

FIRST
EDITION

EXPLORING DIGITAL AND INFORMATION TECHNOLOGY

AN INTRODUCTION TO
COMPUTER APPLICATIONS

**Mc
Graw
Hill**

Exploring Digital and Information Technology

Review Copy



Review Copy

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1 Computer Hardware

What To Expect

After completing this chapter, you will be able to:

- describe types of computers and computer functions;
- differentiate between different types of personal computers;
- describe large computer systems;
- explain computer processors and the relevant parameters;
- identify the memory and storage systems in computers;
- identify the various computer ports;
- describe computer protocols;
- define the terms *video card* and *pixel* and explain the parameters of computer graphics;
- explain how a computer works.

Chapter Topics

- What Is a Computer?
- Computer Components
- Computer Storage
- Connections
- Wireless Connections
- Graphics
- How a Computer Works
- Quantum Computing

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Let's Explore Computers

Take a step back in time to when people didn't have computers. In those days, different jobs required a bunch of different equipment. For writing, there were typewriters. If you wanted to record moving pictures, you needed a video camera, and for still pictures, you would use a regular camera. Drawing pads were there for making illustrations, and for games, you might have a deck of cards. And, of course, there were big old telephones for making calls. We might still use some of these tools today, but computers have combined many of them.

Imagine having to lug around a video camera, a deck of cards, a drawing pad, and a typewriter all the time! That would be pretty tough. Most of the time, people would keep these items stored away, pulling them out only when they needed them. Each had its own special use and couldn't do the job of the others. If you were doing one thing and wanted to switch to another, you had to put one piece of equipment away and get out a different one. Not very handy!

Then the computer came along. It was a game-changer! It combined all these different tools into one neat, efficient, and incredibly useful device. And the cool part is, the computer didn't lose any effectiveness by bringing all these things together.

A computer is way more than just a typewriter. It's a video camera, a drawing pad, a telephone, a game console, and a music player—all in one! It lets you go from writing to video calling to drawing without a hitch. No need to change equipment.

Because it can do so many things in one, the computer is a pretty amazing piece of tech. It has changed the way we learn, talk, work, and have fun. It's like having a magic box that instantly gives you any tool you need. The computer lets us do things that were impossible with old individual tools.

As we dig deeper into computers, we're going to learn how this all-in-one device works and how it can do so many different things without losing any power. We'll see how computers have changed our world, letting us do many things at once and making life a lot more interesting. Keep in mind this picture of the computer as a handy, all-around tool as we go on to learn more about the wonders of computing.

What Is a Computer?

Define the Term *Computer*

Computers are digital devices that accept input, process and store the input, and provide output. A computer is made up of multiple components that create user functionality. **Computers** consist of hardware and software that create data and process information. Hardware is the physical elements of the device, including the computer's processor, memory, storage, ports, and peripheral devices. Software is the virtual elements, including the OS and a variety of software applications.

The Four Basic Computing Functions

A computer is a digital device that completes four basic functions. First, computers accept input. They accept data from many sources, including keyboards, cameras, microphones, and even other computers. Next, computers compile and transform data into useful information; this is called the process function. **Computers** also provide output, which means the ability to display information. This output comes in many forms: images, video, and audio. Finally, computers store data for future use.

Different Types of Computers

Computers are digital devices that come in many shapes, sizes, and designs.

Examples of computers:

- laptops
- desktops
- all-in-ones
- tablets
- smartphones
- mainframes
- servers
- gaming consoles
- embedded devices

Computers are found within countless other items. For example, if a car has a modern ignition system, the computer within the ignition system completes a systems check, unlocks the ignition, signals the fuel system (run by another computer), signals the starter system, and unlocks the transmission.



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What Is Meant by the Term *Computer Hardware*?

Computer hardware refers to the physical parts of a computer system. Examples of hardware include the system unit (also known as the tower or chassis) a printer or monitor, the keyboard, and a mouse. Communication devices such as routers and modems are also considered computer hardware.

The System Unit of a Computer

The system unit is the part of the computer that houses the motherboard, which is the circuit board that holds the computer's main microprocessor. This microprocessor is called the central processing unit. The location of the system unit depends on the type of computer. For example, in a desktop computer, the **system unit** is the chassis or tower unit. With a laptop computer, the system unit is housed beneath the keyboard. In a smartphone, tablet, or all-in-one computer, the system unit is housed beneath the monitor or screen.

Laptop Computers and Their Uses

Laptops are mobile hinged and folding computers with an integrated keyboard. **Laptops** come with a full operating system (OS) and remain top-selling personal computer. Laptop computers are great for people who need a portable digital device that has more computing power than a tablet or phone. Most laptops come with the capability to add more memory. For example, if a new version of Microsoft Office requires additional random access memory (RAM), most laptops can be upgraded. Because they can be carried around the house, to class, to the library, or to a coffee shop, laptops are the most popular computer choice among students.



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Tablet Computers and Their Uses

Tablet computers are highly mobile, which makes them great for travel. **Tablet computers** use touchscreen technology as the main input method. Unlike laptops, tablets cannot be upgraded. Some tablet computers have a smaller operating system (OS) than laptop computers, making them less powerful.

Because they are light yet powerful, tablets are popular for e-mail, gaming, and travel. Tablets are often used by doctors making their rounds or by servers taking orders in restaurants. By adding a separate keyboard, a tablet gains much of a laptop's functionality. But the smaller OS in a tablet may limit what programs can be run on it.

Desktop Computers and Their Uses

Desktop computers are stationary devices that consist of a separate case called the system unit or chassis. Peripheral devices, such as a monitor, keyboard, and mouse, are connected to the system unit. The system unit houses the main components of the computer. Because of its size, a desktop's system unit allows for relatively easy hardware upgrades. Desktops also have a relatively large footprint. A footprint refers to the amount of space a device takes up on a desk, table, or other area. **Desktop computers** are great for families with small children or for businesses because these computers don't get carried around and dropped. **Desktop computers** are sold by many different companies, including Apple, HP, and Dell. Gamers and computer experts like desktops because they can be easily upgraded. Global shipments of desktop PCs have declined recently. Last year there were 268.2 million shipments of desktop PCs compared to 300 million desktop PCs in 2021.



