

Unit 3 and 4

Computer Memory, I/O Devices

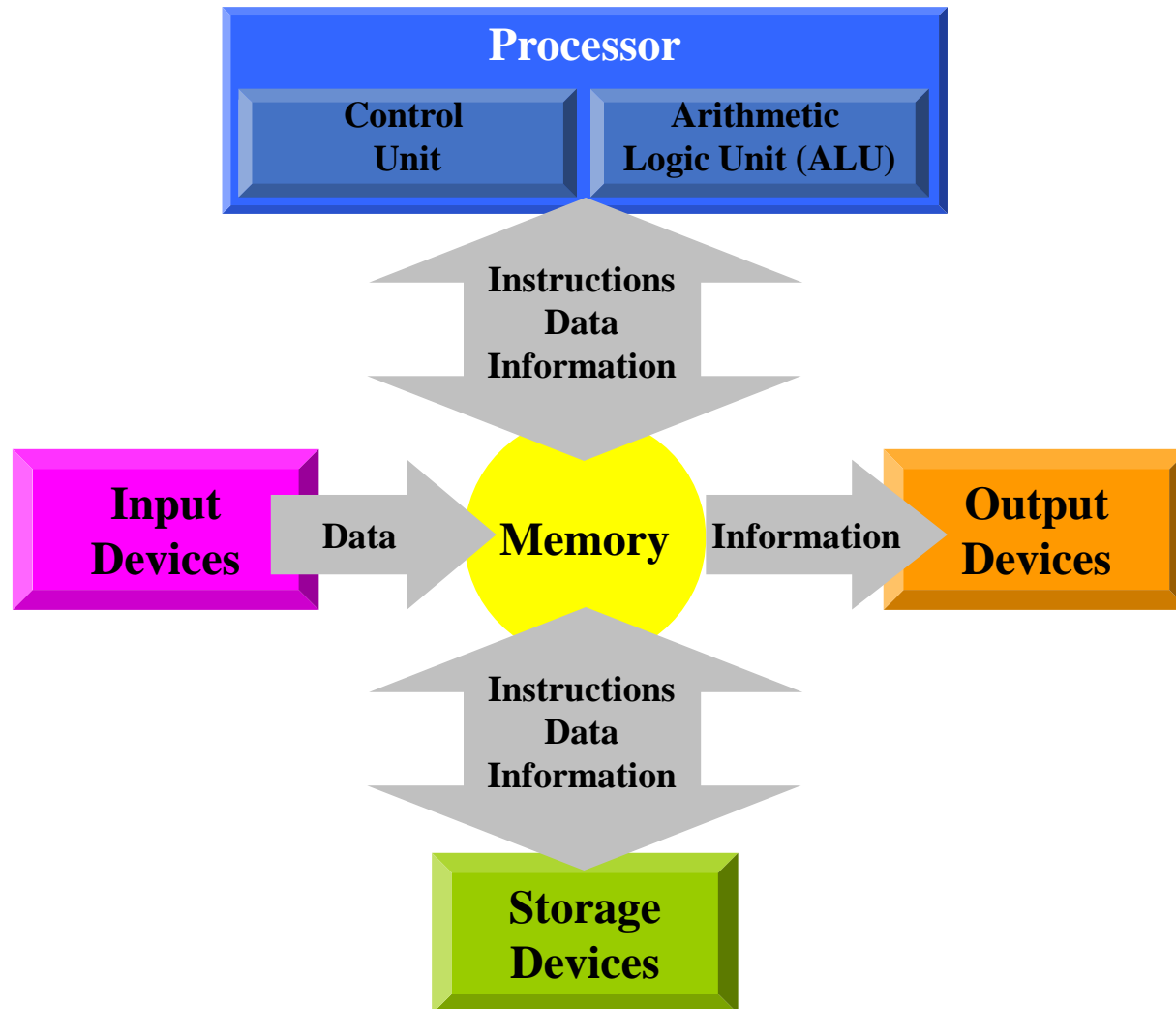
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M.Sc. CSIT

Introduction

- What is computer hardware?
 - Computer devices in physical form
 - Comprised of 4 components:
 - Input devices
 - Central Processing Unit (CPU)
 - Output devices
 - Memory

Introduction (*cont'd*)

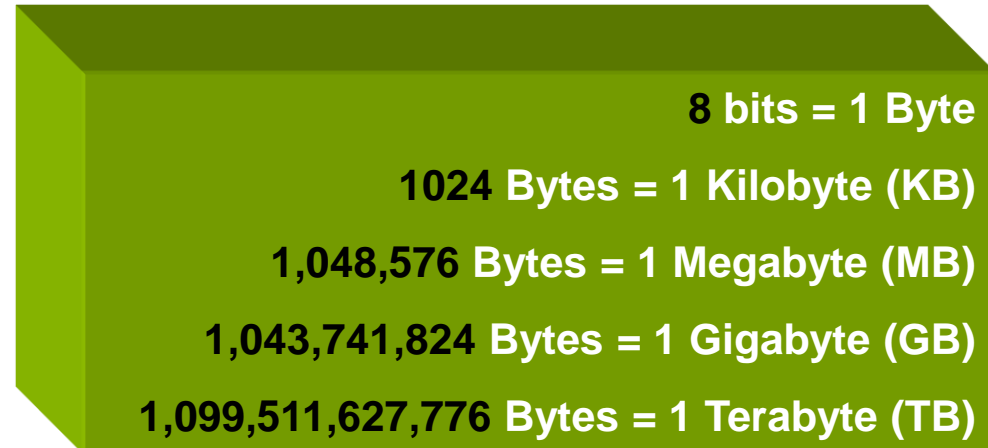


Introduction (*cont'd*)

- Bit and bytes
 - Bit (**B**inary **D**igit) is the basic unit of information in computers
 - 1 bit = 0 or 1 → Computer binary system
 - Refers to transfer rate per second

- **Kilobyte, megabyte, gigabyte, and terabyte** are terms that describe large units of data used in measuring data storage

- Example: 100 GB hard drive



Input Device (cont'd)

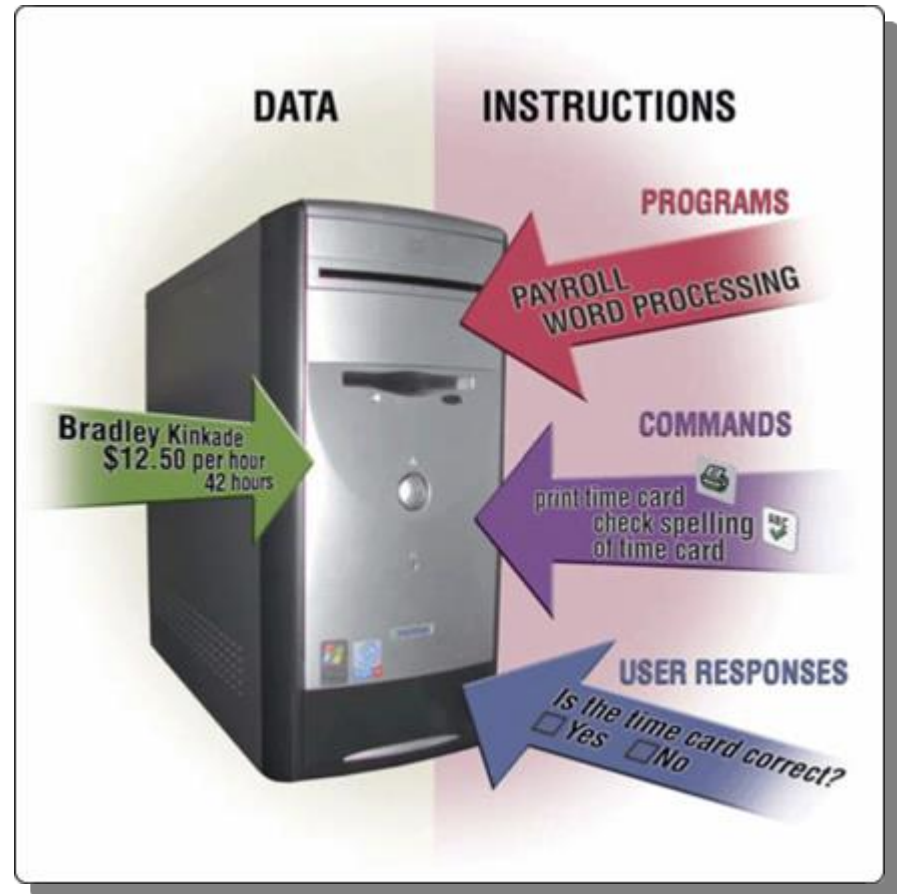
- **Two types of input:**

- **Data**

- Unprocessed text, numbers, images, audio, and video

- **Instructions**

- Programs
- Commands
- User responses



Input Device (*cont'd*)

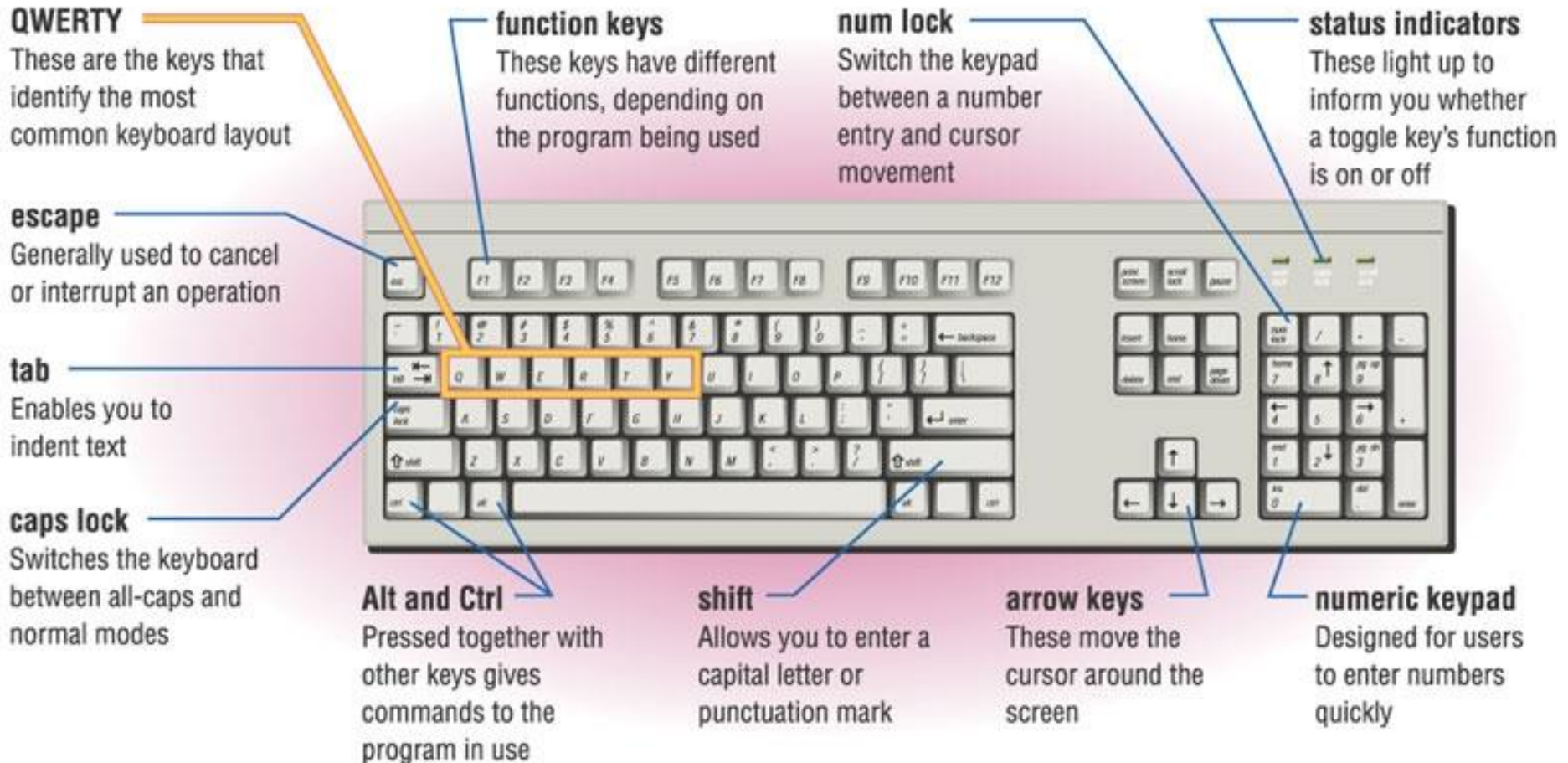
- **Keyboard**

allows the computer user to enter

- Words
 - Numbers
 - Punctuation
 - symbols and
 - special function commands
- into the computer's memory



