



TOPIC 2: COMPUTER HARDWARE

Unit Two: Processing Devices



Unit Two: Processing Devices

• Unit Summary:-

Devices inside the system Unit:

a) The system Unit

- Definitions, Components and parts.

b) The Motherboard

- Definitions, Components and parts.

c) The Central Processing Unit CPU

- Definitions, Components and parts.

d) Memory (internal/primary storage)

- RAM and ROM, Memory Cache, CMOS,
- Units of Measuring Computer Memory
- Computer Data representation & numbering systems



a) The system unit

- Processing devices are the computer electronic components and chips housed in the system unit.
- *The system case is a box-like case that houses the motherboard, the disks and drive bays, the power supply and cooling systems.*
- *The system unit therefore refers to the system case with all the internal components of a computer that facilitate data processing*
- The components in the system unit are connected to the *motherboard*.
- A drive bay is a rectangular opening inside the system unit that typically holds disk drives.



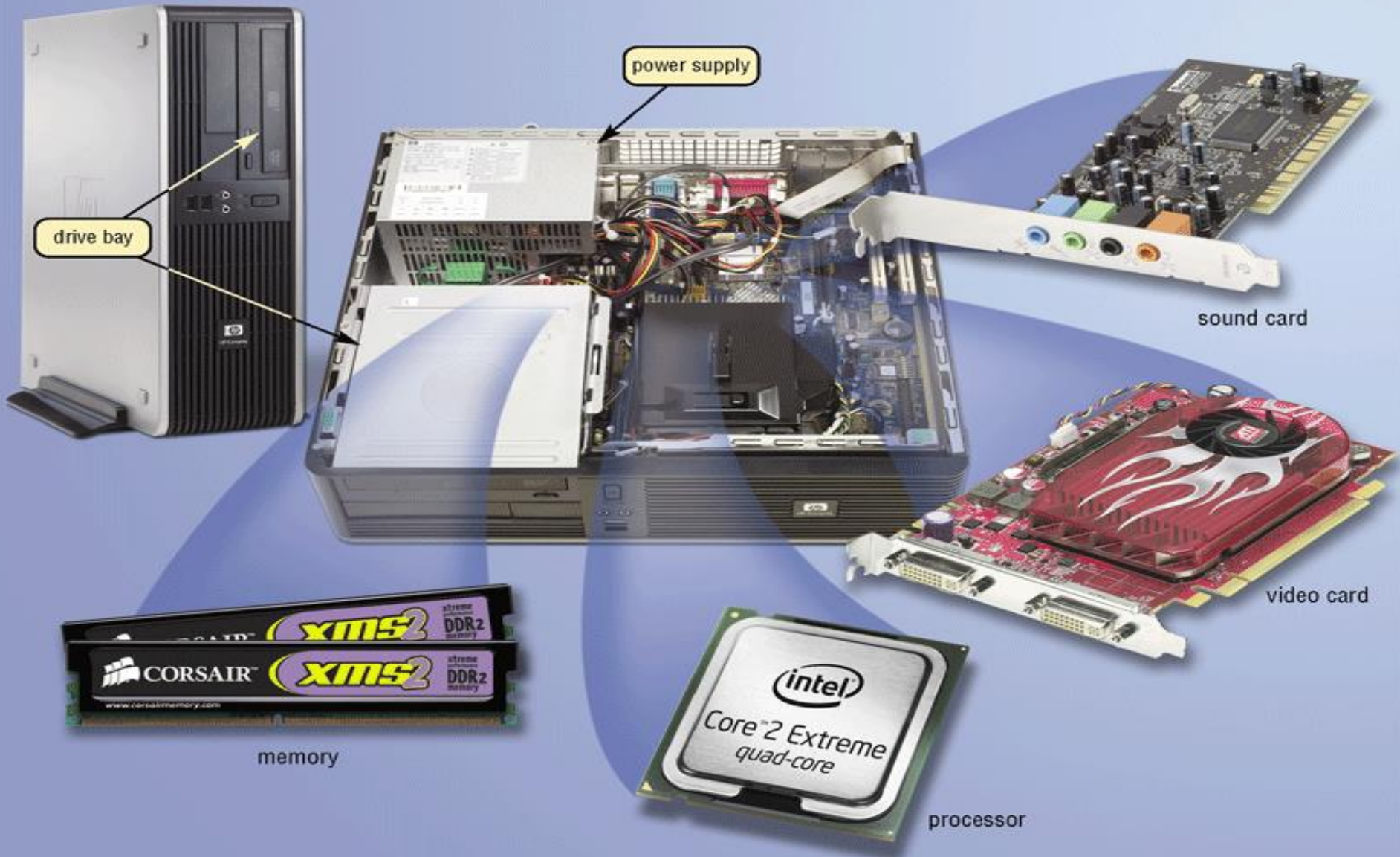
a) The system unit



All sizes of computers have a system unit



Components of the system unit



A system unit contains numerous electronic components

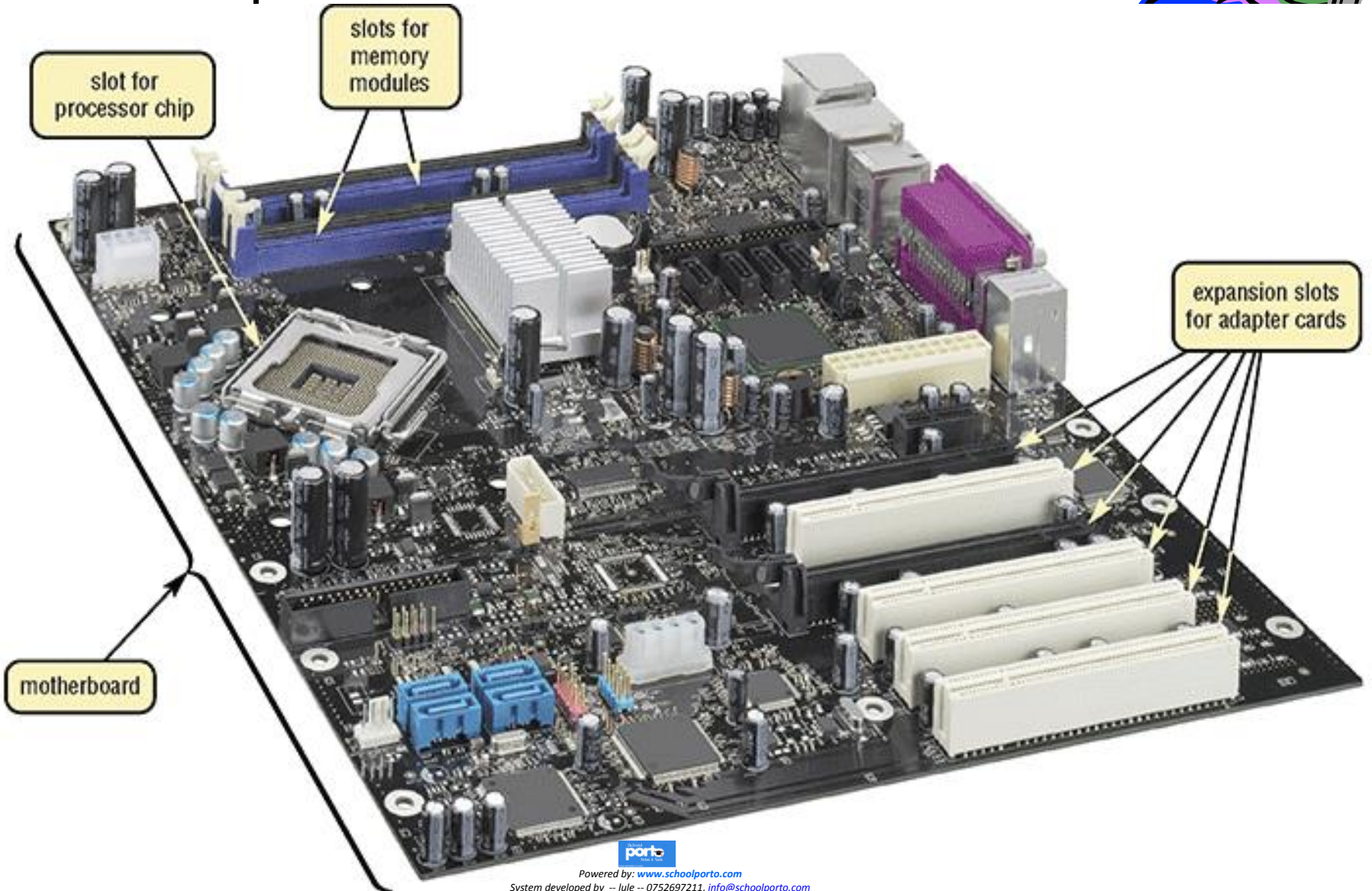


b) The motherboard

- The motherboard is a single circuit board, that provides the path through which the processor communicates with internal and peripheral devices.
- The motherboard is also called the *system board*