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All-in-One Computers and Their Uses

All-in-one computers provide the power of a desktop but with elegance. Because the motherboard is housed within the monitor, there's no bulky chassis or tower system unit. **All-in-one computers** are designed to be stationary without taking up much desk space. Many all-in-one computers have touchscreen interfaces, and all come with full (not just mobile) operating systems. These computers are used by those who like the power of a desktop computer but prefer the neat, clean look and smaller footprint. **All-in-one computers** are not as popular with computer experts or serious gamers because they're not as easy to upgrade as a traditional desktop computer with a separate system unit (chassis).

Embedded Computers

An **embedded computer** is a digital device that accepts input, processes data into information, provides output, and can store data—but it is part of a larger device or system. Examples of embedded computers can be found in digital watches, programmable thermostats, and even programmable coffeepots! Many embedded computers are found in medical devices, like blood pressure monitors. Embedded computers have relatively small operating systems called real-time operating systems (RTOS).



2-in-1 Computers

2-in-1 computers are touchscreen laptops with keyboards that are either detachable or that can be flipped out of the way. This gives them the mobility of tablets while still using full operating systems. Like tablets, **2-in-1 computers** have solid-state hard drives, making them very fast and providing long battery life, but this also means they typically have less storage capacity than laptops.

Smartphones

Smartphones are handheld computers with cellular networking capability.

Common features of smartphones include:

- Internet capability
- Touchscreen
- Front- and rear-facing cameras
- Speaker

The main limitations of smartphones are their relatively small screen size and limited computing power. To maximize limited computing power, smartphones use mobile versions of applications (apps). Smartphones use durable solid-state storage technology to maximize battery life.

Servers

A **server** is a computer system in a network that is shared by multiple users. Servers are also referred to as host computers. Three common types of servers are network, web, and file servers. A network server is used to control access to resources such as printers and applications on a network. A web server is used to control access to resources on the web. Most web servers have a built-in firewall for security. A file server is used for data storage. File servers house various documents and information resources for an organization.

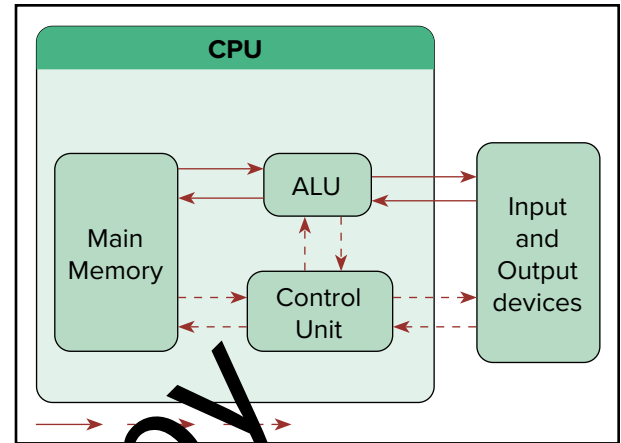
Mainframes and Supercomputers

Mainframe computers are more powerful than servers. Mainframes are used by organizations to process large amounts of data. **Mainframe computers** are very expensive, costing from \$100,000 to more than \$1 million. **Supercomputers** are the most powerful type of computer. They can evaluate complex data very quickly. Many of the supercomputers in the United States are owned by the government. **Supercomputers** can cost \$1 million or more.

Computer Components

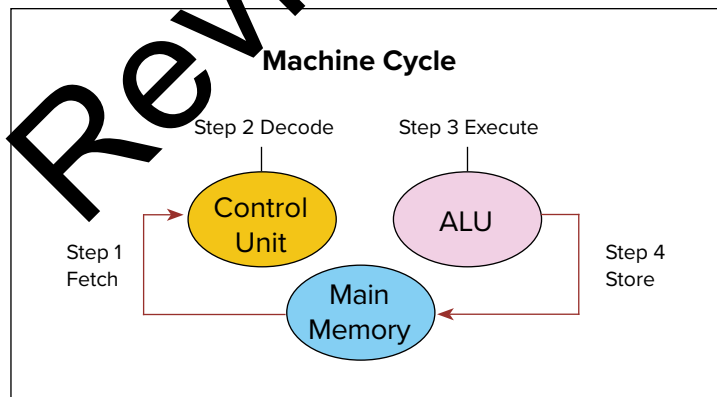
What Is a Digital Device Processor?

A processor or **central processing unit (CPU)** is the brain of the computer where most calculations take place. The processor is the most important component of a digital device and is integrated into a chip called a microprocessor. Without a processor, the digital device would not function. The processor has two main components: the arithmetic logic unit (ALU) and the control unit. The ALU performs the following logic and mathematical tasks: arithmetic (addition, subtraction, multiplication, and division), comparison (equal to, less than, the same as, and more), and logic (*and*, *or*, *not*). The control unit locates, analyzes, and executes each program instruction residing in memory. Essentially, it tells the computer's memory, ALU, and input and output devices how to respond to a program's instructions.



What Is the Machine Cycle?