Input Device (cont'd)



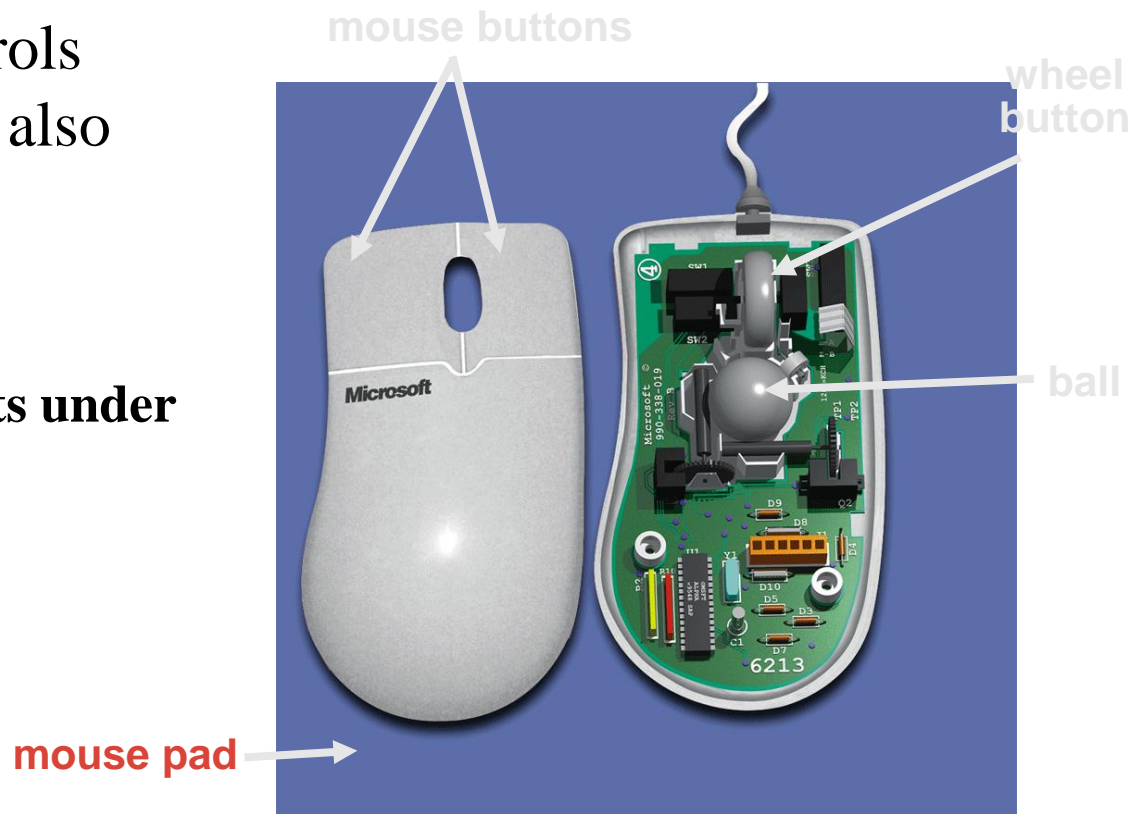
Input Device (cont'd)

- **Pointing Device**

Pointing device controls movement of pointer, also called mouse pointer

Mouse

- **Pointing device that fits under palm of hand**
- **Mechanical mouse has rubber or metal ball on underside**



Input Device (cont'd)

- **Pointing Device (cont'd)**

- Optical mouse**

- **No moving mechanical parts inside**
- **Senses light to detect mouse's movement**
- **More precise than mechanical mouse**
- **Connects using a cable, or wireless**



Input Device (cont'd)

- **Pointing Device (cont'd)**

- Trackball**

- **Stationary pointing device with a ball on its top or side**
 - **To move pointer, rotate ball with thumb, fingers, or palm of hand**

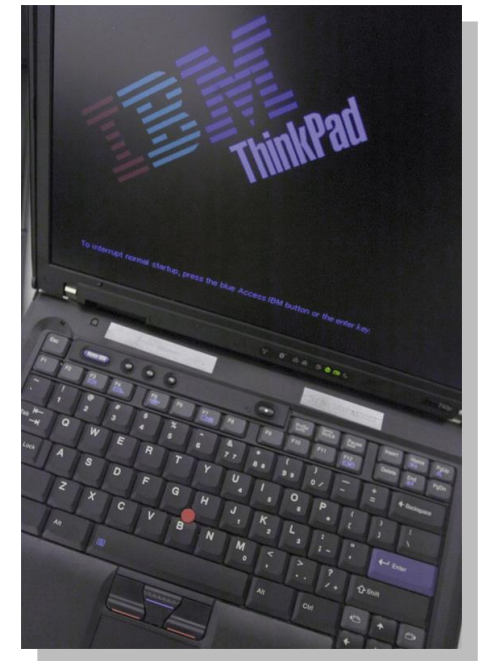
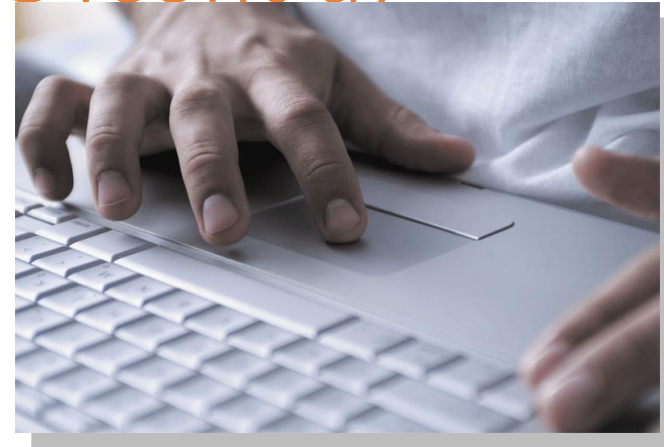


Input Device (cont'd)

- **Pointing Device (cont'd)**

- Touchpad and a pointing stick**

- **Touchpad** is small, flat, rectangular pointing device sensitive to pressure and motion
- **Pointing stick** is pointing device shaped like pencil eraser positioned between keys on keyboard



Input Device (cont'd)

- **Pointing Device (cont'd)**

- Joystick and a wheel**

- **Joystick** is vertical lever mounted on a base
 - **Wheel** is steering-wheel-type input device
 - Pedal simulates car brakes and accelerator

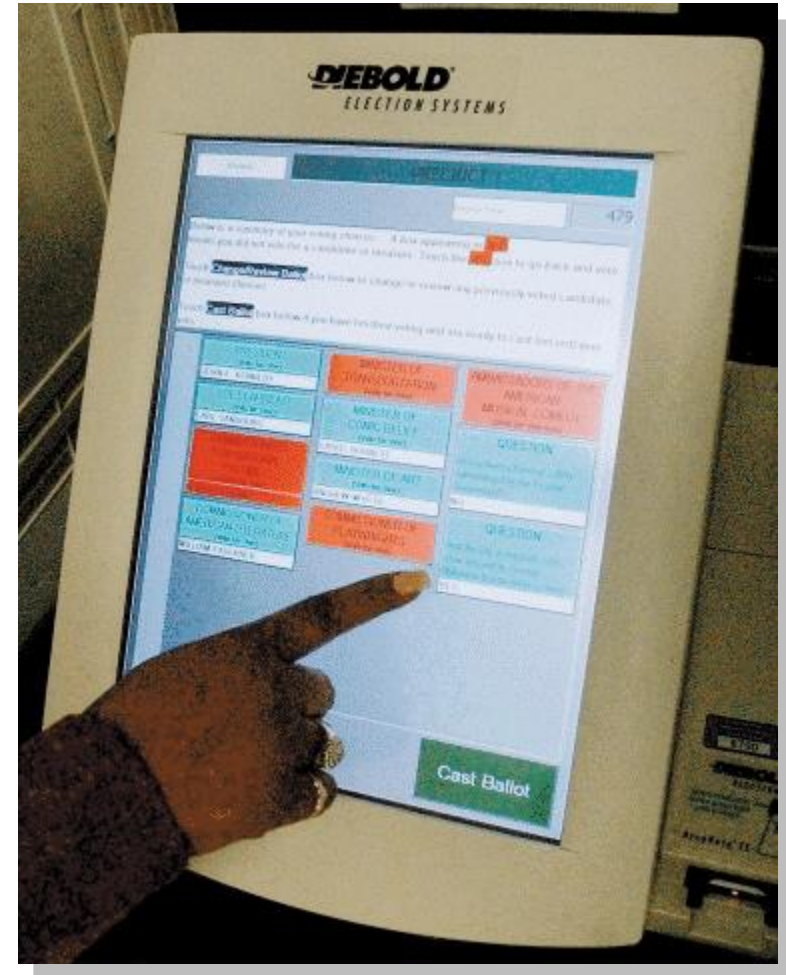


Input Device (cont'd)

- **Pointing Device (cont'd)**

Touch screen

- **Touch areas of screen with finger**
- **Often used with kiosks**



Input Device (cont'd)

- **Sound and voice input**

MIDI (musical instrument digital interface)

- **External device, such as electronic piano keyboard, to input music and sound effects**

Microphone

- **Allow user to input their voice**



Input Device (cont'd)

- **Video input**

- **Process of entering full-motion images into computer**
- **Video capture card is adapter card that converts analog video signal into digital signal that computer can use**
- **Digital video (DV) camera records video as digital signals**



Input Device (cont'd)

- **Scanner**

- **Light-sensing device that reads printed text and graphics**
 - Used for image processing, converting paper documents into electronic images

Flatbed scanner – design to scan flat objects

Handheld scanner – capture small amounts of text

Sheet-fed scanner – scan one flat document at a time



Flatbed



Pen or
Handheld



Drum



Sheet-fed

Input Device (cont'd)

How does a **flatbed scanner** work?