- The components attached to the motherboard include the processor chip (the CPU), memory chips, support electronic circuitry, buses, and Expansion Slots for Adapter Cards.



Basic parts of a motherboard





Expansion slots and Adapter cards

- An *expansion slot* is a socket on the motherboard that can hold an **adapter card**.
- An *adapter card*, also called expansion card, is a circuit board that increases the capabilities of the system or provides connections to peripherals.

An adapter card being inserted into an expansion slot



Commonly used adapter cards and their functions



Adapter Card	Purpose
Sound card	Connects speakers or a microphone
MIDI card	Connects musical instruments
Network interface card (NIC)	Connects other computers
Video card	Connects a monitor
USB card	Connects USB devices
TV tuner card	Allows viewing of television channels
Video capture card	Connects a video camera
Modem card	Converts telephone or cable analog signals to digital and vice versa
FireWire card	Connects FireWire devices

Plug and Play (PnP)



- *PnP* refers to the computer's capability to automatically configure adapter cards and other peripherals as you install them when the computer is still running.
- You don't have to first restart the computer for a plug and play device to work

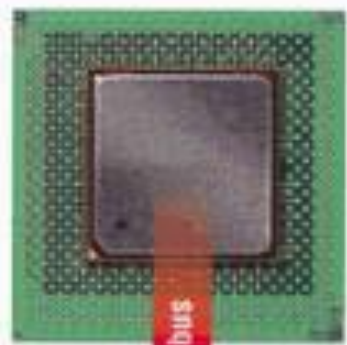


Buses

- The **bus** is a common electrical path, *that enables data flow between the various system components.*
- A *bus*, allows the various devices inside and attached to the system unit to communicate with each other.