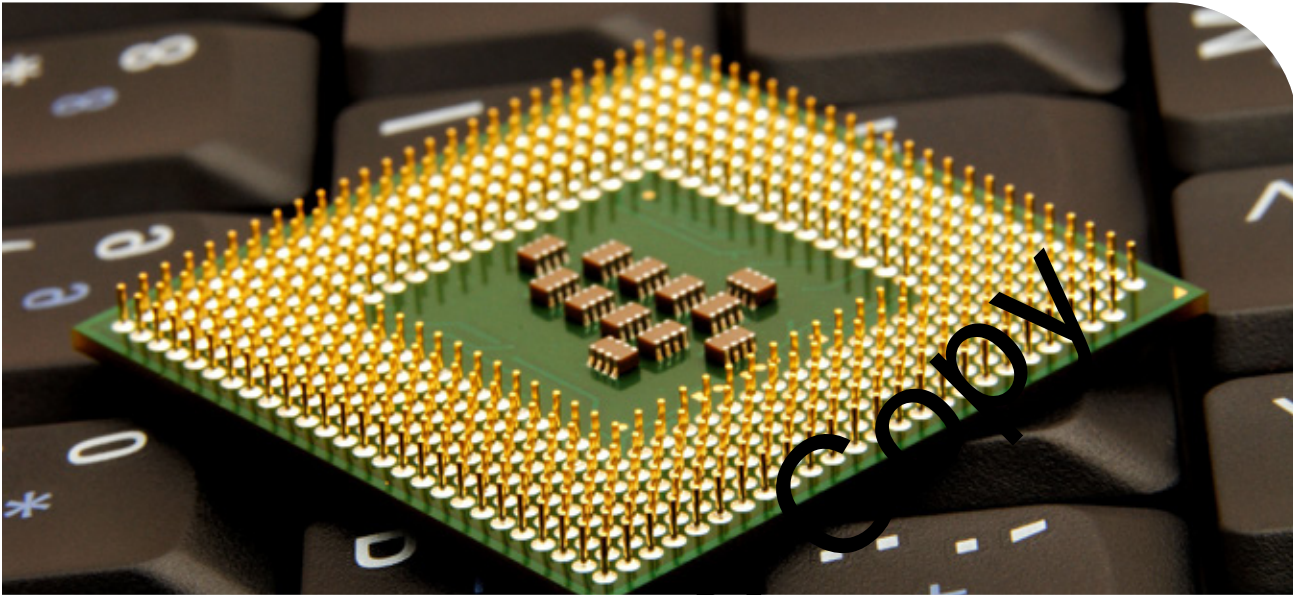
Every time a processor executes an instruction from a program, it goes through the same four steps. This process is called the machine cycle. The steps in the **machine cycle** are:



1. **Fetch**—The processor fetches the instruction or data from RAM.
2. **Decode**—The processor decodes the instruction or data into a readable form the computer can understand.
3. **Execute**—The processor executes the instruction.
4. **Store**—The results of the processing are stored in RAM. Once the results are stored, the processor fetches the next instruction or piece of data.

What Is Clock Speed?

Clock speed, also referred to as clock rate, is the speed at which the processor performs the operations required to run a digital device and instructions executed by the digital device. **Clock speed** is measured in the number of machine cycles the processor can run per second. Cycles per second are referred to as hertz (Hz). Modern processors operate at clock speeds of billions of machine cycles per second, or gigahertz (GHz).



What Is Overclocking?

Overclocking refers to running the processor faster than recommended by the manufacturer. This can increase performance and speed, but it can also void the manufacturer warranty. Some serious gamers and computer experts overclock. It requires additional CPU cooling.

What Is a Single-Core Processor?

A core on a CPU refers to the components on the chip that are needed for processing. A **single-core processor** has only one core. Usually, this means one ALU and one CU. Note that the number of cores isn't a measure of the computer's speed. It is just a description of the processor.

What Is a Multicore Processor?

A **multicore processor** has two or more cores that are responsible for processing. A multicore processor can execute two or more sets of instructions at the same time. This is called **hyperthreading**. **Hyperthreading** affords faster processing by allowing a new set of instructions to start before the prior set of instructions has finished being processed. Multicore processors allow for faster multitasking and overall processing of instructions.

Processor Manufacturers

Intel Corporation—Founded in 1968, Intel is the world's largest manufacturer of processors.

AMD—Founded in 1969, AMD's technology is featured inside gaming consoles and home entertainment systems including Microsoft's Xbox One and Sony's PS4™.

NVIDIA—Founded in 1993, NVIDIA focuses on graphical processing unit (GPU) cores.

Memory

Computer memory is found in microchips on the motherboard. *Memory* can refer to a variety of memory types including caches and registers. Memory composed of solid-state electronics is fast and energy efficient because it does not involve mechanical moving parts. Memory is sometimes referred to as volatile because its data are lost upon computer shutdown. Storage retains data upon computer shutdown and is sometimes called nonvolatile.

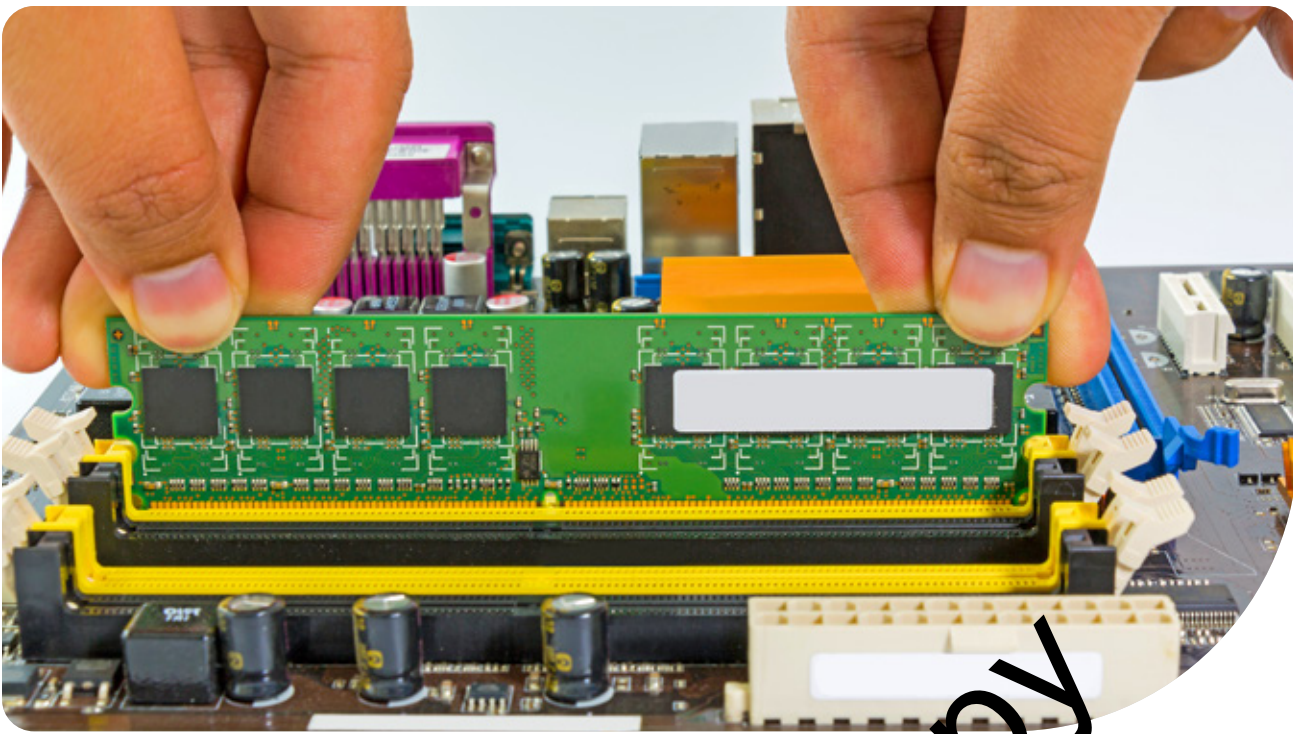
What Is RAM?