Step 1:

Place the document to be scanned face down on the glass window. Using buttons on the scanner or the scanner program, start the scanning process.



Step 2:

The scanner converts the document content to digital information, which is transmitted through the cable to the memory of the computer.



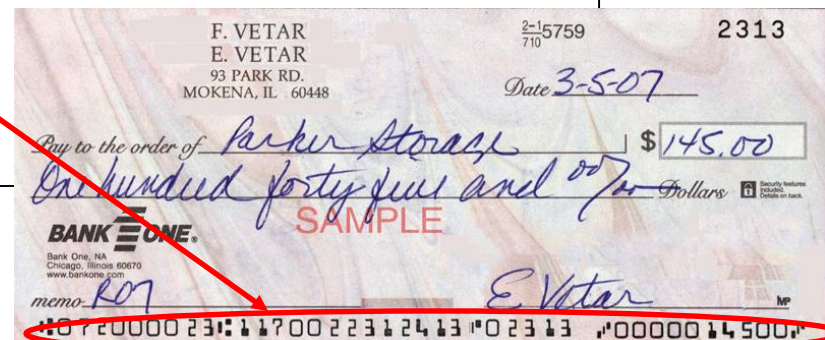
Step 3: Once in the memory of the computer, users can display the image, print it, e-mail it, include it in a document, or place it on a Web page.

Input Device (cont'd)



- **Readers**

- Barcode Readers
- Optical Mark Readers (OMR)
- Radio frequency Identification (RFID) Readers
- Optical Character Recognition (OCR) Devices
- Magnetic Ink Character Recognition (MICR) Readers
- Biometric Readers



Output Device

- **What is output?**
 - **Data that has been processed into a useful form,**
 - **Output device** is any hardware component that can convey information to user



Output Devices (*cont'd*)

- **Display device**
 - **Output device that visually conveys information**
 - Information on display device sometimes called soft copy
 - **Monitor** houses display device as separate peripheral

Output Devices (*cont'd*)

- **Display device**

- LCD monitor**

- **Uses liquid crystal display**
- **Have a small footprint**
- **Mobile devices that contain LCD displays include**
 - **Notebook computer, Tablet PC, PDA, and Smart Phone**



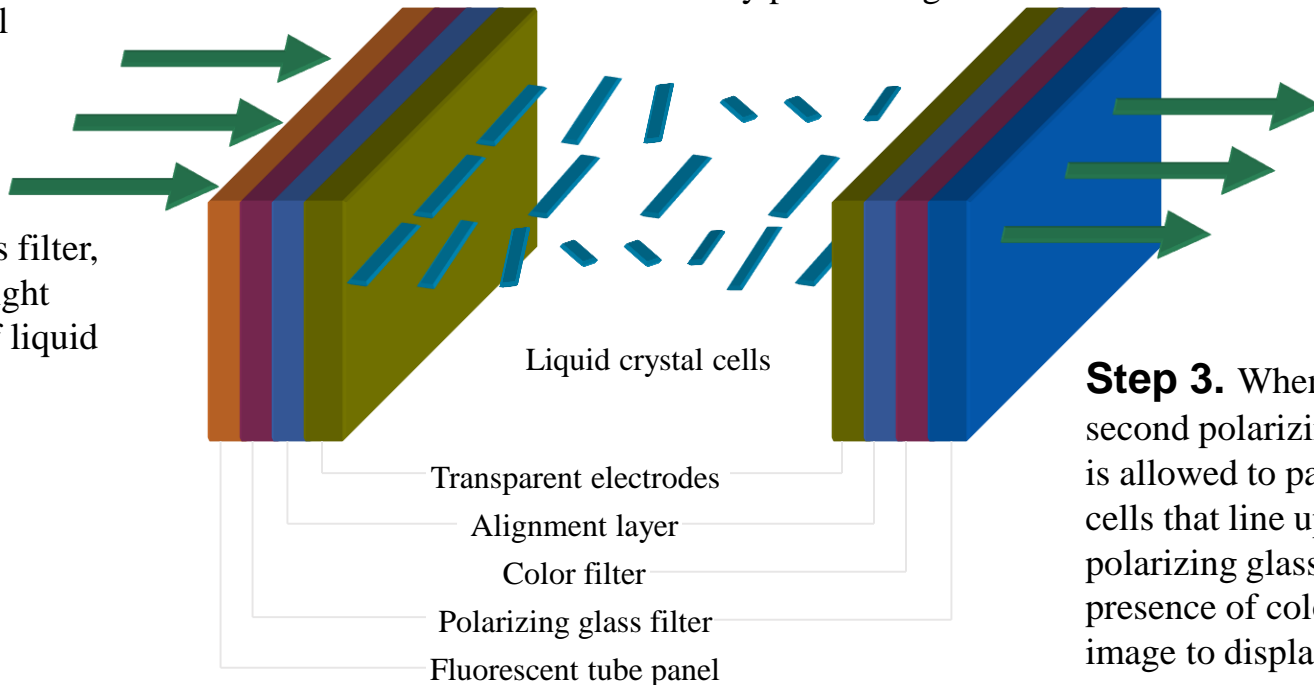
Output Device (cont'd)

How does LCD work?

- Uses liquid compound to present information on a display

Step 1. Panel

of fluorescent tubes emits light waves through polarizing glass filter, which guides light toward layer of liquid crystal cells.



Step 2. As light passes through liquid crystal, electrical charge causes some of the cells to twist, making light waves bend as they pass through color filter.

Step 3. When light reaches second polarizing glass filter, light is allowed to pass through any cells that line up at the first polarizing glass filter. Absence and presence of colored light cause image to display on the screen.

Output Device (*cont'd*)

- **Display device**

- Plasma monitor**

- **Displays image by applying voltage to layer of gas**
 - Larger screen size and higher display quality than LCD, but are more expensive



Output Device (*cont'd*)

- **Display device**

- CRT monitor**

- **Contains cathode-ray tube (CRT)**
- **Screen coated with tiny dots of phosphor material**
 - Each dot consists of a red, blue, and green phosphor
- **Common sizes are 15, 17, 19, 21, and 22 inches**
 - Viewable size is diagonal measurement of actual viewing area

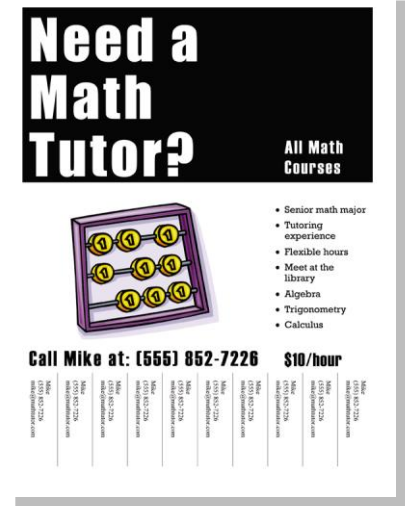


Output Device (cont'd)

- **Printer**

- **Output device that produces text and graphics on a physical medium**
- **Result is hard copy, or printout**
- **Two orientations: portrait and landscape**

portrait




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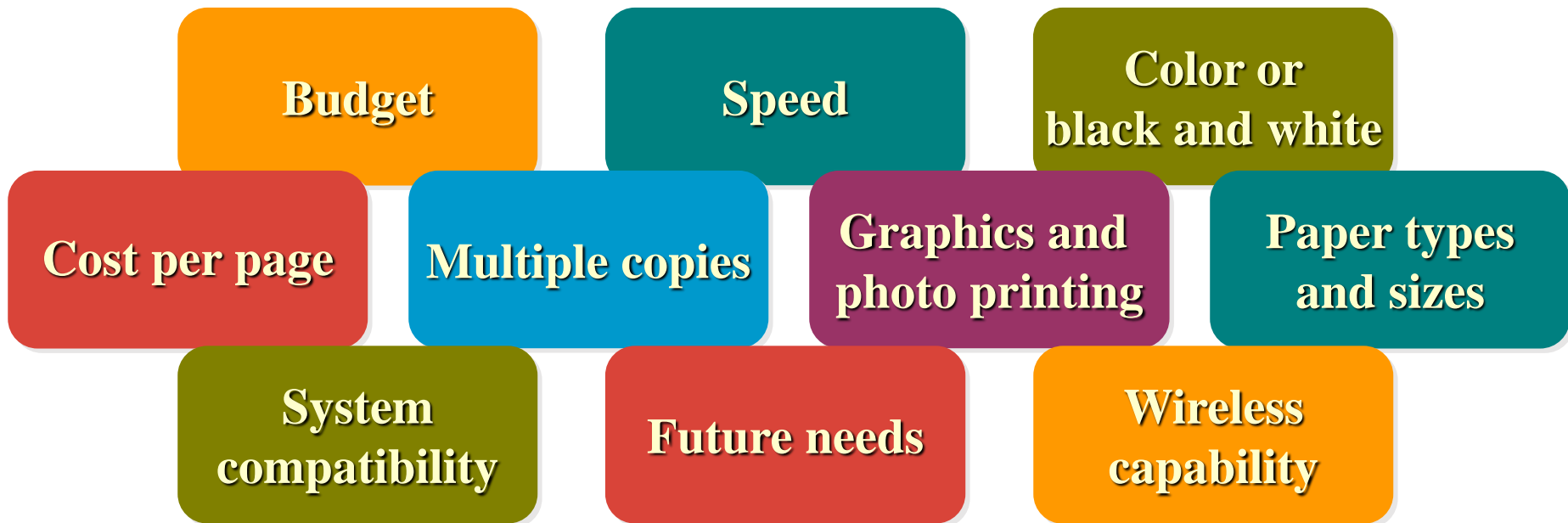
Robert Stewart
Director of the Dayton Symphonic Orchestra for the last five years

Amy Hayes
The first woman conductor of the Great Pops Orchestra

Our Own Jazz
The newest member of the series.