- fastest
- next fastest
- next fastest
- slowest

processor



memory

Buses allow the various devices inside and attached to the system unit to communicate with each other



AGP bus slot

AGP bus



system bus

system bus

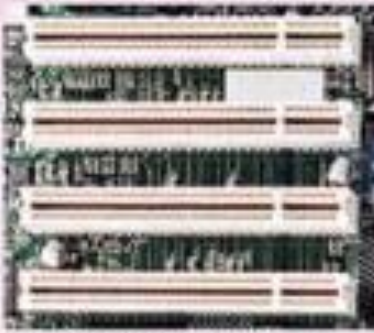
PCI bus

PCI bus



ISA bus

ISA bus (to other devices)



PCI bus expansion slots



ISA bus expansion slots

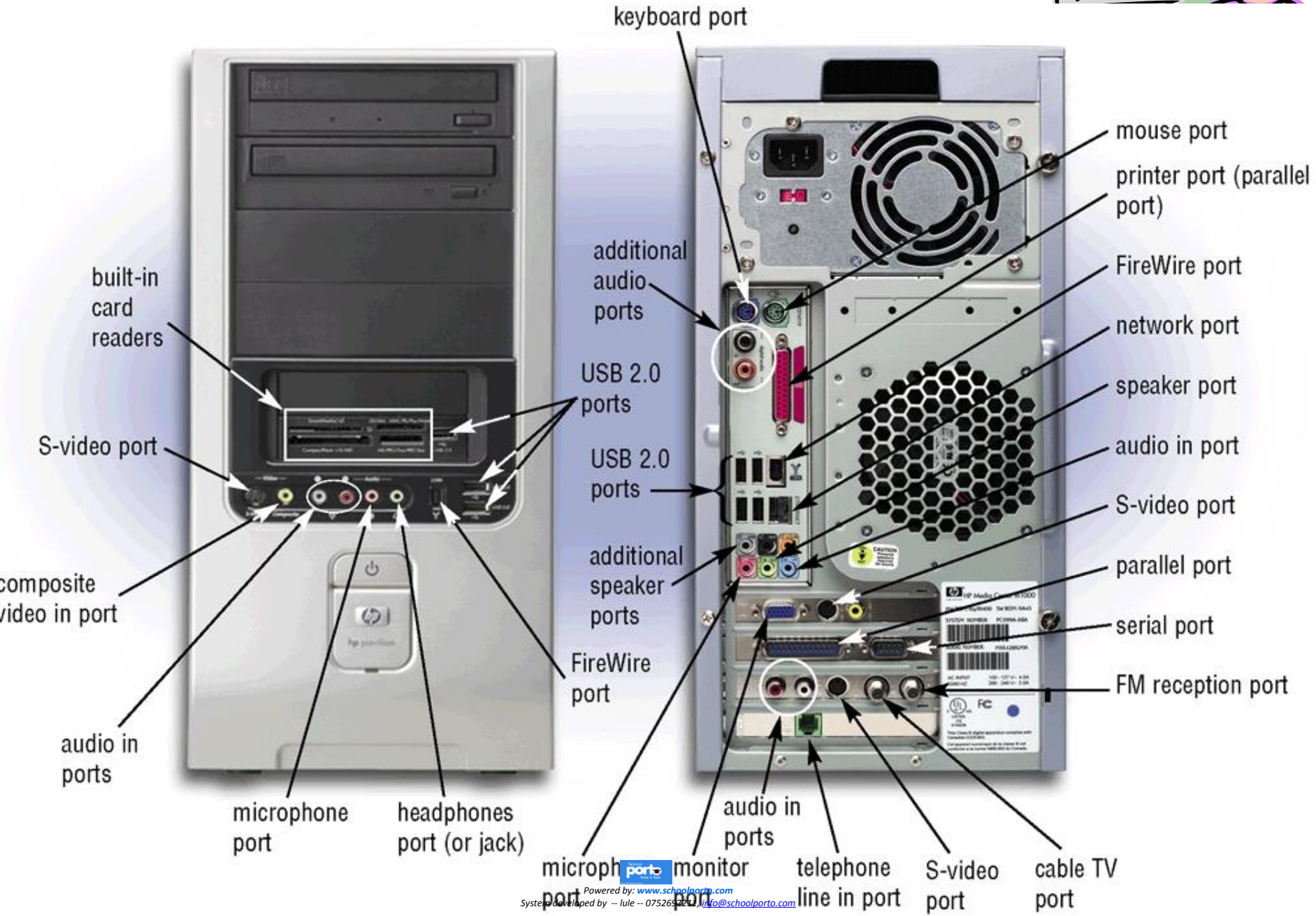
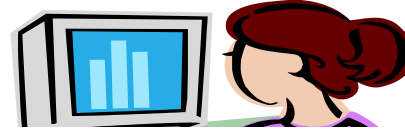




Ports

- A *port* is the point at which a peripheral attaches the system unit.
- A peripheral device, such as a keyboard, monitor, printer, mouse, digital camera, and microphone, often attaches by a cable to a port on the system unit.

