbers, and special symbols are defined by patterns called a coding scheme. Coding schemes map a set of *alphanumeric characters* (letters and numbers) and special symbols to a sequence of numeric values that a computer can process. *ASCII* which stands for American Standard Code for Information Interchange, is the most widely used coding scheme to represent a set of characters. In the ASCII coding scheme, the alphabetic character E is represented as 01000101; the symbolic character * is represented as 00101010; the numeric character 6 is represented as 00110110.

When you press a key on a keyboard, a chip in the keyboard converts the key's electronic signal into a special code, called a scan code, that is sent to the electronic circuitry in the computer. Then the electronic circuitry in the computer converts the scan code into its ASCII binary form and stores it as a byte value in its memory for processing. When processing is finished, the computer converts the byte into a human-recognizable number, letter of the alphabet, or special character that is displayed on a screen or is printed. All of these conversations take place so quickly that you do not realize they are occurring.

Coding schemes are necessary because computers rely on logic circuits, which are controlled by electronic switches whose state can be either on or off. Each switch's on/off state is represented by one bit, whose value is either 0 or 1. Coding schemes translate real-world data into a form that computers can process easily.

Memory

Memory consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processing the data (information). Memory usually consists of one or more chips on the motherboard or some other circuit board in the computer. Memory stores three basic categories of items:

1. The operating system and other programs that control or maintain the computer and its devices
2. Applications that carry out a specific tasks, such as word processing
3. The data being processed by the applications and the resulting information

This role of memory to store both data and programs is known as the *stored program concept.*

Bytes and Addressable Memory

A byte (character) is the basic storage unit in memory. When an application's instruction and data are transferred to memory from storage devices, the instructions and data exist as bytes. Each byte resides temporarily in a location in memory that has an *address.* Simply put, an address is a unique number that identifies the location of a byte in memory. To access data or instructions in memory, the computer references the addresses that contain bytes of data.

Manufacturers state the size of memory in terms of the number of bytes it has available for storage. Common sizes for memory are in the gigabyte range.

Types of Memory

Computers and mobile devices contain two types of memory: volatile and nonvolatile. When the computer's power is turned off, *volatile memory* loses its contents. *Nonvolatile memory,* by contrast, does not lose its contents when power is removed from the computer. Thus, volatile memory is temporary and nonvolatile memory is permanent. RAM is the most common type of volatile memory. Examples of nonvolatile memory include ROM, flash memory, and CMOS.

RAM

RAM, (random access memory) also called main memory, consists of memory chips that can be read from the written to by the processor and other devices. When you turn on power to a computer or mobile device, certain operating system files (such as the files that determine how the desktop or home screen appears) load into RAM from a storage device such as a hard drive. These files remain in RAM as long as the computer or mobile device has continuous power. As additional applications and data are requested, they also load into RAM from storage.

The processor interprets and executes a program or application's instructions while the program or application is in RAM. During this time, the contents of RAM may change. RAM can accommodate multiple programs and applications simultaneously.

How Program Instructions Transfer In and Out of RAM

Step 1: When you start the computer, certain operating system files are loaded into RAM from the hard drive. The operating system displays the user interface on the screen.

Step 2: When you run a browser, the application's instructions are loaded into RAM from the hard drive. The browser and certain operating system instructions are in RAM. The browser window appears on the screen.

Step 3: When you run a paint application, the application's instructions are loaded into RAM from the hard drive. The paint application, along with the browser and certain operating system instructions, are in RAM. The paint application window appears on the screen.

Step 4: When you exit an application, such as the browser, its instructions are removed from RAM. The browser no longer is displayed on the screen.

Most RAM is volatile which means it loses it contents when the power is removed from the computer. Therefore, you must save any data, instructions, and information you may need in the future. Saving is the process of copying data, instructions, and information from RAM to a storage device such as a hard drive.

Types of RAM

- *Dynamic RAM* (DRAM) chips must be reenergized constantly or they lose their contents. Many variations of DRAM chips exist, most of which are faster than the basic DRAM
- *Static RAM* (SRAM) chips are faster and more reliable than any variation of DRAM chips. These chips do not have to be reenergized as often as DRAM chips; hence, the term, static. SRAM chips, however, are much more expensive than DRAM chips. Special applications, such as cache, use SRAM chips.

COMMAND DRAM VARIATIONS	
Name	**Comments**
SDRAM (Synchronous DRAM)	• Synchronized to the system clock • Much faster than DRAM
DDR SDRAM (Double Data Rate SDRAM)	• Transfers data twice, instead of once, for each clock cycle • Faster than SDRAM
DDR2	• Second generation of DDR • Faster than DDR
DDR3	• Third generation of DDR • Designed for computers with multi-core processors • Faster than DDR2
DDR4	• Fourth generation of DDR • Faster than DDR3
RDRAM (Rambus DRAM)	• Much faster than SDRAM

Memory Modules

RAM chips usually reside on a memory module, which is a small circuit board. Memory slots on the motherboard hold memory modules.