Output Device (*cont'd*)

- **How do you know which printer to buy?**
 - Depends on printing needs



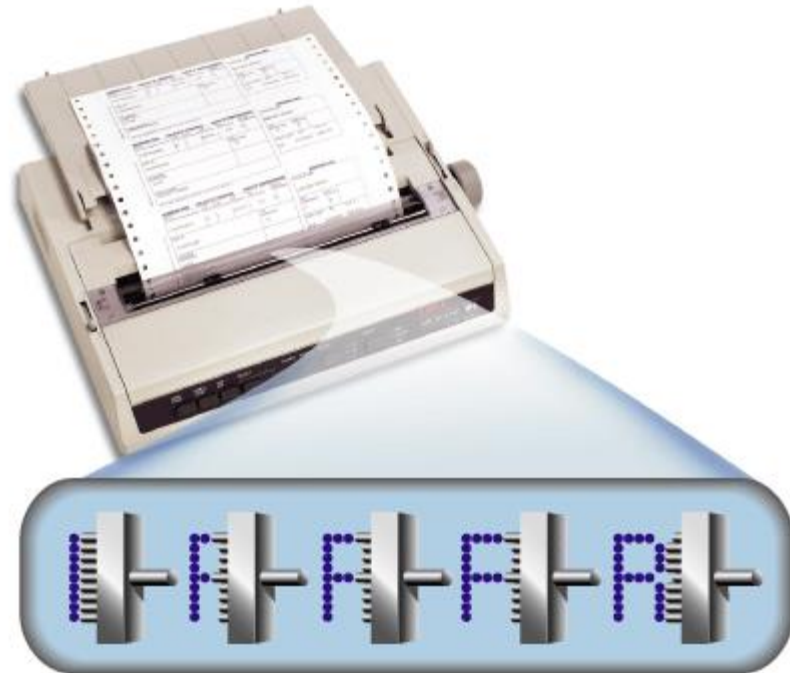
Output Device (*cont'd*)

- **Printer**
 - Two basic types:
 - Impact
 - Non-impact
 - What is the resolution of a printer?
 - Sharpness and clarity
 - Measured by number of dots per inch (dpi) printer can output



Output Device (*cont'd*)

- **Impact printer**
 - Characters/graphics are formed on the paper by physical striking contact between ink ribbon and paper
 - Examples are dot-matrix printer (continuous paper), line printer (mainframe/minicomputer)



Output Device (*cont'd*)

- **Nonimpact printer**

- **Forms characters and graphics without striking paper**

Ink-jet printer

- **sprays tiny drops of liquid ink onto paper**
 - **Prints in black-and-white or color on a variety of paper types**

Output Device (*cont'd*)

Photo printer

- **Color printer that produces photo-lab-quality pictures**
- **Many photo printers have a built-in card slot**



Output Device (*cont'd*)

Laser printer

- **High-speed, high-quality nonimpact printer**
- **Prints text and graphics in very high-quality resolution, ranging from 1,200 to 2,400 dpi**
- **Typically costs more than ink-jet printer, but is much faster**



Output Device (cont'd)

Thermal printer

- Generates images by pushing electrically heated pins against heat-sensitive paper
 - Dye-sublimation printer (also called a digital photo printer) uses heat to transfer dye to specially coated paper



Output Device (*cont'd*)

Mobile printer

- **Small, lightweight, battery-powered printer that allows mobile user to print from notebook computer, Tablet PC, or PDA while traveling**



Output Device (cont'd)

Label printers and Postage printers

- **Small printer that prints on adhesive-type material**
- **Most also print bar codes**
- Postage printer has built-in digital scale and prints postage stamps



Output Device (*cont'd*)

Plotter

- **Sophisticated printer used to produce high-quality drawings**
- **Large-format printer** creates photo-realistic-quality color prints



Output Device (cont'd)

- **Audio output device**
 - **Computer component that produces music, speech, or other sounds**
 - **Speakers and headsets are common devices**



Output device (cont'd)

- **Data projector**

- **Device that takes image from computer screen and projects it onto larger screen**



Output Device (cont'd)

- **Force feedback**
 - **Sends resistance to joystick or wheel in response to actions of user**



CPU

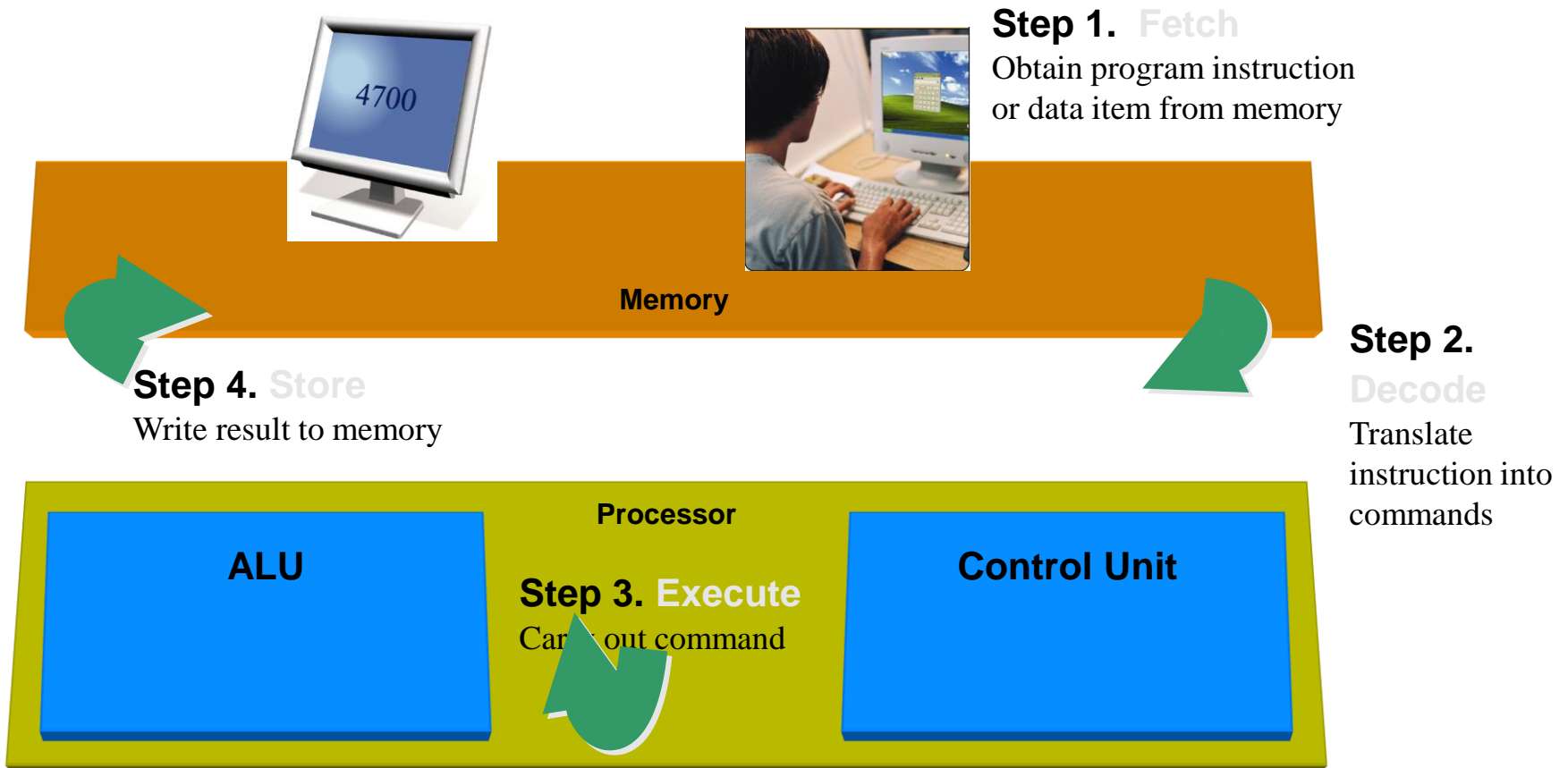
- **What is the central processing unit (CPU)?**
 - Also called the **processor**
 - Interprets and carries out basic instructions that operate a computer
 - **Control unit** directs and coordinates operations in computer
 - **Arithmetic logic unit (ALU)** performs arithmetic, comparison, and logical operations



CPU (cont'd)

- **Machine cycle**

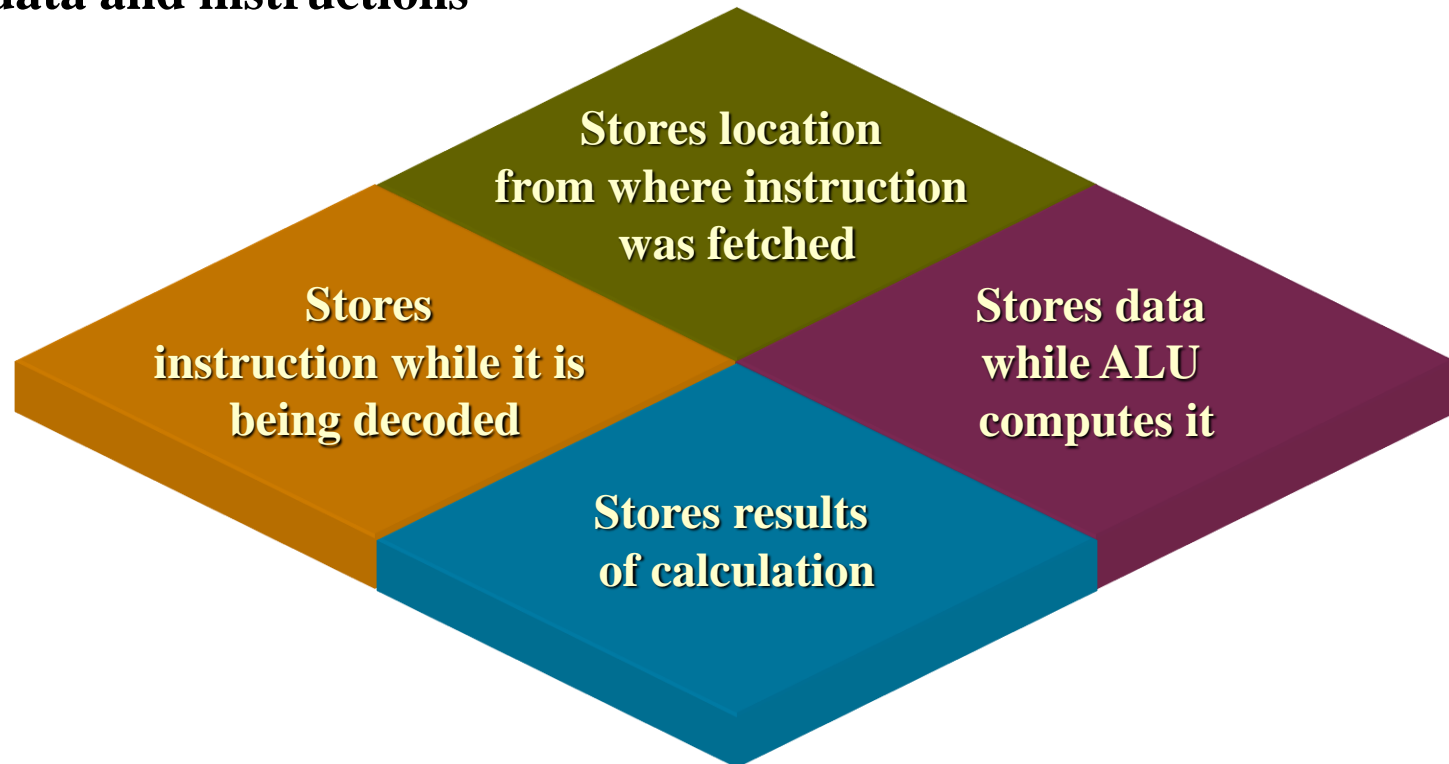
➤ **Four operations of the CPU comprise a machine cycle**



CPU (cont'd)

- **Register**

- **Temporary high-speed storage area that holds data and instructions**



CPU (cont'd)

- **System clock**

- **Controls timing of all computer operations**
- **Generates regular electronic pulses, or ticks, that set operating pace of components of system unit**

