INTRODUCTION TO INFORMATION & COMMUNICATION TECHNOLOGIES

(Computer Hardware, System Unit & its parts.)

Lecture # 04

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What is the system unit?

system unit

- Box-like case that houses the electronic components of the computer

System Unit

The main components of system unit are here under:

- Mother Board
- CPU
- Primary Memory
- Ports & connectors
- Expansion slots & Adaptor Cards
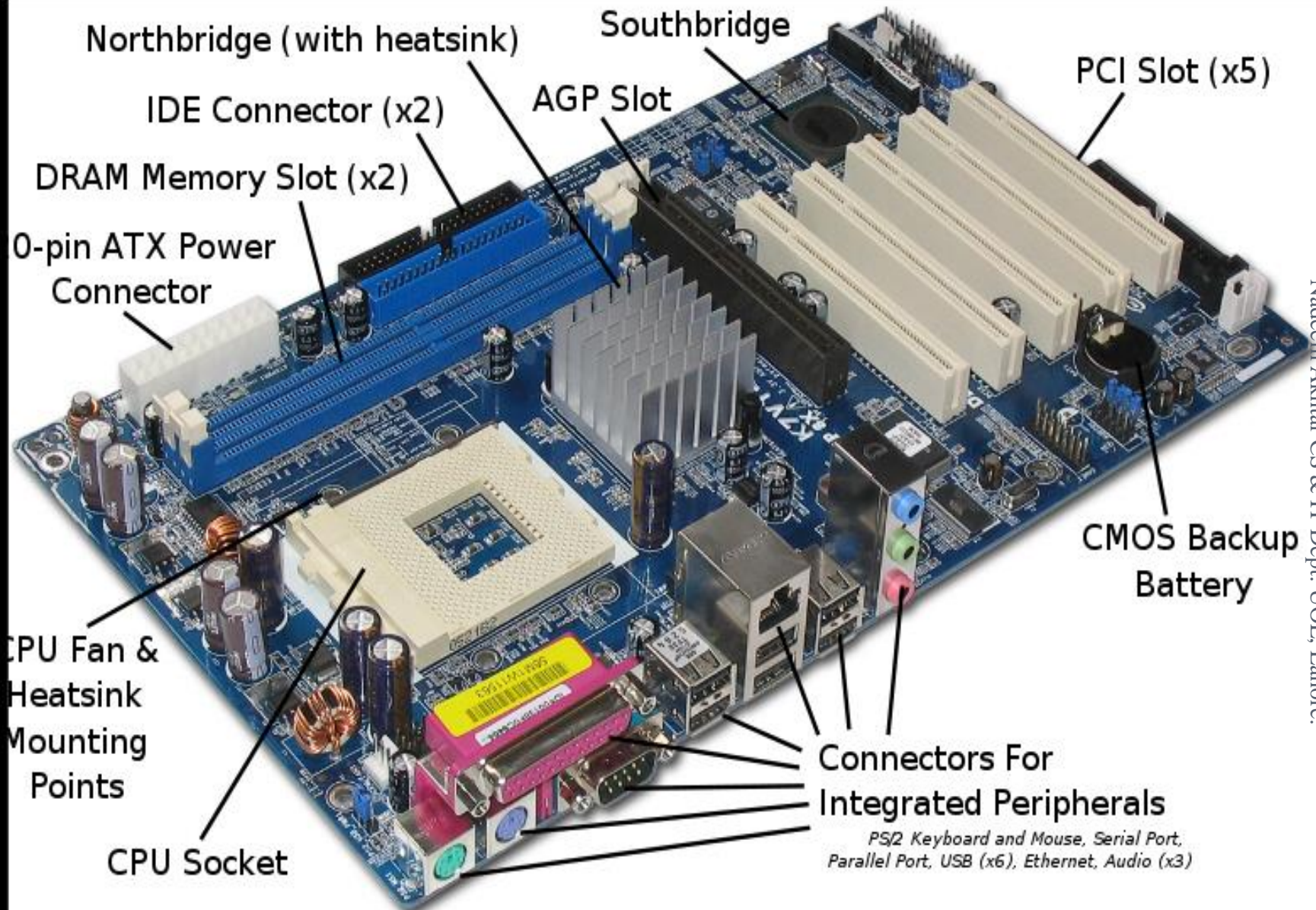- Buses
- Storage
- Power supply

THE SYSTEM UNIT

What are common components inside the system unit?