Random access memory (RAM) is a type of memory found on the motherboard of a digital device. RAM is electronic and has no moving parts. RAM is also called *main memory*, which means the memory is available to programs to execute tasks. RAM is a temporary storage area and is cleared when a device is powered off.

History of RAM

Professor Robert Dennard of IBM developed dynamic random access memory (DRAM) in 1968, and it was released commercially by Intel in 1970. DRAM allowed processors to work at much higher speeds. Static random access memory (SRAM) is faster than DRAM and generally used in cache memory. Professor Dennard was awarded the Kyoto Prize in 2015.





How Much RAM You Will Need

It is important to consider the amount of **RAM** that comes with a digital device. For example, most smartphones come with at least 2GB of **RAM** installed. Most laptops come with at least 4GB of **RAM** installed. The amount of **RAM** directly impacts processing speed.

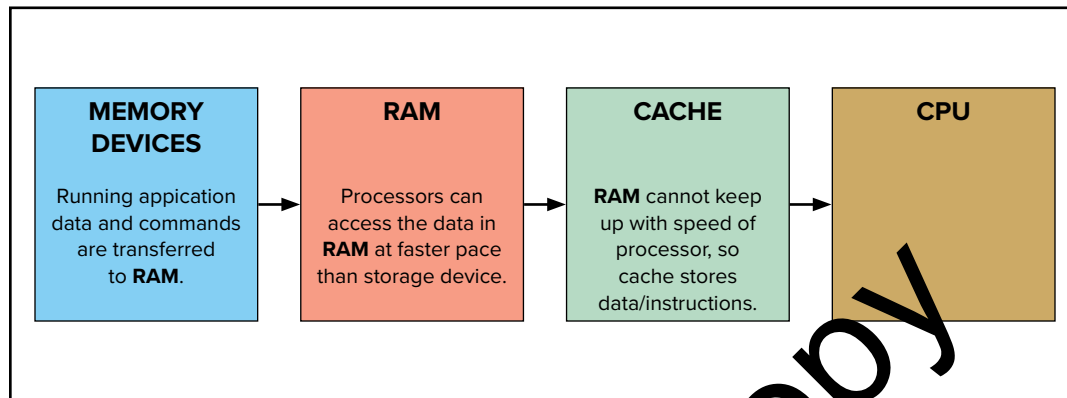
Different computers use different types of **RAM**. Either bring your laptop to the computer store or visit a site such as crucial.com to ensure you are buying the correct variety.

Cache

Cache is high-speed storage usually located directly on the CPU. **Cache** is smaller but faster than **RAM**. It is used to quickly access repeated instructions. The word *cache* is pronounced “cash.”

Memory Cache and Disk Cache

Cache refers to types of memory: memory cache and disk cache. **Memory cache** is high-speed memory used by the CPU to store frequently accessed data and instructions. **Memory cache** is referred to by levels. L1 cache is small and integrated into the CPU. L3 cache is larger and next to the CPU. Computer advertisements often display the amount of L3 cache included. **Disk cache** is high-speed memory used by the hard drive to store frequently accessed data.



ROM

Read-only memory (ROM) is a storage area in a digital device that is installed by the digital device manufacturer. Most **ROM** cannot be altered or removed, which is why it is called *nonvolatile memory*. Information that is commonly stored in **ROM** includes a digital device's boot instructions.

Computer Storage

Digital devices need to store some information indefinitely. Storage devices allow data and information to be retrieved for future use. Data remain intact when the computer is turned off.

Differentiate Between Internal and External Storage

Internal storage is storage that is integral to the computer. This is called the computer's hard drive. **External storage** devices reside outside the computer. Examples of external storage devices include external hard drives and USB or thumb drives. Optical drives (such as a laptop's DVD drive) and memory cards (such as a microSD card for a phone) are usually considered external storage. Though they're housed within the computer, they aren't part of the computer itself.

Hard Drive Capacity

Hard drive capacity is the amount of storage available to save data and information. Capacity is usually measured in gigabytes (billions of bytes) and terabytes (trillions of bytes). Computer applications, such as Microsoft Office, and

multimedia files take up a lot of storage capacity. One megabyte of storage on the first hard drive in IBM's RAMAC in 1957 would have cost \$200,000 in today's dollars. That same megabyte today costs as little as four one-thousandths of a cent.

A Traditional Hard Drive

A **hard drive** is the computer's primary storage device. A hard drive uses fixed disk platters to store data and information. The terms *hard drive* and *hard disk* are used synonymously. Hard drives are the primary storage device in a variety of digital devices, including laptops and servers.

Solid-State Drives

Solid-state drives (SSDs) are all-electronic storage devices. SSDs are used in a variety of products, including smartphones, cameras, and tablet computers. SSDs have no moving parts, which makes them faster and more durable than hard drives. SSDs tend to be more expensive than traditional hard drives.

SSD Capacity

SSD capacity is the amount of storage you have available to save data and information. Capacity is usually measured in gigabytes (billions of bytes). The more **SSD capacity** you need, the more money it will cost. **SSD capacity** is one of the most determinant factors of price when buying a tablet or smartphone.



The Hard Drive

Identify the Capacity of a Hard Drive: Windows 10

The hard drive in your computer stores a large amount of data. **Hard drive capacity** is usually measured in gigabytes (GB). It is a good idea to check the capacity of your hard drive.

Here is how:

1. Click the Search box button.
2. Type "This PC" in the [Ask Me Anything box] and then click on the This PC app.
3. Look in the Devices and Drives section at Local Disk (C:) to find the hard drive capacity and available space on the hard drive.