Each tick
is a
clock cycle

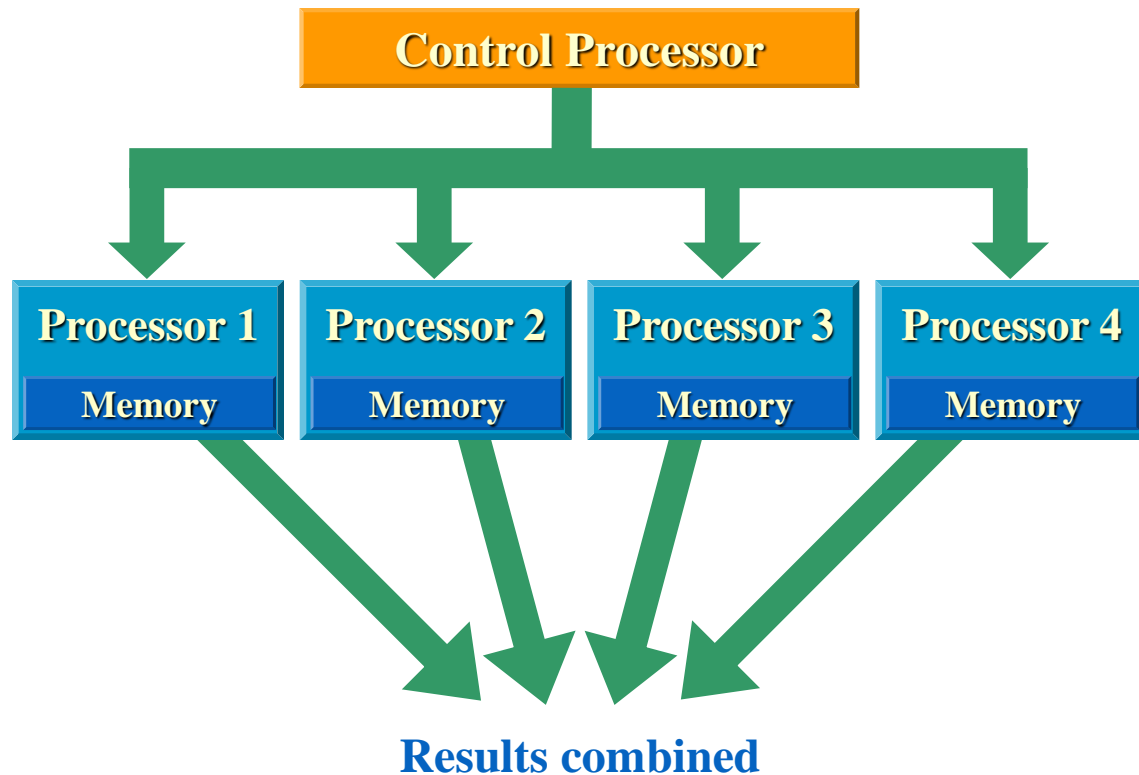
Pace of system
clock is clock speed
Most clock speeds are
in the gigahertz (GHz)
range (1 GHz = one
billion ticks of system
clock per second)

Processor speed can
also be measured in
millions of instructions
per second (MIPS)

CPU (cont'd)

- **Parallel processing**

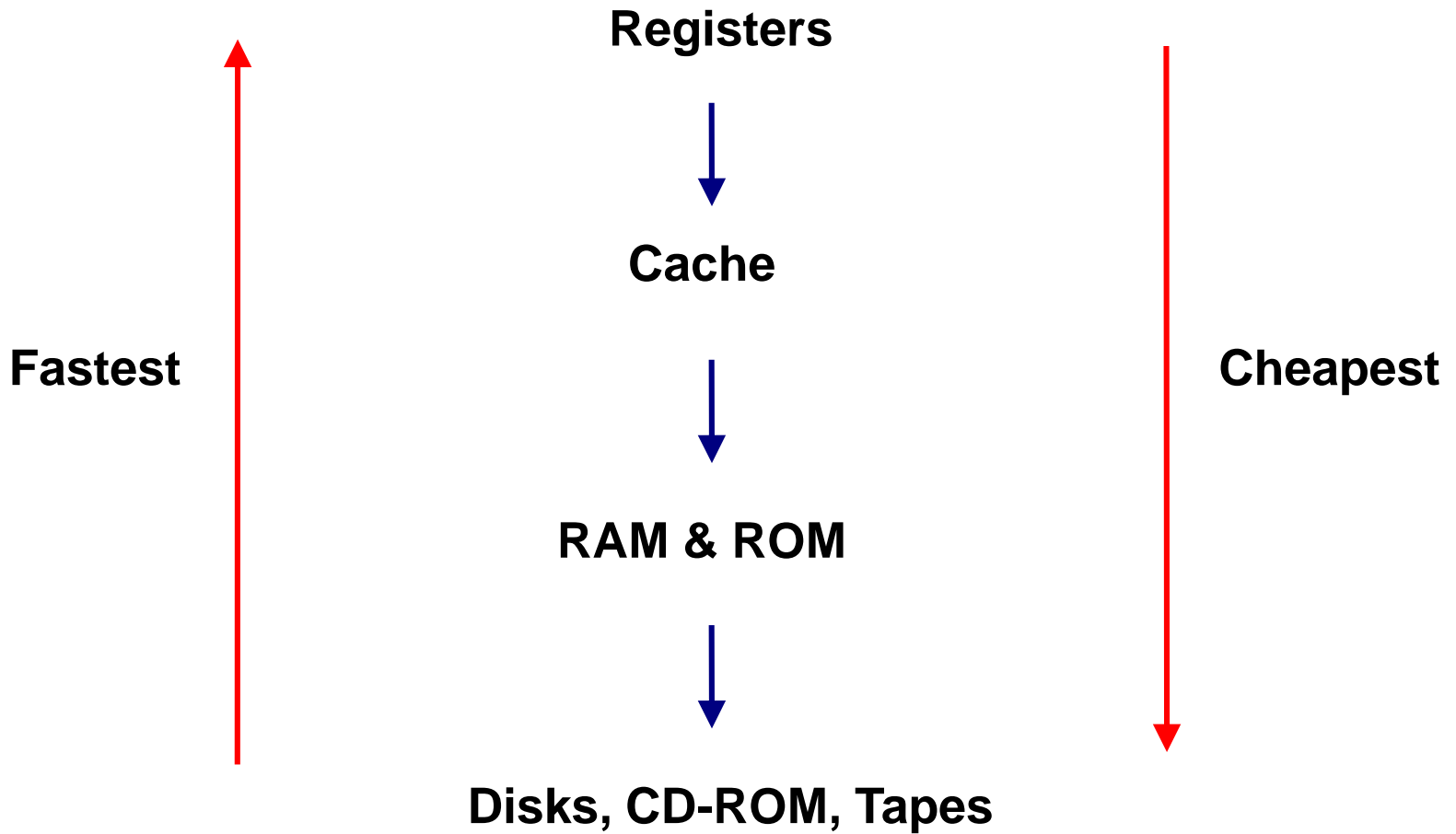
- **Using multiple processors simultaneously to execute a program faster**
- **Requires special software to divide problem and bring results together**



Memory Unit

- **Memory consists of electronic components that store:**
 - instructions waiting to be executed by the processor
 - data needed by those instructions
 - Results of the processed data (information)
- **In short, it stores 3 types of items:**
 - OS and other system software
 - Application programs
 - Data being processed and the result (info)

Memory Unit (*cont'd*)



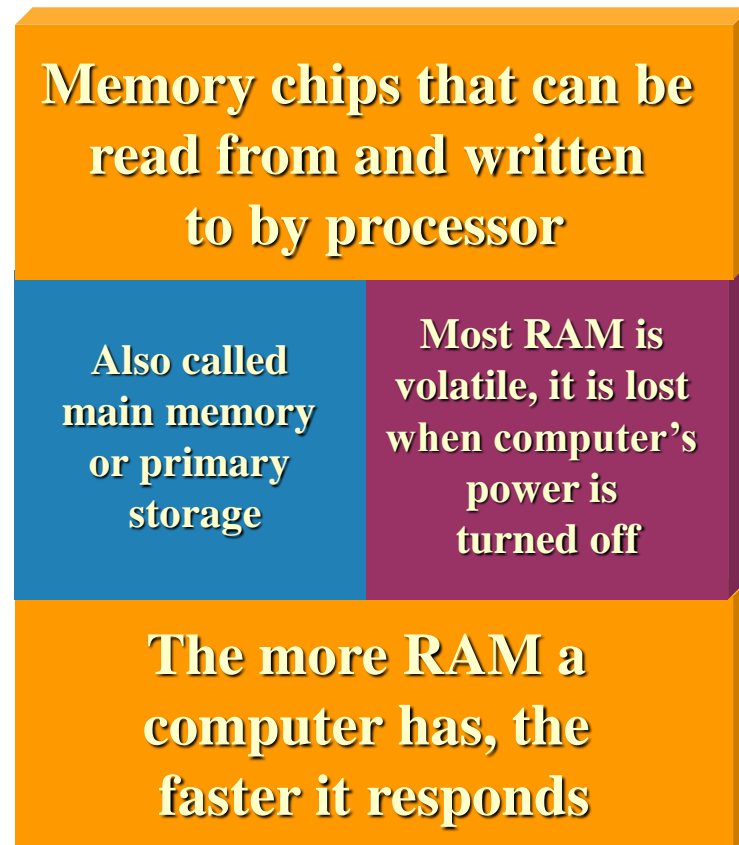
Memory Unit (*cont'd*)

- **How is memory measured?**
 - **By number of bytes available for storage**

Term	Abbreviation	Approximate Size
Kilobyte	KB or K	1 thousand bytes
Megabyte	MB	1 million bytes
Gigabyte	GB	1 billion bytes
Terabyte	TB	1 trillion bytes

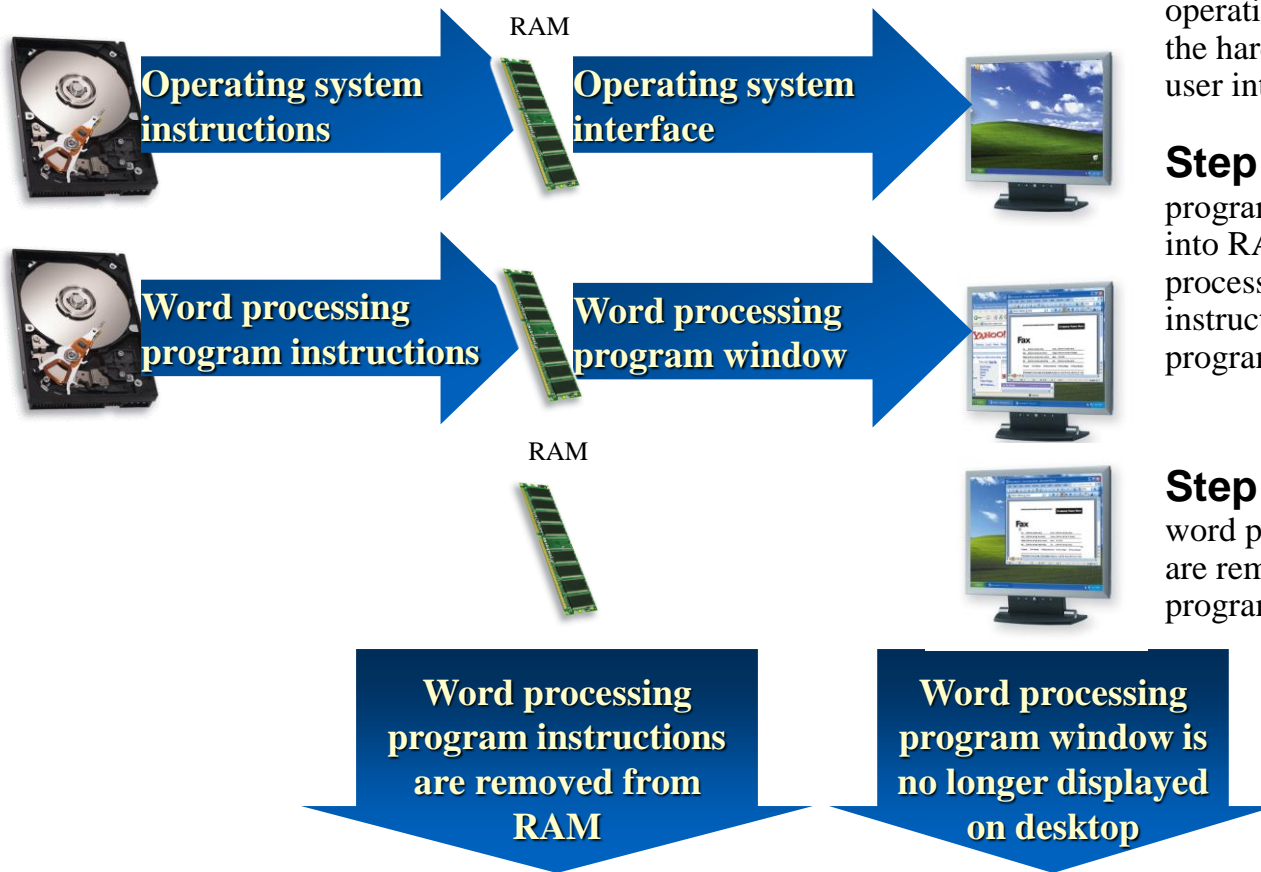
Memory Unit (*cont'd*)

- **Random Access Memory (RAM)?**



Memory Unit (cont'd)

How do program instructions transfer in and out of RAM?