A system unit has many ports



Examples of different types of ports on a system unit



Type	Picture	Type	Picture	Type	Picture	Type	Picture
Audio In		Monitor		FireWire		Side Surround Sound	
Cable TV		Mouse		FM reception		S/PDIF	
Center Surround Sound/Subwoofer		Network		HDMI port		Speaker	
Composite video in		Printer		Headphones		S-video	
Digital Video Interface (DVI)		Rear Surround Sound		Keyboard		Telephone line in	
eSATA port		Serial		Microphone		USB	



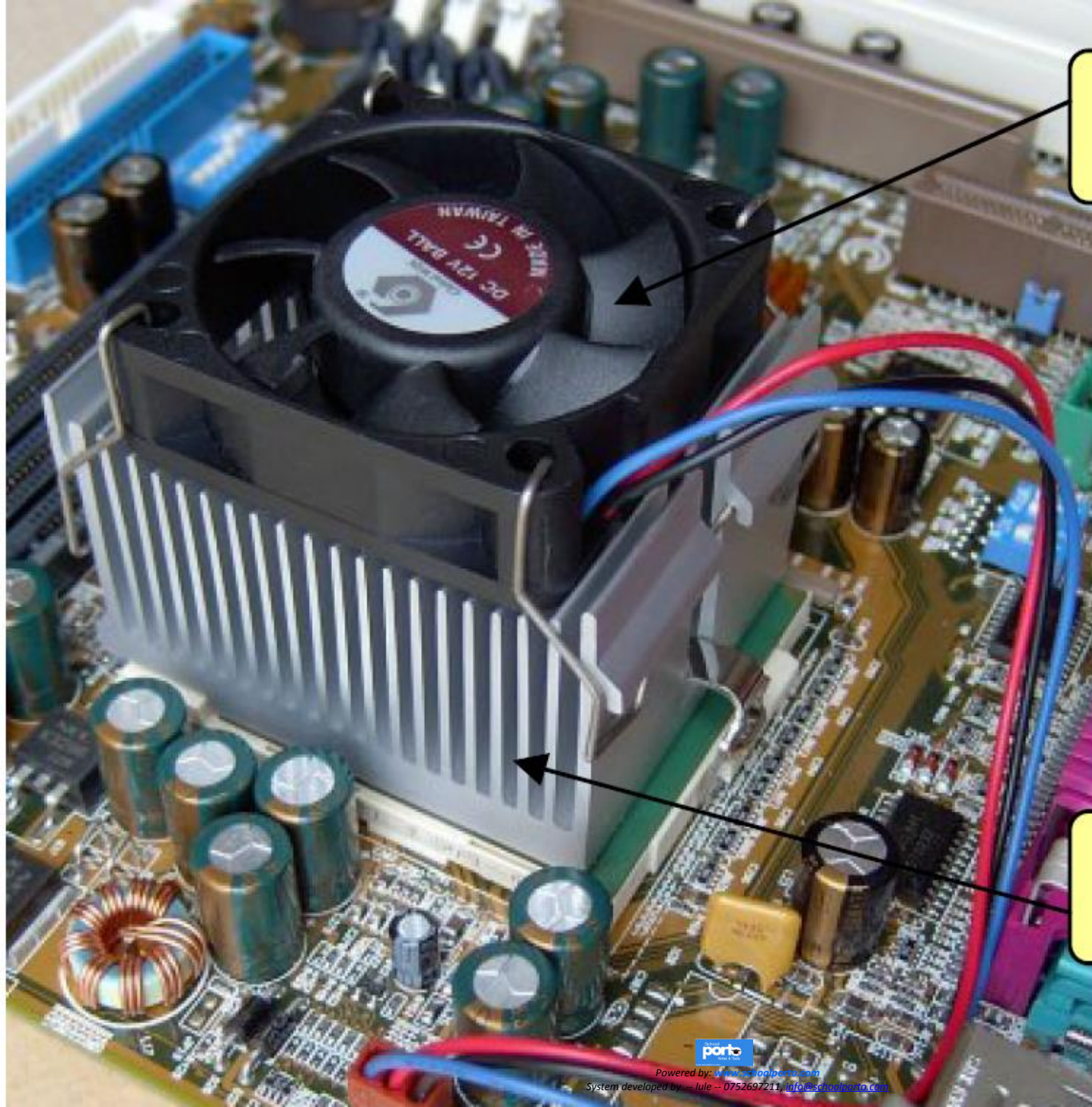
Common ports

- A **serial port** is a type of interface that connects a device to the system unit by transmitting data one bit at a time. It usually used to connect devices that do not required fast data transmission rates, such as a mouse or keyboard.
- **Parallel ports** allow the parallel transmission of data; that is, several bits are transmitted simultaneously. These ports provide the interface for such devices as high-speed printers.
- **USB** (*Universal Serial Bus*) ports are used in high-speed device interfaces.
- **Bluetooth ports** use radio waves to transmit data between two devices, without using cables.



Power Supply and Cooling Technology

- The power supply is the component of the system unit that converts the wall outlet AC power into DC
- Built into the power supply is a fan that keeps the power supply cool.
- 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.