Two types of memory modules are SIMMs and DIMMs. A *SIMM* (single inline memory module) has pins on opposite sides of the circuit board that connect together to form a single set of contacts. With a DIMM (dual inline memory module), by contrast, the pins on opposite sides of the circuit board do not connect and, thus, form two sets of contacts.

Cache

Most to today's computers improve their processing times with **cache** which is a temporary storage area. Two common types of cache or memory cache and disk cache.

Memory cache helps speed the processes of the computer because it stores frequently used instructions and data. Most personal computers today have two types of memory cache: Level 1 cache and Level 2 cache. Some have Level 3 cache.

- *Level 1 cache* is built directly on the processor chip. Level 1 cache usually has a very small capacity.

- *Level 2 cache* is slightly slower than Level 1 cache but has a much larger capacity. Current processors include *advanced transfer cache (ATC)*, a type of Level 2 cache built directly on the processor chip. Processors that use ATC perform at much faster rates than those that do not use it.
- *Level 3 cache* is a cache on the motherboard that is separate from the processor chip.

When the processor needs an instruction or data, it searches memory in this order: Level 1 cache, then Level 2 cache, the Level 3 cache (if level 3 exists), the RAM – with a greater delay in processing for each level of memory it must search. If the instruction or data is not found in memory, then it must search a slower speed storage medium, such as a hard device or optical disc.

ROM

Read-only memory (ROM) refers to memory chips storing permanent data and instructions. The data on most ROM chips cannot be modified – hence, the name read-only. ROM is nonvolatile, which means its contents are not lost when power is removed from the computer. In addition, to computers and mobile devices, many peripheral devices contain ROM chips. For example, ROM chips in printers contain data for fonts.

Manufacturers of ROM chips often record data, instructions, or information on the chips when they manufacture the chips. These ROM chips, called **firmware,** contain permanently written data, instructions, or information, such as a computer or mobile device's start-up instructions.

Flash Memory

Flash memory is a type of nonvolatile memory that can be erased electronically and rewritten. Most computers use flash memory to hold their start-up instruction because it allows the computer to update its contents easily. For example, when the computer changes from standard time to daylight savings, time, the contents of a flash memory chip (and the real-time clock chip) change to reflect the new time.

Flash memory chips also store data and programs on many mobile devices and peripheral devices, such as smartphones portable media players, printers, digital cameras, automotive devices, and digital voice recorders. When you enter names and addresses in a smartphone, a flash memory chip stores the data. Some portable media players store music on flash memory chips others store music on tiny hard drives or memory cards. Memory cards contain flash memory on a removable device instead of a chip.

CMOS

Some RAM chips, flash memory chips, and other memory chips use complementary metal-oxide semiconductor (CMOS) technology because it provides high speeds and consume little power. CMOS technology uses battery power to retain information even when the power to the computer is off. Battery-backed CMOS memory chips, can keep the calendar, date, and time current even when the computer is off. The flash memory chips that store a computer's start-up information often use CMOS technology.

Memory Access Times

Access time is the amount of time it takes the processor to read data, instructions, and information from memory. A computer's access time directly affects how fast the computer oversees data. Accessing data in memory can be more than 200,000 times faster than accessing data on a hard disk because of the mechanical motion of the hard disk.

Today's manufacturers use a variety of terminology to state access time. Some use fractions of a second, which for memory occurs in nanoseconds. A *nanosecond* is one billionth of a second. A nanosecond is extremely fast. In fact, electricity travels about one foot in a nanosecond.

Adapters

An **adapter card**, sometimes called an *expansion card* or *adapter board*, is a circuit board that enhances the functions of a component of a desktop or server system unit and/or provides connections to peripheral devices. An **expansion slot** is a socket on a desktop or server motherboard that can hold an adapter card.

Two popular adapter cards are sound cards and video cards. A *sound card* enhances the sound-generating capabilities of a personal computer by allowing sound to be input through a microphone and output through external speakers or headphones. A *video card,* also called a *graphics card,* converts computer output into a video signal that travels through a cable to the monitor, which displays an image on the screen.

PURPOSE OF VARIOUS ADAPTER CARDS	
Type	**Purpose**
Bluetooth	• Enables Bluetooth connectivity
MIDI	• Connects to musical instruments
Modem	• Connects to transmission media, such as cable television lines or phone lines
Network	• Provides network connections, such as to an Ethernet port
Sound	• Connects to speakers or a microphone
TV tuner	• Allows viewing of digital television broadcast on a monitor
USB	• Connects to high –speed USB ports
Video	• Provides enhanced graphics capabilities, such as accelerated processing or the ability to connect a second monitor
Video capture	• Connects to a digital video camera

Sometimes, all functionality is built in the adapter card. With others, a cable connects the adapter card to a device, such as a digital video camera, outside the computer.