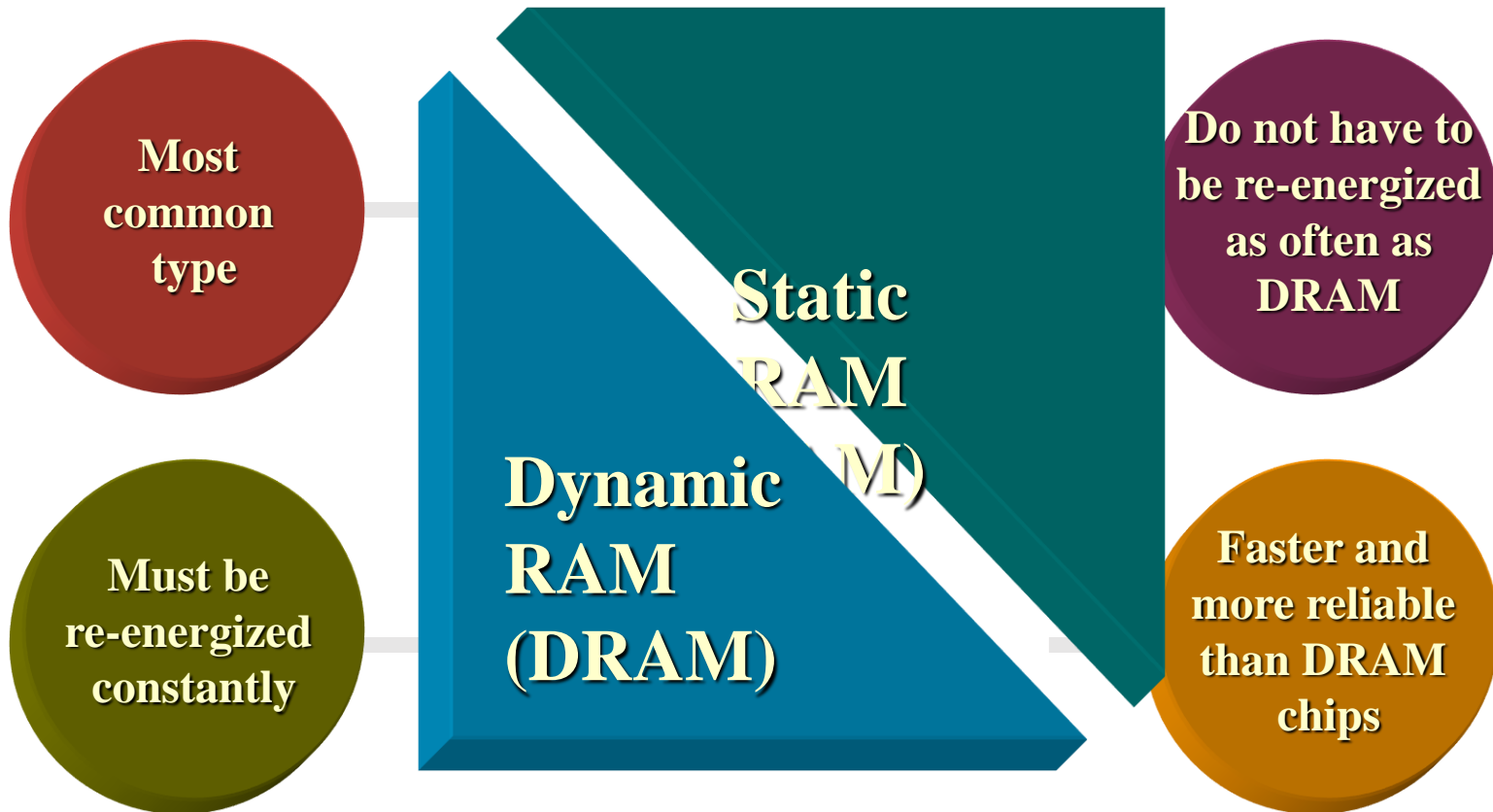
Step 1. When you start the computer, certain operating system files are loaded into RAM from the hard disk. The operating system displays the user interface on the screen.

Step 2. When you start a word processing program, the program's instructions are loaded into RAM from the hard disk. The word processing program and certain operating system instructions are in RAM. The word processing program window is displayed on the screen.

Step 3. When you quit a program, such as the word processing program, its program instructions are removed from RAM. The word processing program is no longer displayed on the screen.

Memory Unit (*cont'd*)

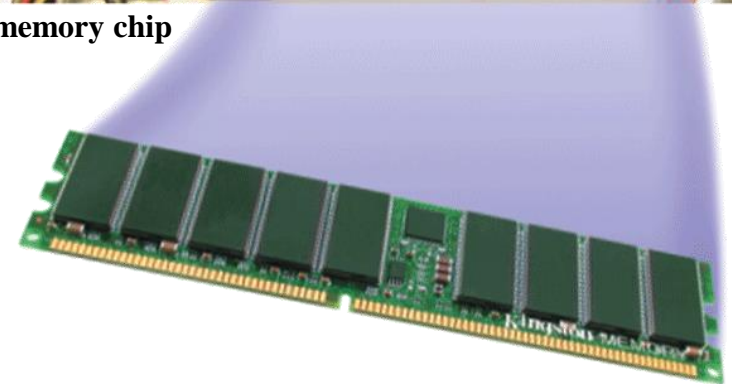
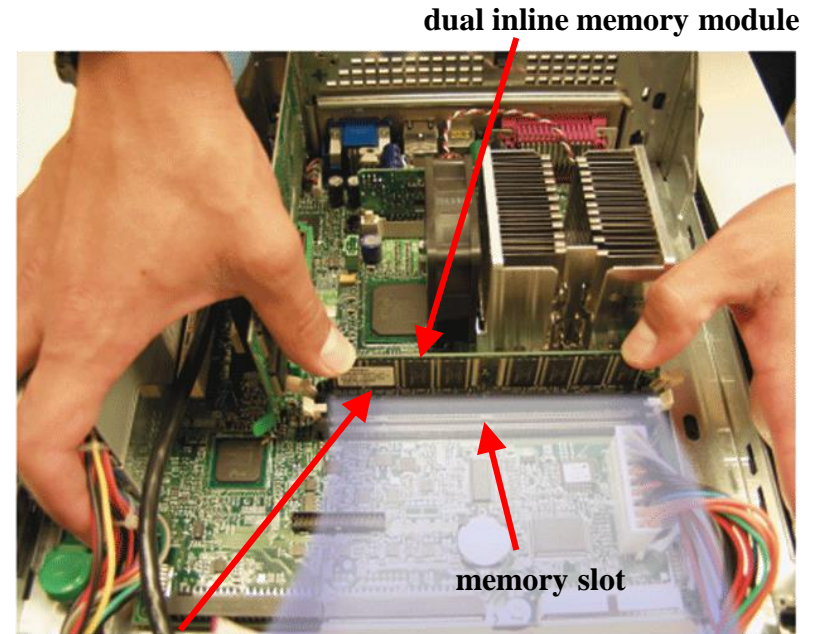
- **Two basic types of RAM chips**



- **Newer Type: Magnetoresistive RAM (MRAM)**

Memory Unit (cont'd)

- **Where does memory reside?**
 - Resides on small circuit board called **memory module**
 - **Memory slots** on motherboard hold memory modules



Memory Unit (cont'd)

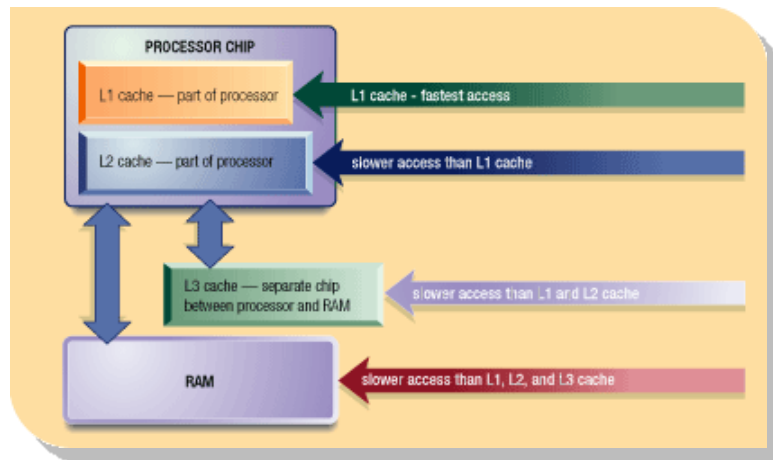
- **How much RAM do you need?**
 - **Depends on type of applications you intend to run on your computer**

RAM	256 MB to 1 GB	512 MB to 2 GB	2 GB and up
Use	<ul style="list-style-type: none">• Home and business users managing personal finance• Using standard application software such as word processing• Using educational or entertainment CD-ROMs• Communicating with others on the Web	<ul style="list-style-type: none">• Users requiring more advanced multimedia capabilities• Running number-intensive accounting, financial, or spreadsheet programs• Using voice recognition• Working with videos, music, and digital imaging• Creating Web sites• Participating in video conferences• Playing Internet games	<ul style="list-style-type: none">• Power users creating professional Web sites• Running sophisticated CAD, 3D design, or other graphics-intensive software

Memory Unit (cont'd)

- **Cache**

- **Helps speed computer processes by storing frequently used instructions and data**
- **Also called **memory cache****



- L1 cache built into processor
- L2 cache slower but has larger capacity
- L2 advanced transfer cache is faster, built directly on processor chip
- L3 cache is separate from processor chip on motherboard (L3 is only on computers that use L2 advanced transfer cache)

Memory Unit (cont'd)

- Read-only memory (ROM)

Memory chips that store permanent data and instructions

Nonvolatile memory, it is not lost when computer's power is turned off

EEPROM

(electrically

Three types: erasable programmable

read-only memory)

Type of PROM

containing microcode

programmer

can erase

PROM

(programmable

read-only

memory)

Blank ROM

chip onto which

a programmer

can write permanently

Firmware—
Manufactured with permanently written data, instructions, or information

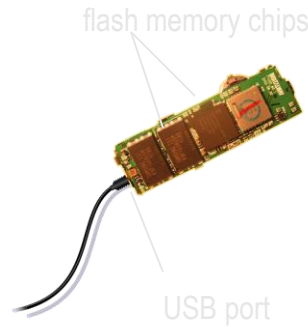
Memory Unit (cont'd)

- **Flash memory**

- **Nonvolatile memory that can be erased electronically and rewritten**
- **Used with PDAs, smart phones, printers, digital cameras, automotive devices, audio players, digital voice recorders, and pagers**

Step 1.