Heat sink fan

Heat sink

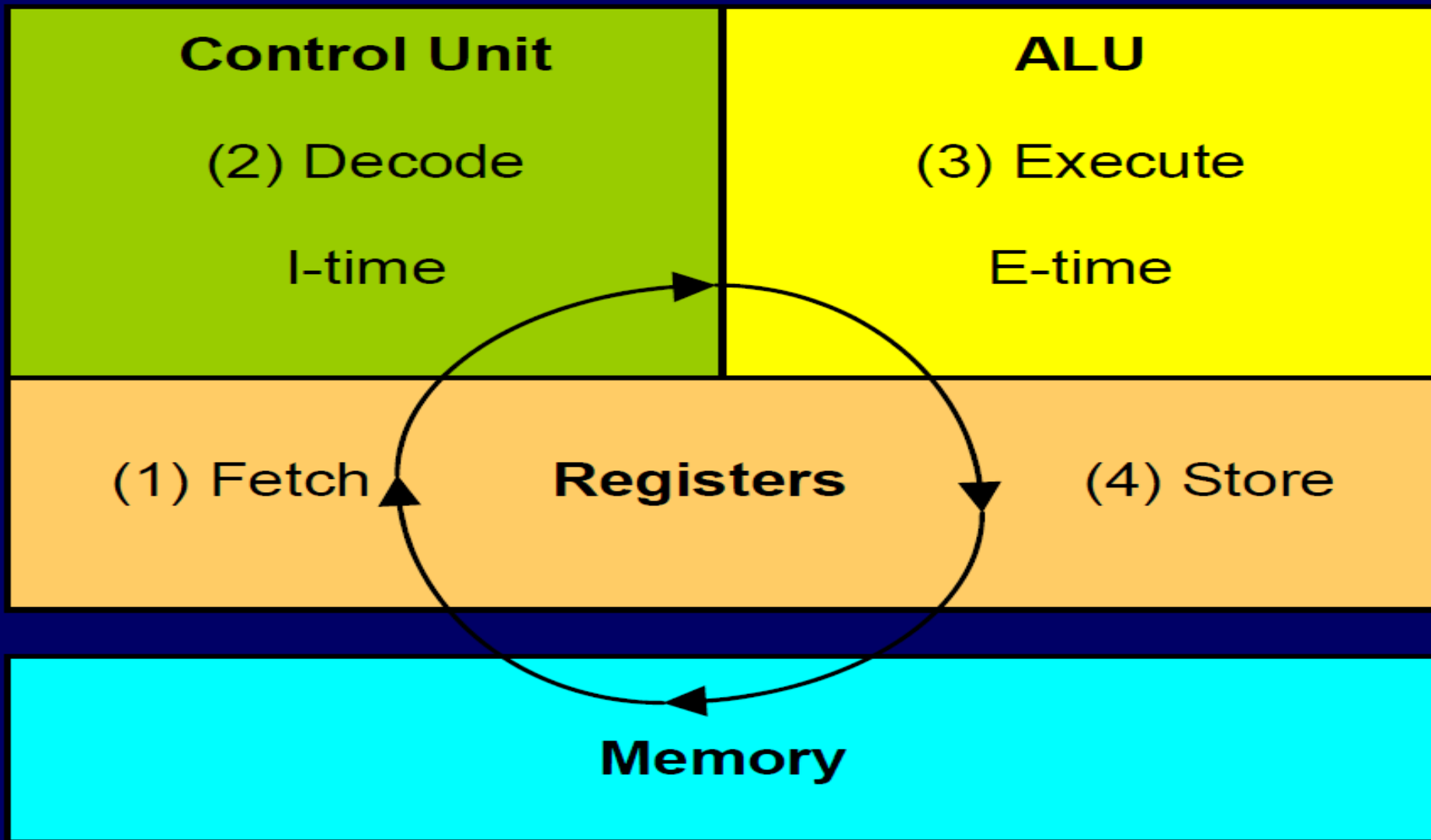


c) The CPU

- The *central processing unit (CPU)*, is a chip that interprets, carries out the basic instructions and manages most of a computer's operations.
- It is at times referred to as the 'brain' of the computer.
- It has two basic sections: the control unit (CU) and the arithmetic/logic unit (ALU), which work together to perform the processing operations.
- *Other CPU components are the Registers and the System Clock.*



Components of a CPU.



The control unit (CU)



- The *control unit* is the component of the processor that directs and coordinates most of the operations in the computer.
- It interprets each instruction issued by programs and then initiates the appropriate action to carry out the instruction.
- For every instruction, the control unit repeats a set of four basic steps called the machine cycle steps:



The machine cycle steps

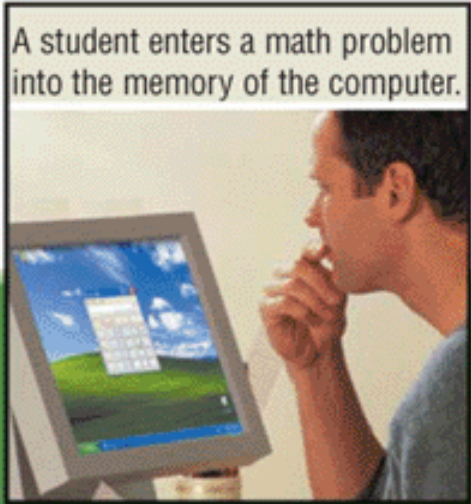
- **Step 1: Fetching the instruction.** The instruction to be executed is obtained from memory.
- **Step 2: Decoding the instruction.** The instruction is translated into commands the computer understand and sent to the ALU.
- **Step 3: Executing the instruction.** The commands are carried out.
- **Step 4: Storing results.** The results are stored in registers or memory.