Defragment and Optimize a Hard Drive: Windows 10 and 11

It is important to keep your hard drive running at peak efficiency. One thing you can do to maintain the efficiency of your hard drive is to use a disk utility that comes with Windows: the Defragmenter.

Here are the steps to defragment a hard drive:

1. Open Disk Defragmenter by clicking the Search window. Type “Disk Defragmenter,” then select Disk Defragmenter.
2. Under Current Status, select the disk you want to defragment.
3. To determine whether the disk needs to be defragmented or not, click Analyze Disk.
4. Click Defragment Disk.

Use Disk Cleanup: Windows 10 and 11

Another Windows disk utility that can help maintain the efficiency of your hard drive is **Disk Cleanup**.

1. In the Search Box (on the taskbar—usually the bottom left of your window), type “**Disk Cleanup**” and select the **Disk Cleanup** app.
2. If necessary, select the drive you wish to clean up.
3. Under Files to Delete, select the files that you wish to remove (such as Temporary Internet Files).
4. Click OK, then Delete Files.

Connections

Ports

A **port** is a slot or hole that matches the cord or expansion card being connected to the port. Input and output devices plug into the ports located on your digital device. A connector plugs into a port. Common types of ports include USB, Thunderbolt, and **HDMI**. For example, a thumb-drive connector plugs into a USB port.

Connectors

A **connector** is the specialized end of a cord, plug, or expansion card that connects into a port. On a cable, the connector is the end that connects to a port.

USB

Universal Serial Bus (USB) is a type of interface that enables communication between digital devices. USB allows for data transfer between devices and for devices to be electrically charged. USB drives are sometimes referred to as thumb drives, flash drives, or jump drives. USB drives use solid-state flash memory to store information on an internal memory chip. USB drives allow fast data transfer, are inexpensive, and are durable.

HDMI Connectors

HDMI is a standard interface for audio-video connectivity. **HDMI** allows for the transmission of high-definition audio and video signals.



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Ethernet

Ethernet ports and **Ethernet** cables are used for local area networks or for connecting devices in home networks. A common use in the home is to connect a modem to a router using **Ethernet** cable to access the Internet. **Ethernet** cable comes in different categories. CAT5 cable can transfer data at up to 100 megabits per second. CAT5e can transfer data at up to 1 gigabit per second, while CAT6 cable can transfer data at up to 10 gigabits per second. CAT8 can transfer data at up to 40 gigabits per second.

Lightning Connectors

Lightning ports and connectors were developed by Apple for use in iPods, iPads, iPhones, and Apple Watch docks. The **lightning connector** is an eight-pin connector, and, with adapters, it can connect to USB, **HDMI**, or VGA connectors. Most iPhone users like the fact that a lightning connector can be inserted in a lightning port in either direction (unlike the USB port). Apple plans to replace the lightning connector and port with the USB-C connector and port in October 2024.

VGA Connectors

Video Graphic Array connectors, often called VGA or HD-15 connectors, are analog connectors that were once very popular for connecting monitors and televisions to computers. VGA connectors were largely replaced by Digital Visual Interface (DVI) connections and **HDMI** connections in the early 2000s. Although they are analog only, VGA connectors are capable of high resolution and frame rates.

3.5-mm Audio Connectors and Uses

3.5-mm connectors are among the most popular for audio devices such as earbuds or headphones. These connectors are small and convenient, and they have been used for nearly 70 years. These connectors became popular in the 1950s with the introduction of the transistor radio. In the 1980s, the Sony Walkman portable cassette player came with a 3.5-mm audio port, making this connection the standard for all headsets. When cell phones became popular, the 3.5-mm audio connection became commonplace, though it evolved and had more contacts incorporated to allow for a microphone as well as headphone capability.



MIDI Ports and Connectors

Musical Instrument Digital Interface (MIDI) allows digital musical devices to connect to and interface with computers. MIDI can carry digital music signals and is common in today's music scene.

Wireless Connections

Protocol

A **protocol** is a set of rules for communication between devices that determines how data is transmitted and received. Many protocols are used to help streamline the communication of all digital devices. For example, **Wi-Fi** uses the 802.11 protocol. This protocol ensures that devices enabled with **Wi-Fi** can connect to any **Wi-Fi** network.

Wireless Ports

Wireless ports allow for the transmission of data between both fixed and mobile devices using short-range radio waves or light waves. Most **Bluetooth** transmissions remain strong up to 35 feet away and then start to reduce in signal strength. Infrared (IR) requires line-of-sight transmission and is commonly used for TV controllers.

Wi-Fi

Wi-Fi is a wireless local area network. The word **Wi-Fi** is a play on the old audio term *hi-fi*. A **Wi-Fi** transmission site is called a **hotspot**. Most computers, tablets, smartphones, and gaming platforms are **Wi-Fi** capable. **Wi-Fi** uses the 802.11 protocol with 2.4 GHz and 5.0 GHz radio waves.

Bluetooth

Bluetooth-enabled devices are found in numerous items, including basketballs, key fobs, and pet collars. **Bluetooth** is a short-distance wireless communication technology that uses short-wavelength radio waves to transfer data. Because they use short-wavelength radio waves, **Bluetooth** signals easily pass through walls, furniture, and so on.

IrDA

IrDA stands for the Infrared Data Association, which establishes the protocols for infrared communication transfer. **IrDA** is a wireless connection that uses infrared (relatively long) radio waves to transmit data. Longer-wavelength waves don't easily pass through walls or furniture (line-of-sight only). **IrDA** devices are often used with a wireless mouse, keyboard, remote control, and so on.



Graphics

Graphics Output

Graphics are the depiction of image data on a display or output device. **Graphics** are usually created by a separate processor within the computer known as the graphics processing unit (GPU).

What Is a Video Card?

A **video card** is a piece of hardware inside your computer that helps display images on your screen. Think of it like a mini-computer dedicated just to graphics! It has its own “brain” called a GPU, which handles the heavy lifting of creating visuals. The video card also comes with its own special memory to store graphics data and ports, like **HDMI** or DisplayPort, to connect to monitors. Plus, it usually has a fan or cooling system to keep it from getting too hot. All these parts work together to make your games, videos, and other graphics look smooth and vibrant on your screen. Gaming computers usually have upgraded graphics cards.