Purchase and download MP3 music tracks from a Web site. With one end of a special cable connected to the system unit, connect the other end into the MP3 player.



Step 3.

Plug the headphones into the MP3 player, push a button on the MP3 player, and listen to the music through the headphones.



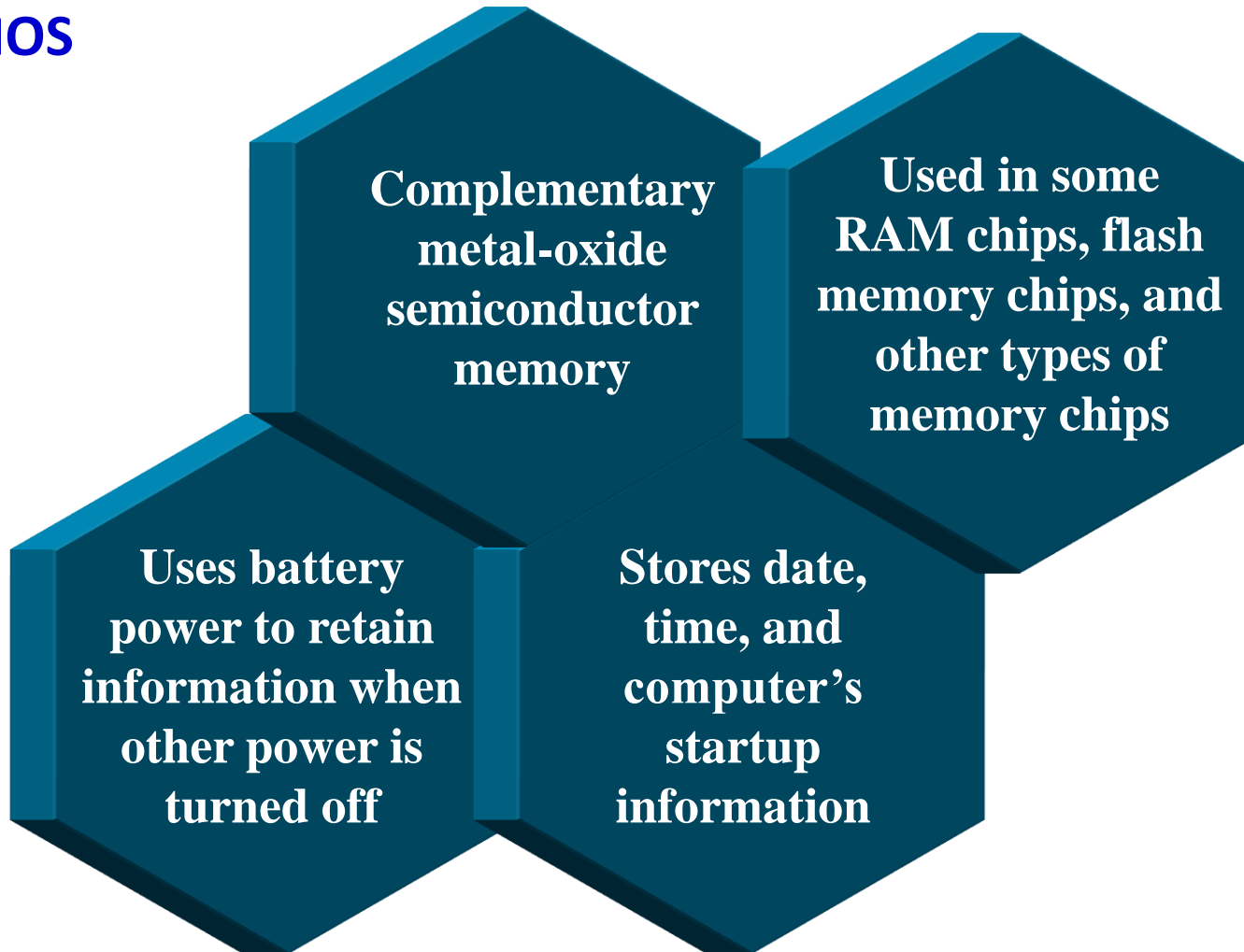
MP3 Player

Step 2.

Instruct the computer to copy the MP3 music track to the flash memory chip in the MP3 player.

Memory Unit (*cont'd*)

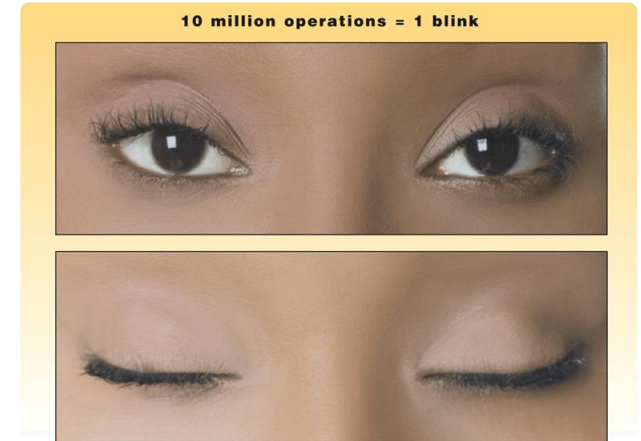
- **CMOS**



Memory Unit (cont'd)

- **What is access time?**

- **Amount of time it takes processor to read data from memory**
- **Measured in **nanoseconds** (ns), one billionth of a second**
- **It takes 1/10 of a second to blink your eye; a computer can perform up to 10 million operations in same amount of time**



Term	Speed
Millisecond	One-thousandth of a second
Microsecond	One-millionth of a second
Nanosecond	One-billionth of a second
Picosecond	One-trillionth of a second

Ports

- Many I/O devices connect into bus via standard interface called a port. An I/O port is a connector at end of bus into which device can be plugged.
- Older I/O ports were low speed, still in limited use
- Serial (e.g. RS-232, 25 pin tech. spec, used for mouse, modem, network interface) one bit at a time, over one line.
- Parallel (e.g. Centronics, used for printers) multiple bits at a time, over multiple lines.
- Newer ports, e.g. USB port handle multiple devices and much higher data throughput

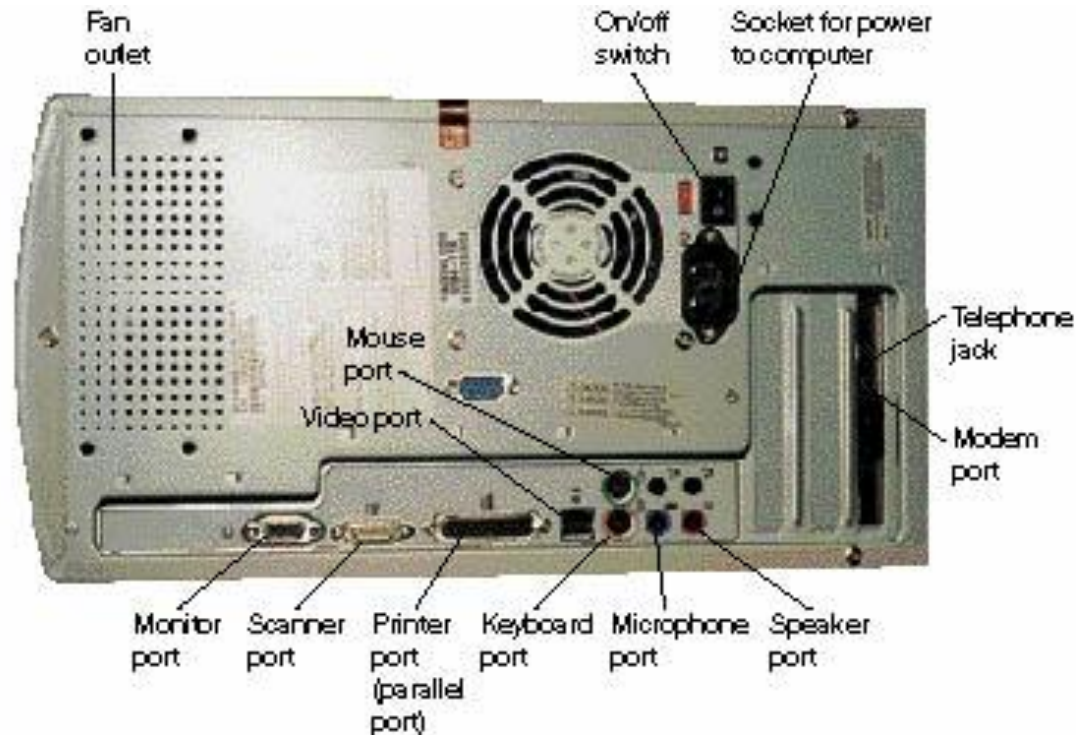
Ports (*cont'd*)

A port is a connecting socket or jack on the outside of the system unit into which are plugged different kinds of cables.