Arithmetic/logic unit (ALU),

- The ALU performs the arithmetic, comparison, and logical operations in a computer.
- It performs the execution step of a machine cycle.
- *Arithmetic operations include addition, subtraction, multiplication, and division.*
- *Logical operations work with conditions and logical operators such as AND, OR, and NOT.*
- For example, if you wanted to search a student database for Candidates of Computer studies, you would search for any students classified under ‘Computer studies AND listed under Candidates.

An example of a machine cycle



A student enters a math problem into the memory of the computer.

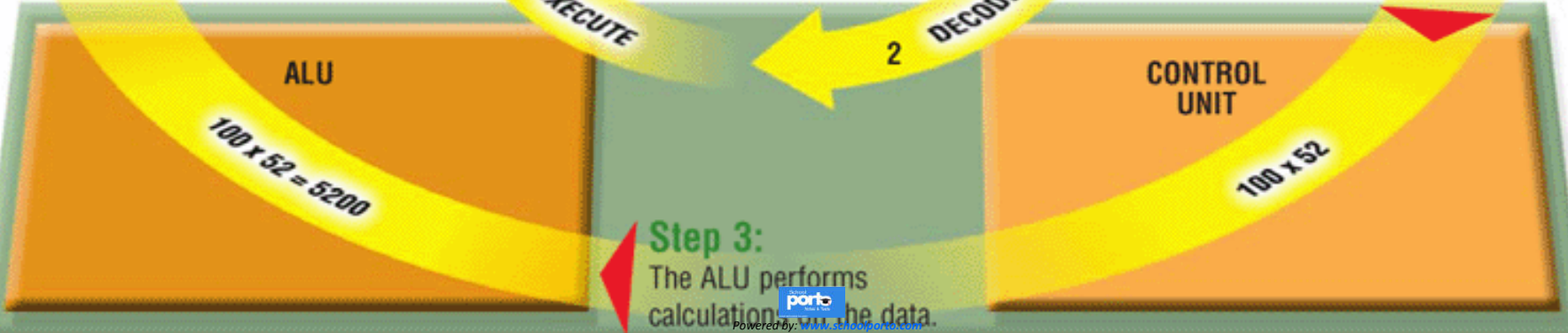
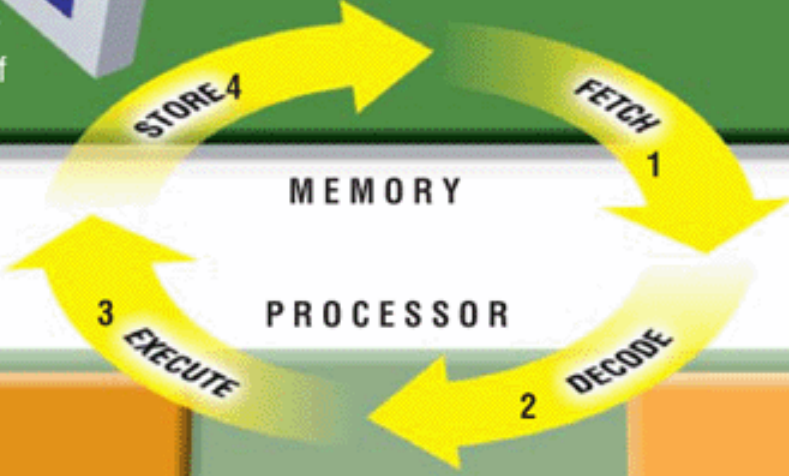
Step 1:
The control unit fetches the math problem's instructions and data from memory.



The results in memory appear on the screen of the monitor.

Step 4:
The results of the math problem are stored in memory.

Step 2:
The control unit decodes the math problem's instructions and sends the instructions and data to the ALU.



Step 3:
The ALU performs calculation on the data.



Registers

- Registers are high-speed working storage areas *that temporarily hold instructions and data.*
- Registers work under the direction of the control unit to accept, hold, and transfer instruction or data and comparisons at high speed.
- Registers are not part of Memory or Secondary Storage: Registers hold data *immediately related to the operation being executed. Memory is used to store data that will be used in the near future. Secondary storage holds data that may be needed later (in future)*



Types of registers

- **Instruction register**, which contains the instruction being executed;
- **Address register**, which keeps track of where a given instruction or piece of data is stored in memory;
- **Storage register**, which temporarily holds data taken from or about to be sent to memory;
- **The Accumulator**, which collects the result of computations;
- **General-purpose register**, which is used for several functions, as assigned by the CU



The *system clock*

- The *system clock* is a small chip that is used by the CPU to synchronize the timing of all computer operations.
- The system clock generates electronic pulse or ticks at a fixed rate, which set the operating pace of components in the system unit.
- Each tick is called a *clock cycle*, which affects machine cycle time.
- The faster the clock, the more instructions the CPU can execute per second.



Clock speed.

- This refers to the speed at which a processor executes instructions
- Clock speed is measured in hertz.
- *A hertz is one cycle or tick per second. A Megahertz (MHz) equates to one million ticks of the system clock per second.*
- Processor's speed is sometimes measured according to the number of MIPS (millions of instructions per second) it can process.