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What Is Screen Size?

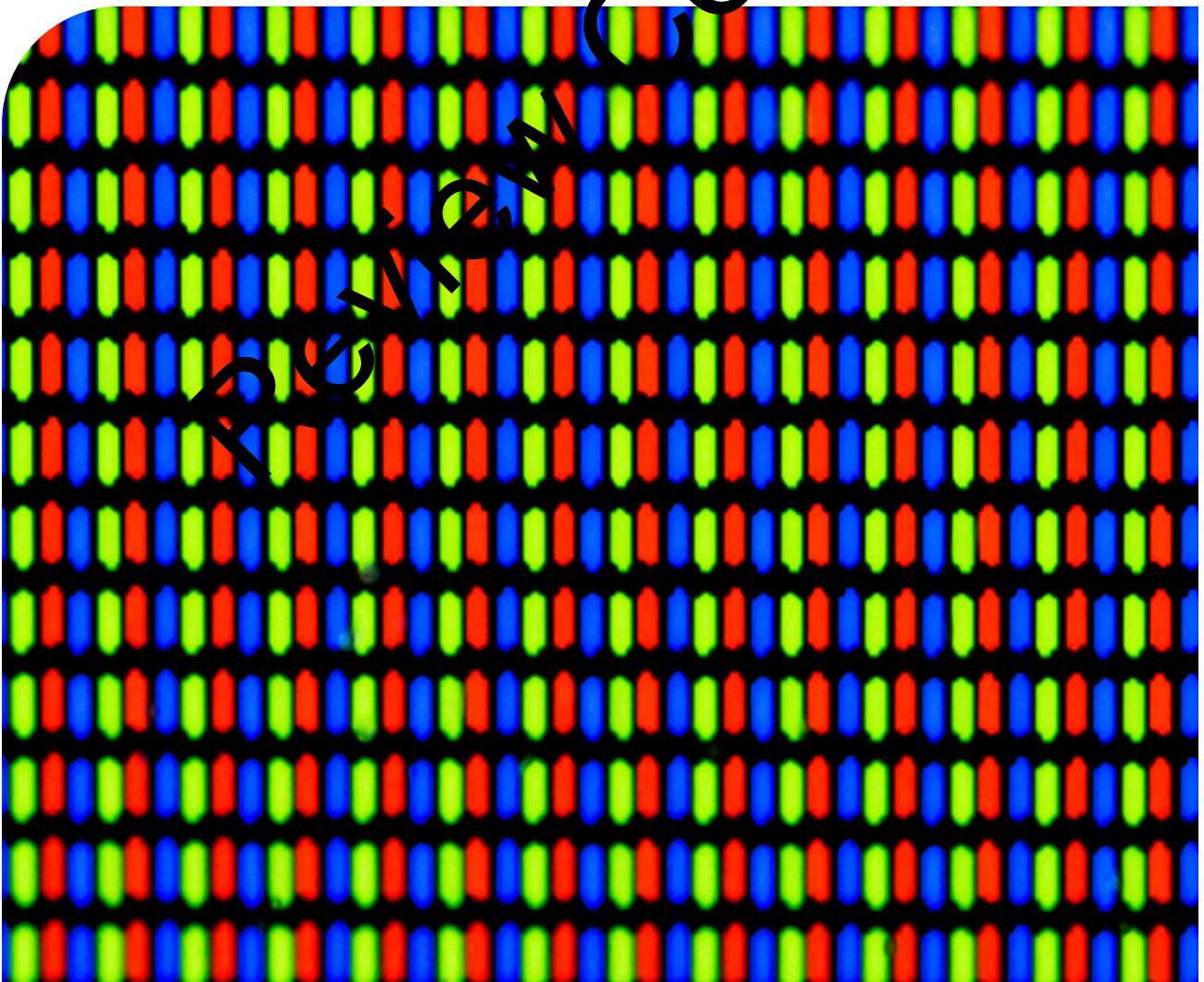
Screen size is the actual viewable area of a display device.

Screen size is measured diagonally from one corner of the screen's viewable area to the other.

Screen size can be a major factor when determining which digital device to buy.

What Is a Pixel?

A **pixel** is the smallest element in an electronic image. It is simply a dot on the screen of a display device. The more pixels in an image, the better the image quality. Different displays can have differently shaped pixels.

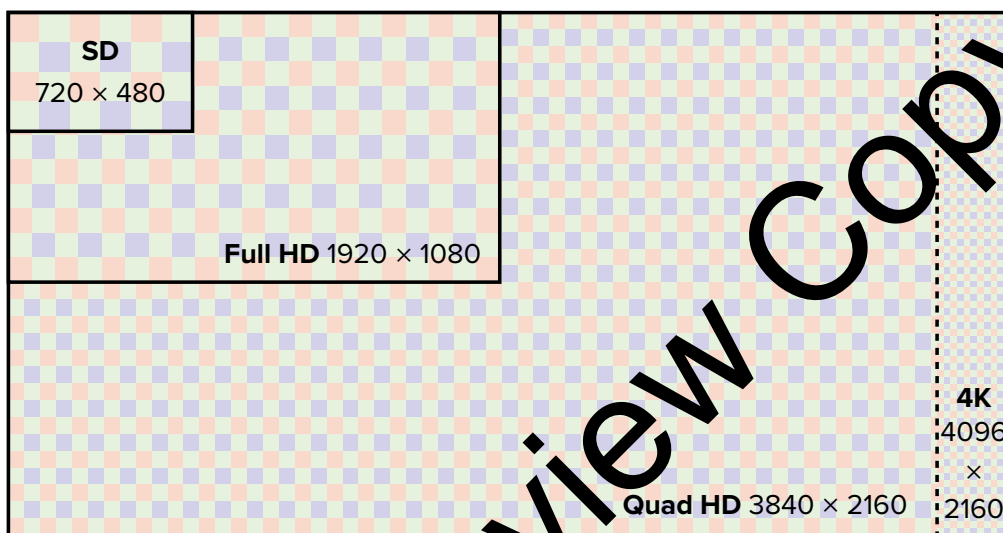


What Is Resolution?

Resolution is the clarity of an image. The resolution of monitors and other display devices is measured in pixels. The more pixels in a display device, the higher the resolution. Larger displays need more pixels to achieve the same resolution.