- Serial port - sends bits one at a time, one after another
- Parallel port
- SCSI port
- USB port
- FireWire port
- Dedicated port
- Infrared port

Ports (cont'd)

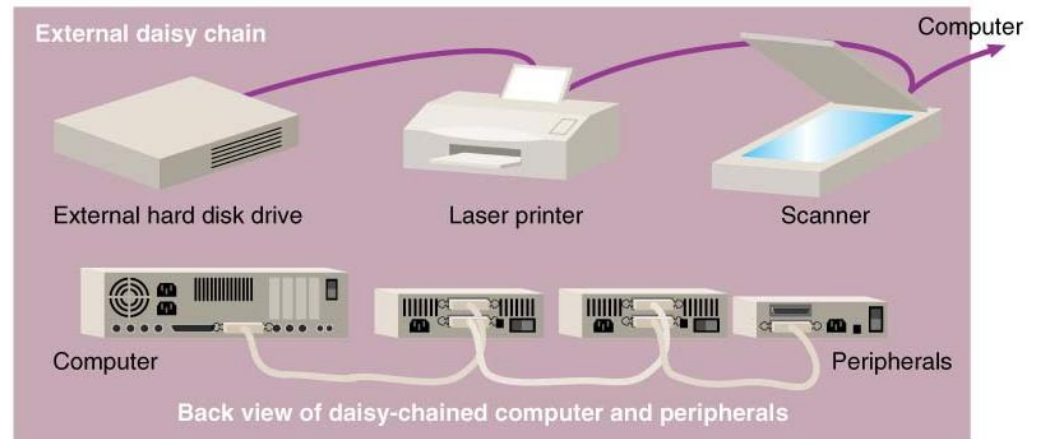
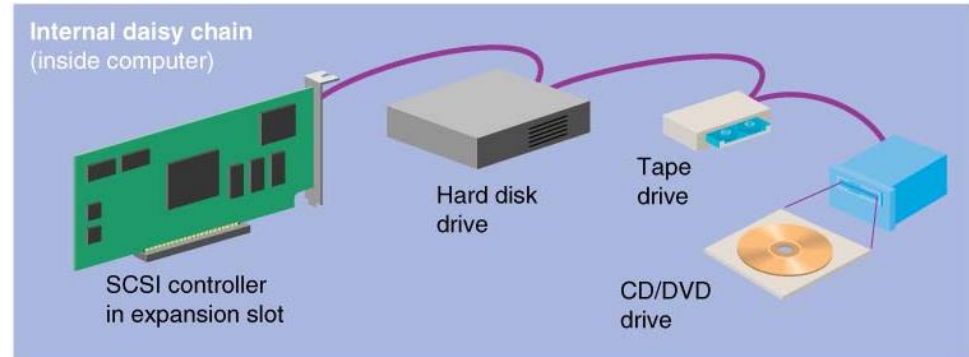
- Serial port
- Parallel port - transmits 8 bits simultaneously
- SCSI port
- USB port
- FireWire port
- Dedicated port
- Infrared port



The back of a Macintosh machine

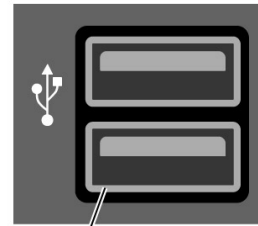
Ports (cont'd)

- Serial port
- Parallel port
- SCSI port - allows data to be transmitted in a “daisy chain” to up to 7 devices
- USB port
- FireWire port
- Dedicated port
- Infrared port



Ports (cont'd)

1. Serial port
2. Parallel port
3. SCSI port
4. USB port - can theoretically connect up to 127 peripheral devices daisy-chained to one general-purpose port
5. FireWire port
6. Dedicated port
7. Infrared port



USB ports



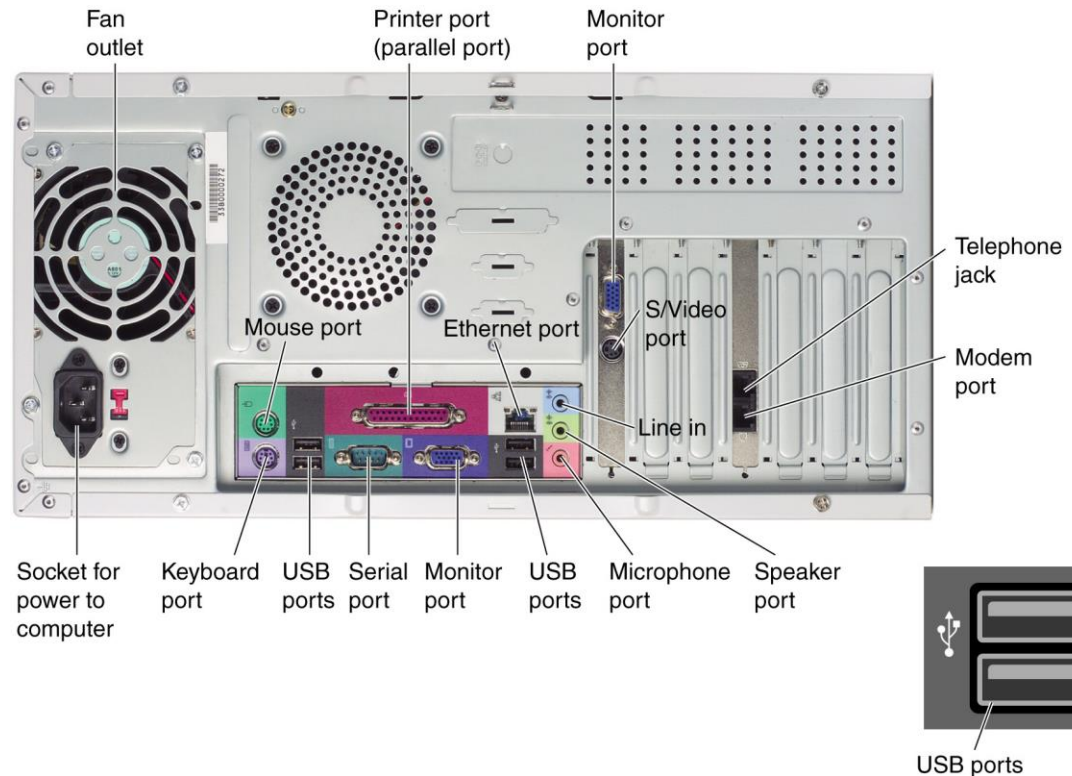
USB port and connector

Ports (*cont'd*)

1. Serial port
2. Parallel port
3. SCSI port
4. USB port
5. FireWire port – for camcorders, DVD players, and TVs
6. Dedicated port
7. Infrared port

Ports (cont'd)

1. Serial port
2. Parallel port
3. SCSI port
4. USB port
5. FireWire port
6. Dedicated port - special-purpose ports
7. Infrared port



Dedicated ports: mouse port, modem port, and keyboard port

Ports (*cont'd*)

1. Serial port
2. Parallel port
3. SCSI port
4. USB
5. FireWire port
6. Dedicated port
7. Infrared port - allows a computer to make a cableless connection with infrared-capable devices

Bus

- **A pathway which is associate 3 computer components**
- **Consists of 3 types:**
 - 1.Data BUS
 - Transmits data/**instructions** to & from the different components
 - 2.Address BUS
 - transmit the signals that specify locations in memory
 - 3.Control BUS
 - Carries control signals data and address in data bus and address bus to make sure that the data traffic flows smoothly.

Bus (*cont'd*)

- Data travels between components (CPU, memory & I/O devices) of the computer along communication paths called buses. (Note: can also have buses external to system)
- Bus is made up of multiple lines, which may be wires or conductors on a printed board.
- Bus may carry data between two components only (point-to-point) or it may be shared between many (multipoint). System bus connects CPU with main memory & other system components.

How Data is Organized?

- **Data storage hierarchy**

- Characters: a letter, number or special characters
- Field: a unit of data consisting of one or more characters (bytes)
- Record: collection of related fields
- File: collection of related records
- Database: an organized collection of integrated files

Data Access Method

- **Sequential vs. direct access**

- Sequential storage: data is stored and retrieved in sequence
 - E.g. Magnetic tape
 - Slow but cheaper
- Direct access storage: the computer can go directly to the information that you want
 - E.g. CD
 - Fast but expensive
 - (1) complexity in maintaining file allocation table
 - (2) need to use hard-disc technology

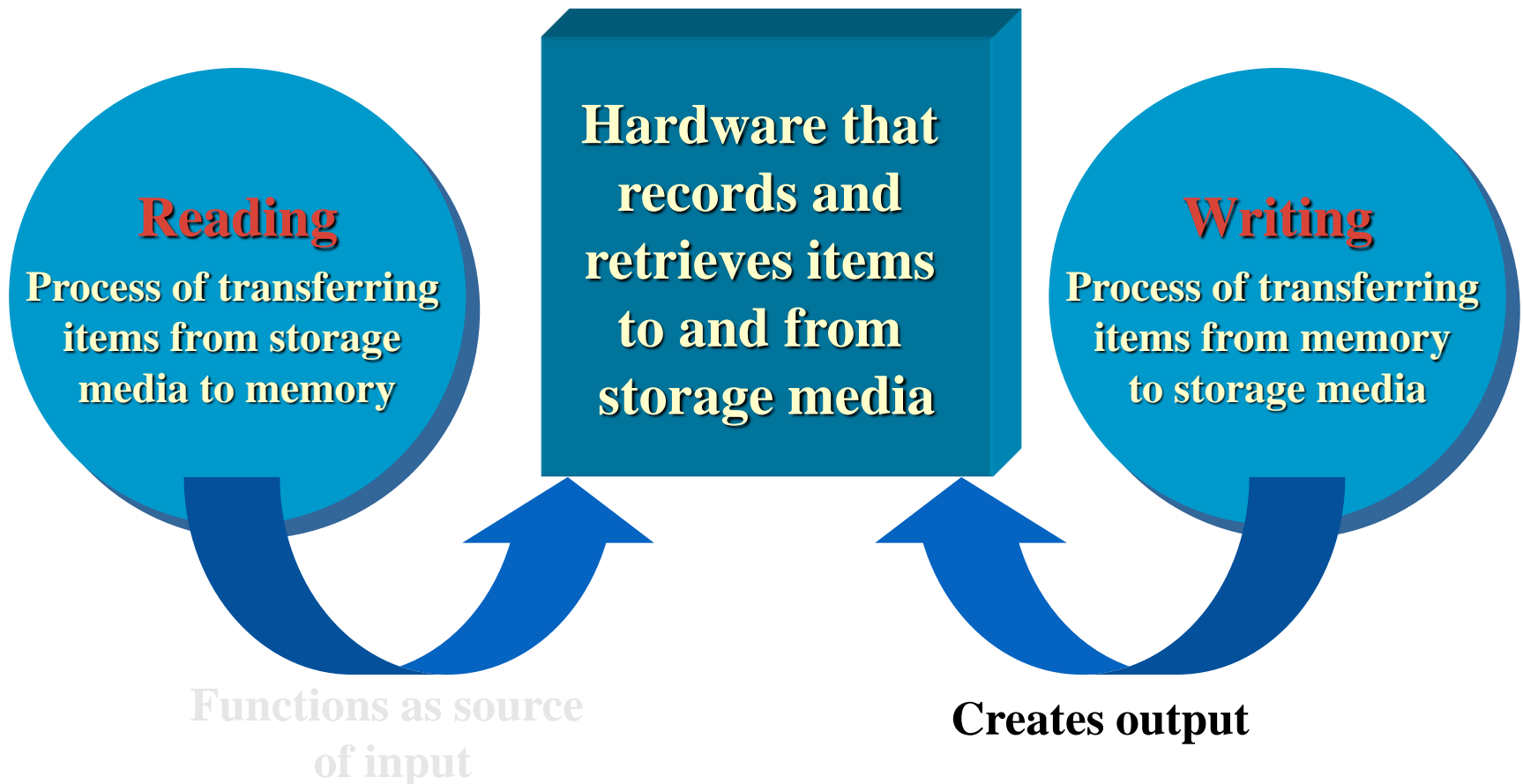
Storage

- Holds data, instructions, and information for future use
 - **Storage medium** is physical material used for storage
 - Also called secondary storage



Storage (cont'd)

- What is a **storage device**?



Storage (*cont'd*)

- **Magnetic tapes**

- Sequential access to data
- Suitable for small/medium size storage that are not accessed frequently
- Used for backup and long-term storage

- **Diskettes**

- Direct access to data
- Use magnetic disk
- Consists of track, sector and cluster

Storage (*cont'd*)

- **Hard Disk**
 - Direct access
 - Faster than diskettes because faster spinning rate
- **Optical Disc**
 - Example CD-ROM
 - High capacity data
- **Storage Area Network/File Server**

Hard Drive – storage



Storage (*cont'd*)

- Why is storage necessary?
 - Retain data when the computer is turned off
 - Are cheaper than memory
 - Play an important role during startup
 - Are needed for output