Today's computers support **Plug and Play** technology, which means the computer automatically can recognize peripheral devices as you install them. Plug and Play support means you can plug in a device and then immediately begin using it.

USB Adapters

Because of their smaller size, mobile computers typically do not have expansion slots. Instead, users can purchase a **USB adapter,** which is a dongle that plugs into a USB port, enhances functions of a mobile computer, and/or provides connections to peripheral devices. USB adapters can be used to add memory, communications, multimedia, security, and storage capabilities to mobile computers. A USB flash drive is a common USB adapter that provides computers and mobile devices with additional storage capability as long as it is plugged in.

Unlike adapter cards, that require you to open the system unit and install the card on the motherboard, you can change a removable flash memory device without having to open the system unit or restart the computer. This feature, called *hot plugging,* allows you to insert and remove a device while the computer is running (important to stop or eject the device before removing it).

Buses

A computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels. Each channel, called a **bus**, allows the various devices both inside and attached to the system unit to communicate with one another. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus.

Buses are used to transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices. Buses consist of a data bus and an address bus. The *data bus* is used to transfer actual data, and the *address bus* is used to transfer information about where the data should reside in memory.

Bus Width

The size of a bus, called the *bus-width* determines the number of bits the computer can transmit at one time. A 32-bit bus can transmit 32 bits (4 bytes) at a time. On a 64-bit bus, bits transmit from one location to another 64 bits (8 bytes) at a time. The larger the number of bits handled by the bus, the faster the computer transfers data.

If a number in memory occupies 8 bytes, or 64 bits, the computer must transmit it in two separate steps when using a 32 bit bus: once for the first 32 bits and once for the second 32 bits. Using a 64 bit bus, the computer can transmit the number in a single step, transferring all 64 bits at once. The wider the bus, the fewer number of transfer steps required and the faster the transfer of data. Most personal computers today use a 64-bit bus.

In conjunction with the bus width, many computer professionals refer to a computer's word size. **Word size** is the number of bits the processor can interpret and execute at a given time. That is, a 64-bit processor an manipulate 64 bits at a time. Computers with a larger word size can process more data in the same amount of time than computers with a smaller word size. In most computers, the word size is the same as the bus width.

Types of Buses

A computer has a system bus, possibly a backside bus, and an expansion bus.

- A *system bus,* also called the *front side bus (FSB),* is part of the motherboard and connects the processor to main memory.
- A *backside bus (BSD)*, connects the processor to cache.
- An *expansion bus* allows the processor to communicate with peripheral devices.

When computer professionals use the term, bus, by itself, they usually are referring to the system bus.

Power Supply and Batteries

Many personal computers plug in standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts. This type of power is unsuitable for use with a computer or mobile device, which requires a direct current (DC) ranging from 5 to more than 15 volts. The **power supply** or laptop AC adapter convers the wall outlet AC power into DC power. Different motherboards and computers require different wattages on the power supply. If a power supply is not providing the necessary power the computer will not function properly.

Built into the power supply is a fan that keeps the power supply cool. Some have variable speed fans that change speed or stop running, depending on temperature in the case. Many newer computers have additional fans near certain components in the system unit, such as the processor, hard drive, and ports. Some users install more fans to help dissipate heat generated by the components of the computer.

Some external peripheral devices, such as a cable modem, speakers, or a printer, have an AC adapter, which is an external power supply. One end of the AC adapter plugs in the wall outlet and the other end attaches to the peripheral. The AC adapter converts the AC power into the DC power that the peripheral requires, and also often charges the battery in a mobile computer or device.

Mobile computers and devices can run using either a power supply or batteries. The batteries typically are rechargeable lithium-ion batteries. Many newer mobile devices and computers, such as some ultrathin laptops, do not have removable batteries.

Proper Care for Computers and Mobile Devices

Caring for a computer or mobile device requires keeping hardware in good condition and maintaining programs and apps.

Hardware Maintenance

Before performing any of the following steps, turn off and unplug the device from its power source. If the computer or mobile device has a removable battery, remove it. Disconnect all peripheral devices. Perform maintenance in a clean clutter free area.

- Use a damp cloth to clean the screen gently
- If a keyboard exists, use a can of compressed air to remove dirt and debris
- When transporting a laptop, use a case with plenty of padding
- If an air vent exists for a fan, ensure the vent is free from dust and debris.
- When inserting media or USB, be sure it is clean.

Software Maintenance

Software maintenance can help your computer or mobile device run optimally. Follow these steps if you notice a decline in your computer or device's performance.

- Uninstall programs and remove apps you no longer need.
- For a desktop or laptop with a hard disk, perform a defragment.
- Install programs and apps only from reputable software manufacturers.