- Processor
- Processor
  - Memory module
  - Expansion cards
    - Sound card
    - Modem card
    - Video card
    - Network interface card
- Processor
- Memory module
- Expansion cards
  - Sound card
  - Modem card
  - Video card
  - Network interface card
- Ports and Connectors

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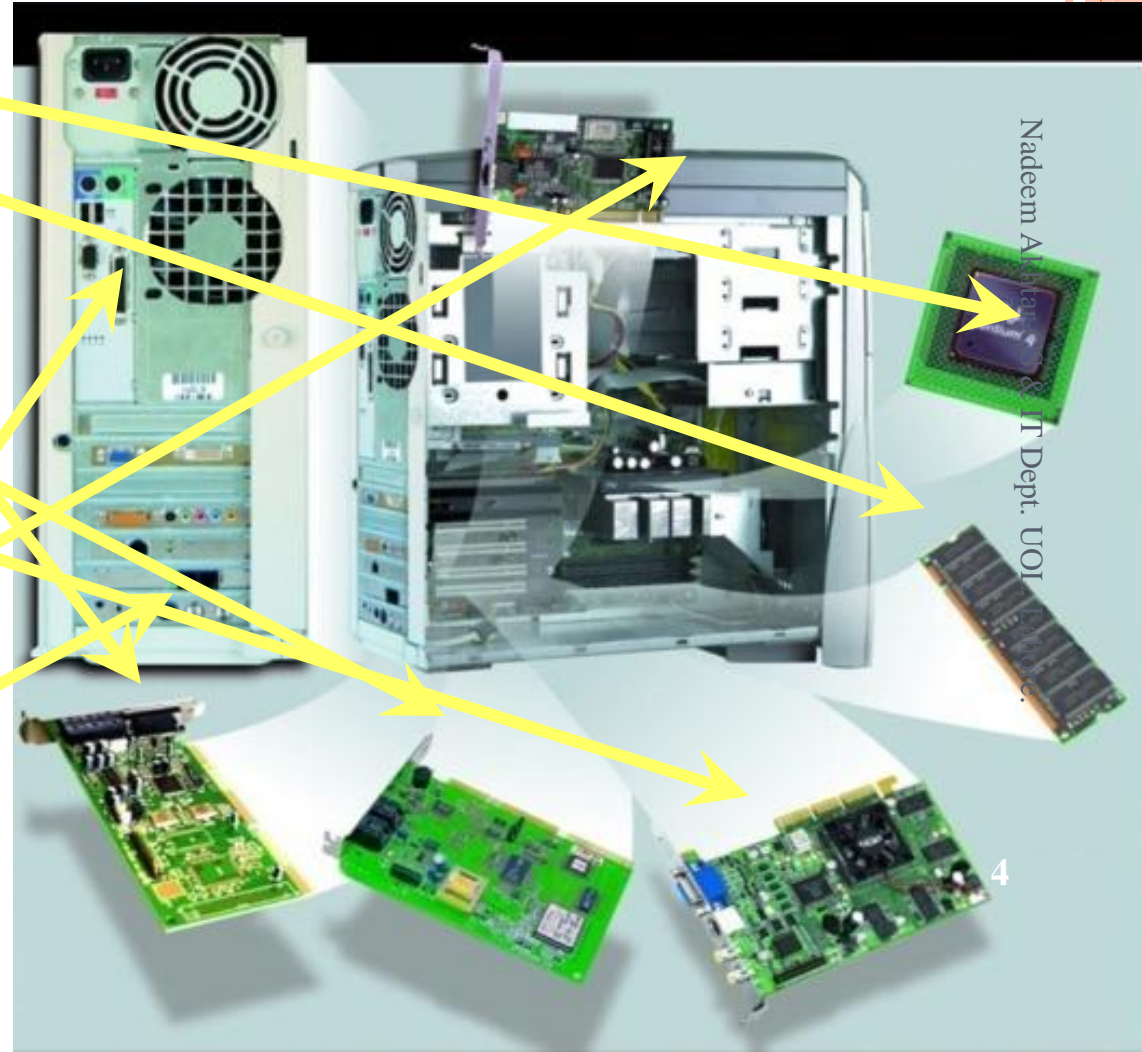
Mother Board