Computer memory





d) Memory (internal/primary storage)

- While performing a processing operation, a processor needs a place to temporarily store instructions to be executed and the data to be used with those instructions.
- The CPU cannot process data on an input device or disk directly; the data must first be available in memory.



d) Memory (internal/primary storage)

- A computer's memory in the system unit is located physically close to the CPU to decrease access time.
- It provides the CPU with a working storage area for program instructions, data and information.
- Memory is also known as primary storage or internal storage.
- Memory usually consists of one or more chips on the motherboard.



Types of memory:

- The system unit contains two types of memory: volatile and nonvolatile.
- The contents of *volatile memory are lost when* the computer power is turned off.
- *The contents* of nonvolatile memory are not lost when power is turned off.
- RAM is the most common type of volatile memory.
- Examples of nonvolatile memory include ROM, flash memory, and CMOS.
- Below, we discuss these types of memory.



Random Access Memory (RAM)

- *Random Access Memory (RAM) is the memory chips that are mounted directly on the motherboard or mounted on peripheral*
- cards that plug into the motherboard. The RAM chips consist of millions of switches that are sensitive to changes in electric
- current. When the computer is powered on, certain operating system files are loaded from a storage device such as a hard disk
- into RAM. These files remain in RAM as long as the computer is running. As additional programs and data are requested, they are read from storage into RAM. The processor acts upon
- the data while it is in RAM. During the running time, the
- contents of RAM may change as the program is executed.

RAM chip
being
inserted
into a
motherbo
ard



dual inline
memory
module

memory chip



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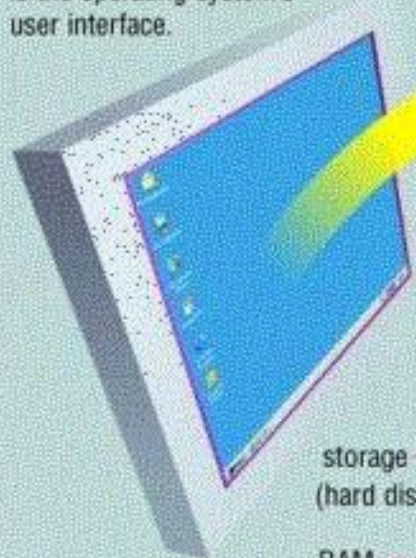
Random Access Memory (RAM)

- The amount of RAM a computer requires often depends on the types of applications you plan to use on the computer. A computer only can manipulate data that is in memory. A computer needs a certain amount of memory to store programs, data and information.
- The more RAM a computer has, the faster the computer will respond.
- A software package usually indicates the minimum amount of RAM it requires. RAM in computers purchased today ranges from 128MB, 512MB, 1GB to 64GB.

How program instructions transfer in and out of RAM

Step 1:

When your computer is running, certain operating system files are in RAM. Shown here is the operating system's user interface.



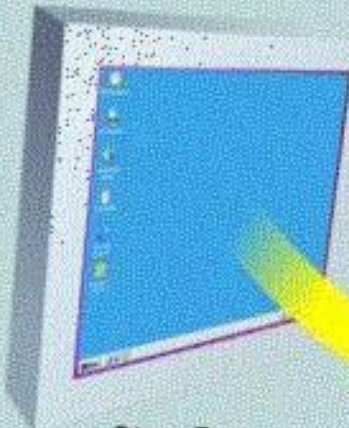
Step 2:

When you start a word processing program such as Word, the program loads into RAM from a hard disk. As you create a document, it is in RAM and displays on your screen.



storage
(hard disk)

RAM



Step 3:

When you quit Word, RAM may be used to store another program or data. Word is removed from your screen, and the operating system's user interface redisplay.

Step 4:

When you start a spreadsheet program such as Excel, the program loads into RAM from a hard disk. As you create a spreadsheet, it is in RAM and displays on your screen.



Step 5:

When you quit Excel, RAM may be used to store another program or data. Excel is removed from your screen and the operating system's user interface redisplay.



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Basic types of RAM

- Dynamic RAM (DRAM) must be refreshed (or recharged) constantly by the CPU.
- Static RAM (SRAM) is faster and more reliable than any form of DRAM. The term static refers to the fact that it does not have to be re-energized as often as DRAM.
- Magneto resistive RAM (MRAM), stores data using magnetic charges instead of electrical charges.
- MRAM has greater storage capacity, consumes less power, and has faster access times.
- Virtual RAM (VRAM): Modern operating systems can use spare storage space on the hard disk as if it is working memory and this is referred to as Virtual memory or Virtual RAM



Read-only memory (ROM)

- *Read-only memory (ROM) refers to memory chips storing permanent data and instructions. That is, the items stored in ROM*
- chips cannot be modified—then, the name read-only. ROM is usually nonvolatile. In ROM, the combination of circuit states is
- fixed, and therefore its contents are not lost if the power is removed. The data, instructions, or information stored on ROM
- chips often are recorded when the chip is manufactured. ROM chips that contain permanently written data, instructions, or
- information are called *firmware*. *Firmware can be read and used, but cannot be changed by user.*



Basic types of ROM

- *Programmable read only memory (PROM) is a blank ROM chip on which you can permanently place data and programs.*
- Once the data and instructions are programmed into PROM chip, the chip functions like a regular ROM and cannot be erased
- or changed. A variation of the PROM chip, called *electrically erasable programmable read-only memory (EEPROM) chip,*
- allows a programmer to erase the microcode with an electric signal.