What Is Native Resolution?

Native resolution is the maximum resolution of a display device. A laptop with 1920 (horizontal pixels) $\times$ 1080 (vertical pixels) has 2,073,600 total pixels. The first number is horizontal resolution, and the second is vertical resolution. A display is said to be pixel perfect when the incoming video signal has the same number of pixels as the native resolution of the display.

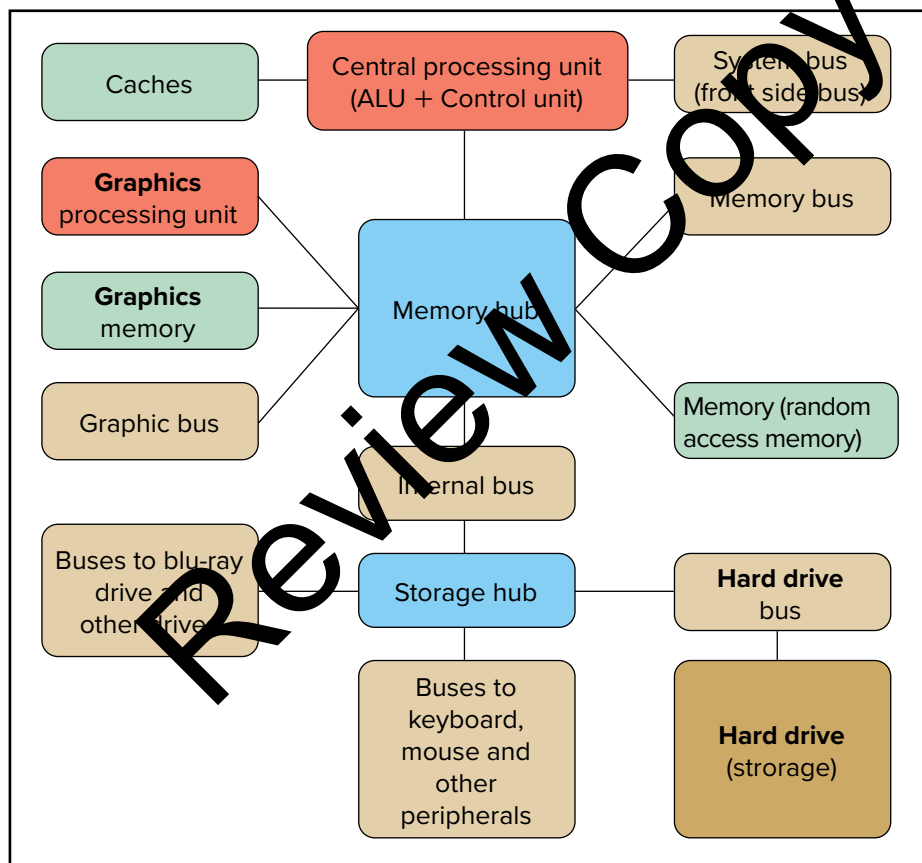


How a Computer Works

Computer System Design

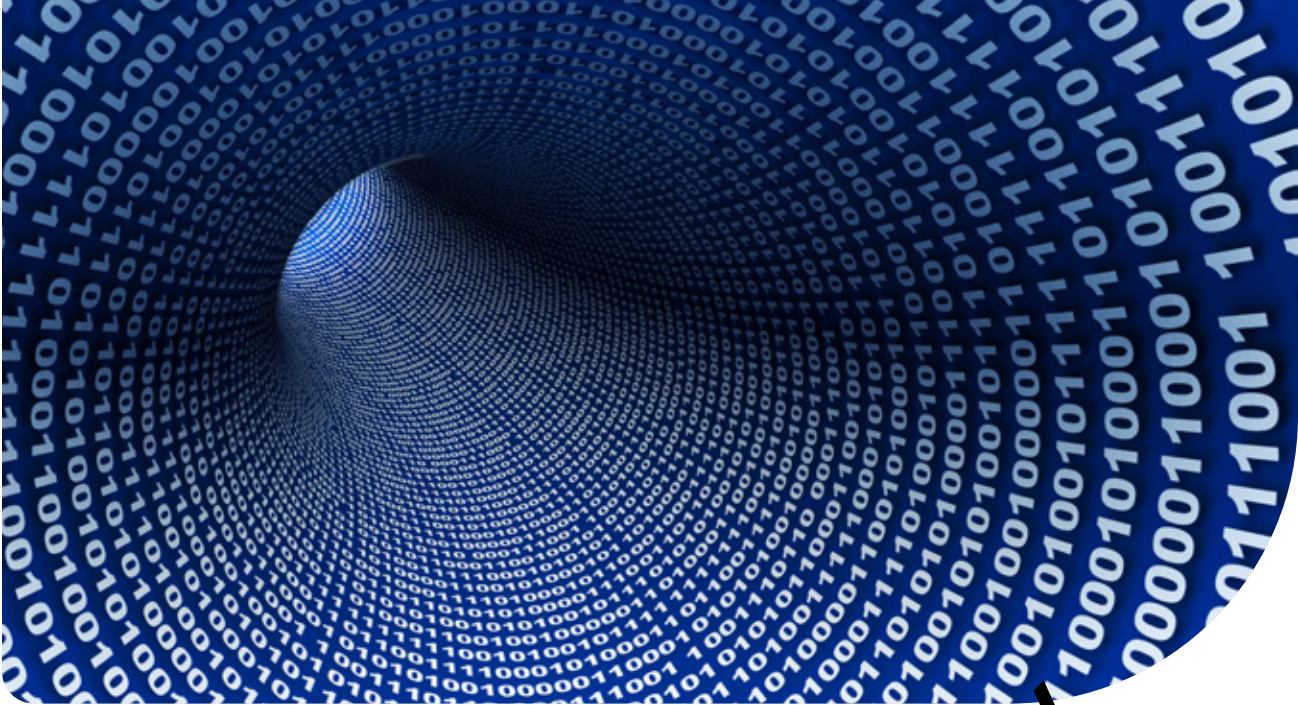
In the diagram below, the red areas are the computer's two processors: the central processing unit, known as the CPU or the processor, and the graphics processing unit, known as the GPU. Memory is depicted in light green. The system cache provides memory for data that the CPU is using repeatedly. The random access memory (**RAM**) holds data for the CPU's use. Note that the GPU has its own memory. Storage is shown in dark orange. This is the computer's hard drive that keeps data even after the computer is powered down. Knowing a basic computer layout makes understanding how they work much simpler.