- It is the primary printed circuit board in a computer or other electronic device
- Main circuit board in system unit
  - ✓ Contains chips,
  - ✓ Integrated circuits,
  - ✓ and transistors
- Also called system board/Main board

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Northbridge (with heatsink)

Southbridge

PCI Slot (x5)

IDE Connector (x2)

AGP Slot

DRAM Memory Slot (x2)

0-pin ATX Power Connector

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CMOS Backup Battery

CPU Fan & Heatsink Mounting Points

Connectors For Integrated Peripherals

PS/2 Keyboard and Mouse, Serial Port, Parallel Port, USB (x6), Ethernet, Audio (x3)
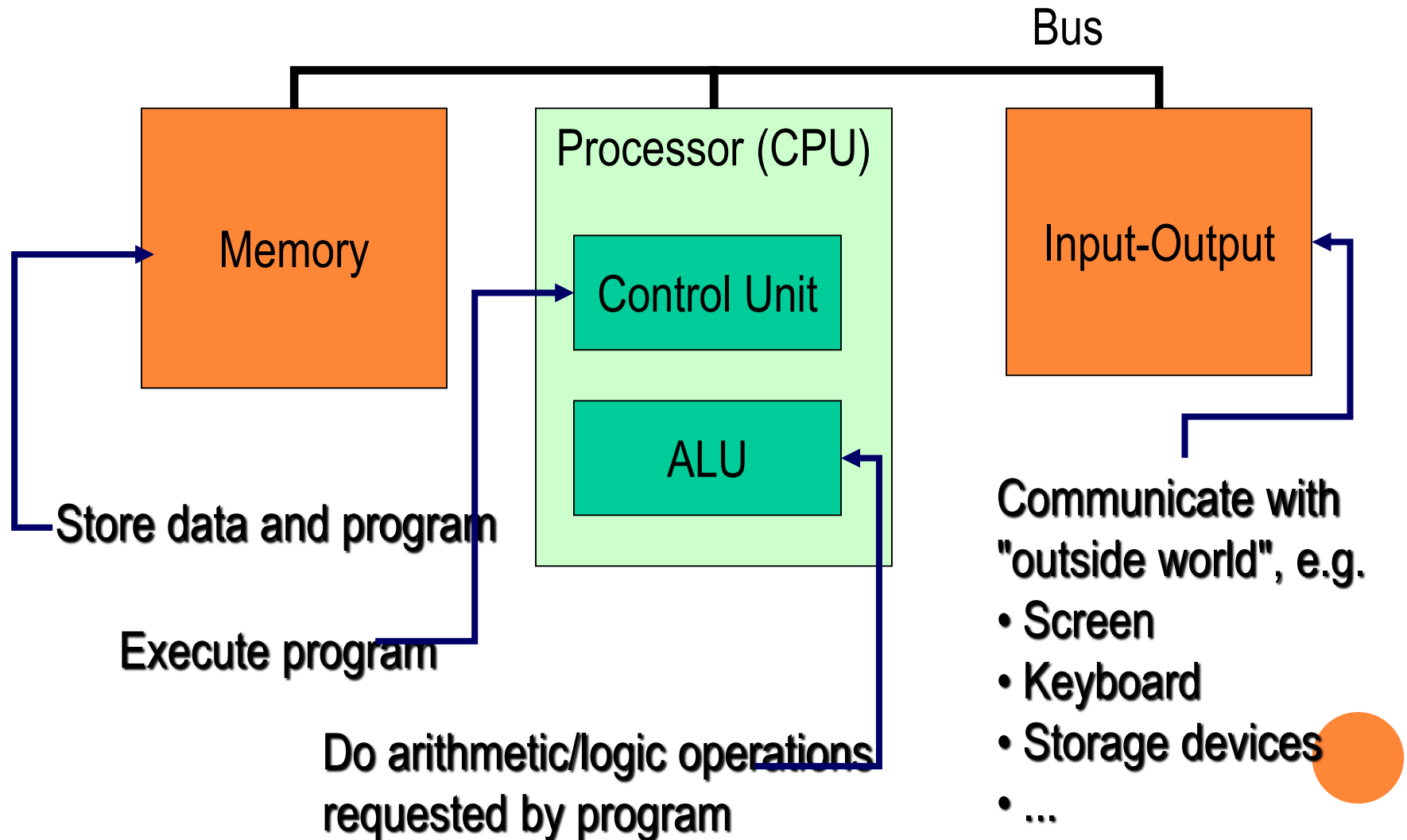
CPU Socket