Differences Between RAM and ROM

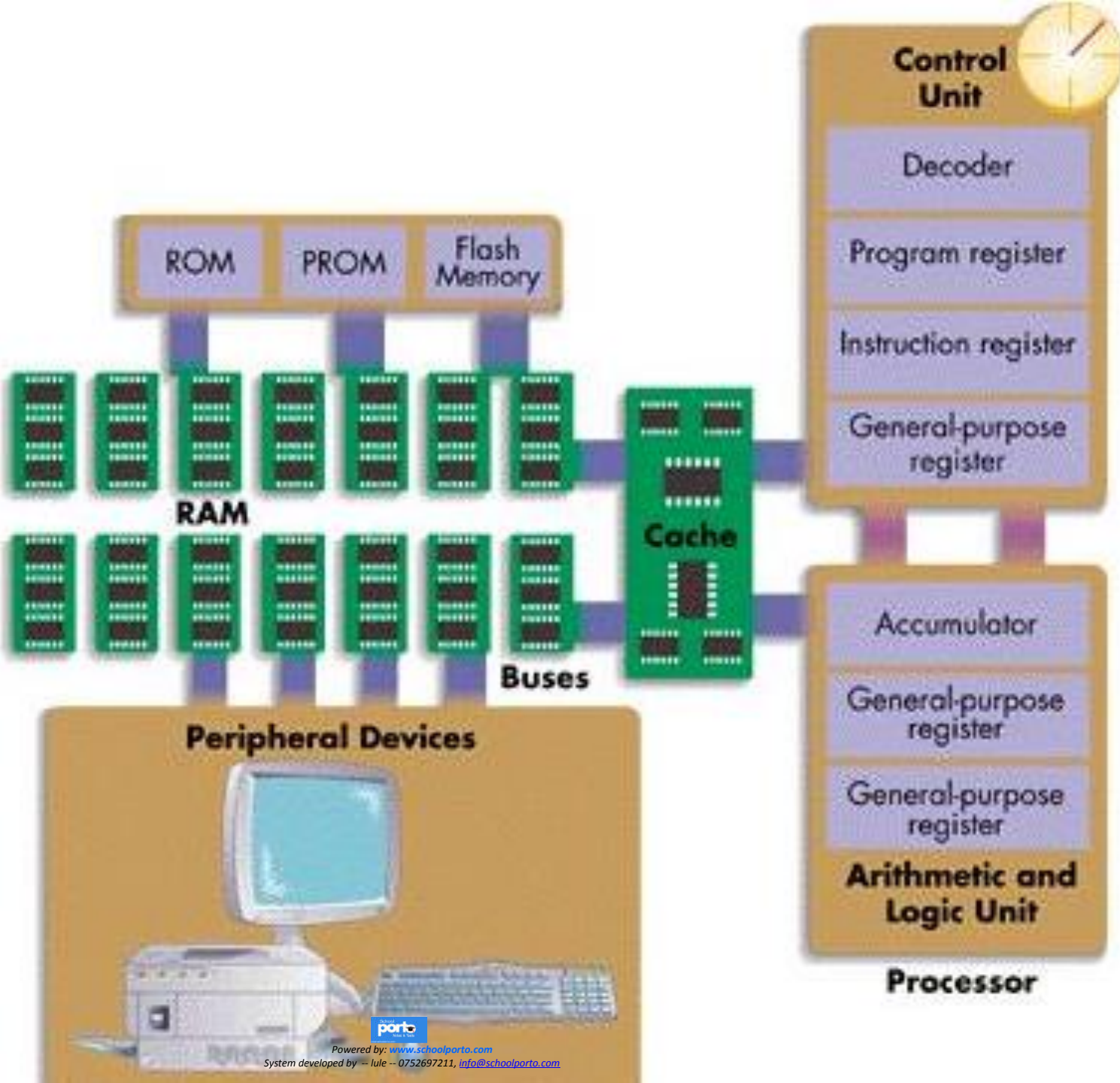
RAM	ROM
1. Volatile, temporally	1. Non Volatile, permanent
2. Contents lost when power goes off	2. Contents remain when power goes off
3. Read and Write	3. Read Only
4. Can be increased	4. Cant be Increased



Memory cache

- A cache is a relatively small block of very fast memory designed for the specific purpose of speeding up the internal transfer of data and software instructions.
- Cache uses internal storage technologies that are much faster than conventional RAM.
- Cache speeds up processing time because it stores frequently used instructions and data.

The processor first checks cache, then RAM for needed data and instruction.





Flash memory

- Flash memory is a chip also that keeps its contents when the power is shut off.
- Flash memory can be erased electronically and reprogrammed.
- Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents.

CMOS



- Complementary Metal-Oxide Semiconductor (CMOS) technology provides high speeds and consumes little power.
- CMOS technology uses battery power to retain information even when the power to the computer is off.
- Battery-backed CMOS memory chips, for example, can keep the calendar, date, and time current even when the computer is off.