Computer System Design Graphic



Bits

Computers communicate using their own language. This language is called *binary*. Binary language consists of two digits: 0 and 1. Each 0 or 1 is called a *binary digit*, or a *bit* (b). **Bits** are the smallest unit of data a computer can process.



Bytes

Eight bits grouped together are called a **byte**. Each number, special character, and letter of the alphabet is represented by a unique combination of bits. For example, an ampersand (&) is represented as 00100110.

Storage Capacity

Bits and bytes are also used to represent the quantity of data the computer processes. Common quantities of information include:

Kilobyte (KB)	Megabyte (MB)	Gigabyte (GB)	Terabyte (TB)	Petabyte (PB)
—about 1 thousand bytes	—about 1 million bytes	—about 1 billion bytes	—about 1 trillion bytes	—equals 1,000 terabytes
—1 KB is equal to about one page of text.	—1 MB is equal to about 875 pages of text.	—1 GB is equal to 341 digital images (3 MB average file size).	—1 TB is equal to about 349,000 digital images (3 MB average file size) or 40 single-sided Blu-ray discs.	—1 PB is equal to about 358,000,000 digital images (3 MB average file size) or about 42,000 single-sided Blu-ray discs.

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Word Size

Word size refers to the amount of data a processor can hold and process at one time. Today's processors generally have word sizes of 32 or 64 bits. A 64-bit processor can process information faster than a 32-bit processor can.

The Boot Process

The **boot process** is the loading of an OS into the main memory of a device. The boot process consists of four steps:

1. The device is powered on, and the CPU activates the basic input/output system (BIOS).
2. The Power-On self-test is executed.
3. The OS is loaded into **RAM**.
4. The OS checks the registry settings and loads saved configuration settings.

Computer Speed

The speed of a digital device's processor is determined by several factors. Three of the most important determinants of a **computer's speed** are clock speed, word size, and bus width.

Hertz

Heinrich **Hertz** proved the existence of electromagnetic waves. **Hertz** is a measurement for how frequently something happens. It's shortened to "Hz." When something happens once every second, it's at a frequency of 1 Hz.

What Are Megahertz and Gigahertz?

Megahertz is abbreviated MHz and is equal to one million cycles (or instructions) per second. 1 MHz is one million instructions per second. Gigahertz is abbreviated GHz and is equal to one billion cycles (or instructions) per second. A 3.8 GHz processor can execute 3.8 billion instructions per second.

Bus

A **bus** is a channel over which information flows. Think of a bus as a highway on which data travels in a computer. A bus has two parts: the address bus and the data bus. The address bus transfers information and instructions about where the data should go inside the digital device. The data bus transmits actual data. The most important bus is the one connecting the central processing unit to the memory. Some call this the *system bus* or the *front-side bus*.

Bus Width

Bus width is the amount of data that can be transmitted at a given time. The wider the bus, the more information that can travel along it, which creates faster transmission speeds. **Bus width** is measured in bits. A 64-bit bus can transmit 64 bits of data.

ASCII

ASCII, the American Standard Code for Information Interchange (pronounced AS-key), is a common encoding standard. **ASCII** code can represent the 26 uppercase and lowercase letters in the English language, as well as numbers and many different symbols. **ASCII** can represent a total of 256 characters.

What Is Unicode?

Unicode is a common encoding standard that can represent all world languages. **Unicode** uses at least 16 bits per character. **Unicode** has virtually limitless characters, allowing for the large number of characters in certain foreign languages.

Quantum Computing

Quantum computing uses the power of atoms and molecules for memory and processing tasks. One of the keys of quantum computing is the quantum bit or qubit. Qubits are the basic units of information that are similar to the 0s and 1s (bits) that represent transistors in today's computers. Qubits are more powerful because a qubit can represent both a 0 and 1 at the same time and can affect other qubits using quantum entanglement. This allows quantum computers to take shortcuts to the correct answers for certain types of calculations. Quantum computers could be much faster at running artificial intelligence (AI) programs and could also create more secure data encryption.



Chapter Review

1. Describe the four main computing functions.
2. Explain what is meant by *computer hardware*. Identify computer hardware that is commonly used today.
3. Describe the system unit of a computer. What major computer components are commonly housed in the system unit?
4. Differentiate between a laptop and desktop computer.
5. What differentiates a smartphone and a personal media player (PMP)? How are they different? How are they similar?
6. What is a server computer? How is one used? Discuss when you might use a server computer.
7. Describe a computer processor. Why are computer processors so important? Who are the main manufacturers of computer processors? Do all computers need a computer processor to run correctly?
8. Explain the four steps of the machine cycle. How does a machine cycle apply to computer processors?
9. What is the difference between a single-core and multi-core processor?
10. Explain computer memory. Why do computers need memory?
11. What is **RAM**? What are the various sizes of **RAM** used in computers? Do a smartphone and tablet use **RAM**? How much **RAM** do most laptops, tablets, and smartphones come with?
12. Describe cache. How is cache used by a computer?
13. Explain **ROM**. What makes **ROM** different from **RAM**?
14. Compare and contrast USB and Firewire/Thunderbolt. What types of devices use each type of port/connector?
15. What are **Ethernet** ports/connectors/cables? What are **Ethernet** cables/ports used for?
16. Discuss computer storage capacity. What is the unit of measure for computer storage? List some of the various computer storage capacities. What storage capacity do most laptops, tablets, and smartphones come with?
17. When discussing display devices, how are pixel and resolution related? Is resolution an important consideration when choosing which computer to buy?
18. What is the difference between a bit and a byte? How large is each? What are bit and bytes used for in a computer?

Ethics Discussion

Digital devices are produced using multiple production inputs, including natural resources and labor. Responsible production practices are one consideration when purchasing a new digital device. Conduct research on the Internet about the ethical production of digital devices/computers. What are some of the issues that surround the ethical production of digital devices/computers? What ethical factors would you consider if you were purchasing a new digital device/computer?