The Von Neumann Architecture

➢Before discussing the CPU, memory and other system unit components let us introduce the **Von Neumann Architecture**

➢ All computers more or less based on the same basic design, the **Von Neumann Architecture**


Von Neumann Architecture

The Von Neumann Architecture

Bus

Memory

Processor (CPU)

Control Unit

ALU

Input-Output

Store data and program

Execute program

Do arithmetic/logic operations requested by program

Communicate with "outside world", e.g.
• Screen
• Keyboard
• Storage devices
• ...

CENTRAL PROCESSING UNIT

What is the central processing unit (CPU)?

- **Also called the processor it interprets and carries out the basic instructions that operate a computer**
- **Most devices communicate with the CPU in order to carry out a task**
- **This model of the typical digital computer is often called the von Neumann computer.**
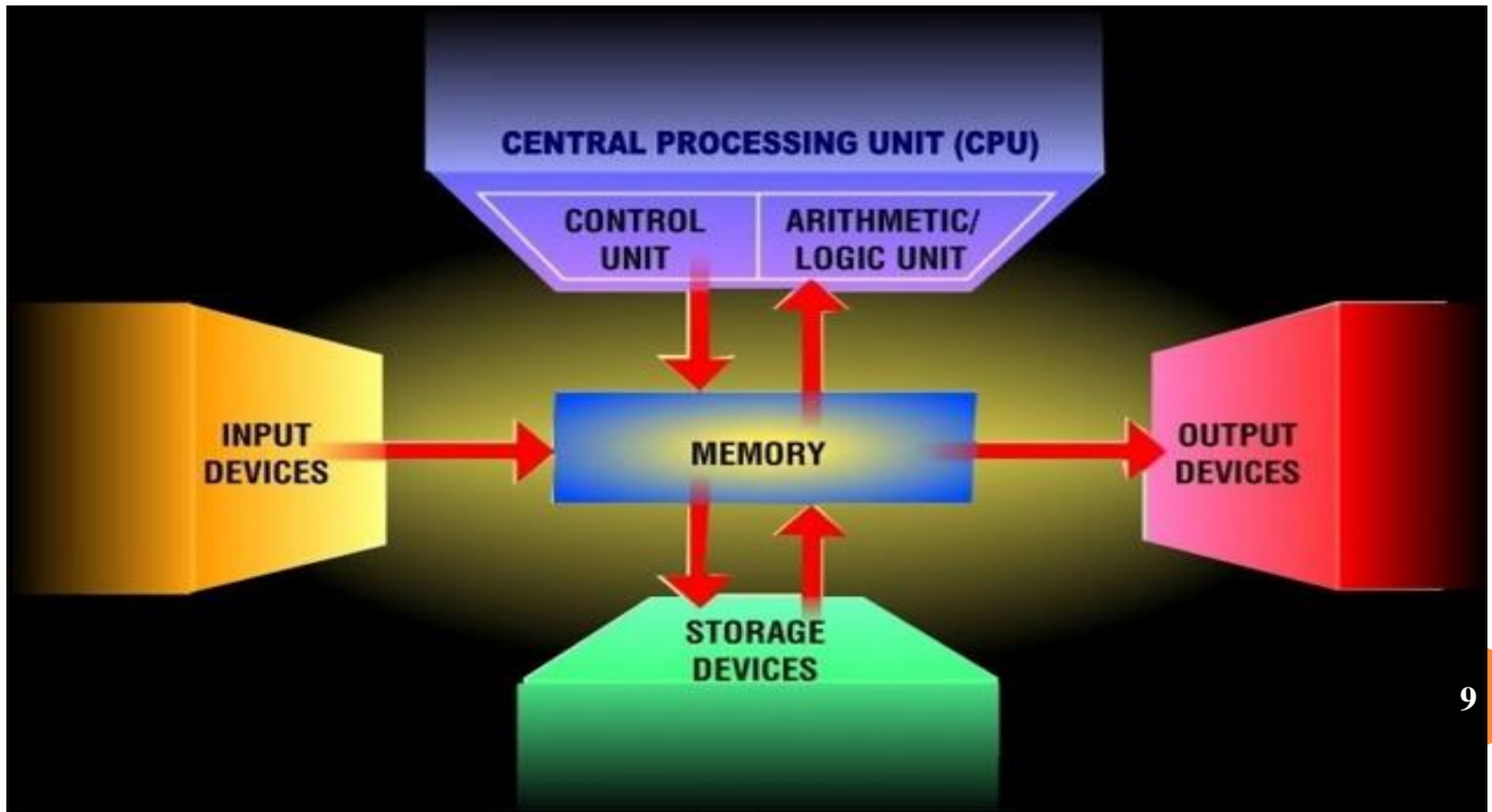
CENTRAL PROCESSING UNIT

What are the components of the central processing unit (CPU)?

The CPU consists of three main parts:

- The Control Unit - coordinates activities of the computer
- The Arithmetic Logic Unit (ALU) - performs the calculations
- Registers - store a small amount of data and instructions

CPU

Control Unit

Arithmetic/ Logic Unit (ALU)

Registers

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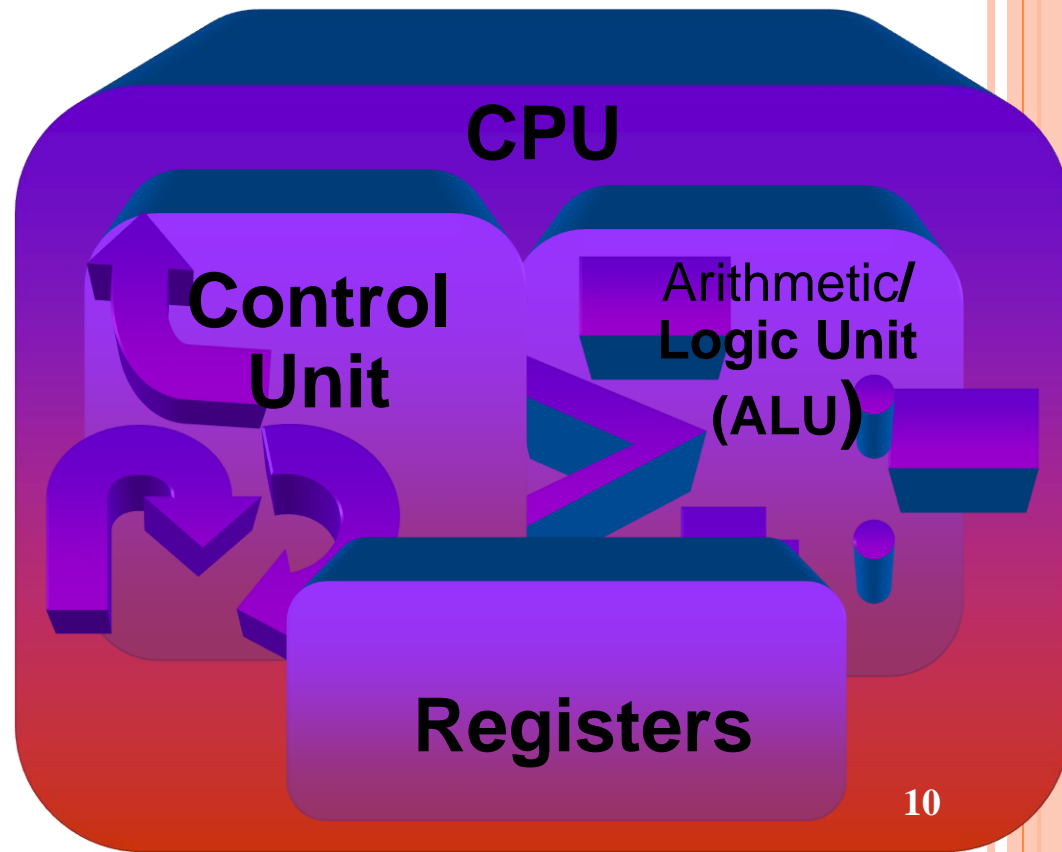
CENTRAL PROCESSING UNIT

What is the control unit?

Control Unit

✦ **Directs and coordinates most of the operations in the computer**

The control unit repeats a set of four basic operations:

✦ **Fetch – obtain a program instruction or data item from memory**

✦ *Decode - translate* **the instruction into commands**

✦ **Execute - carry out the command**

✦ **Store - write the result to memory**

CENTRAL PROCESSING UNIT

How is the speed of the CPU measured?
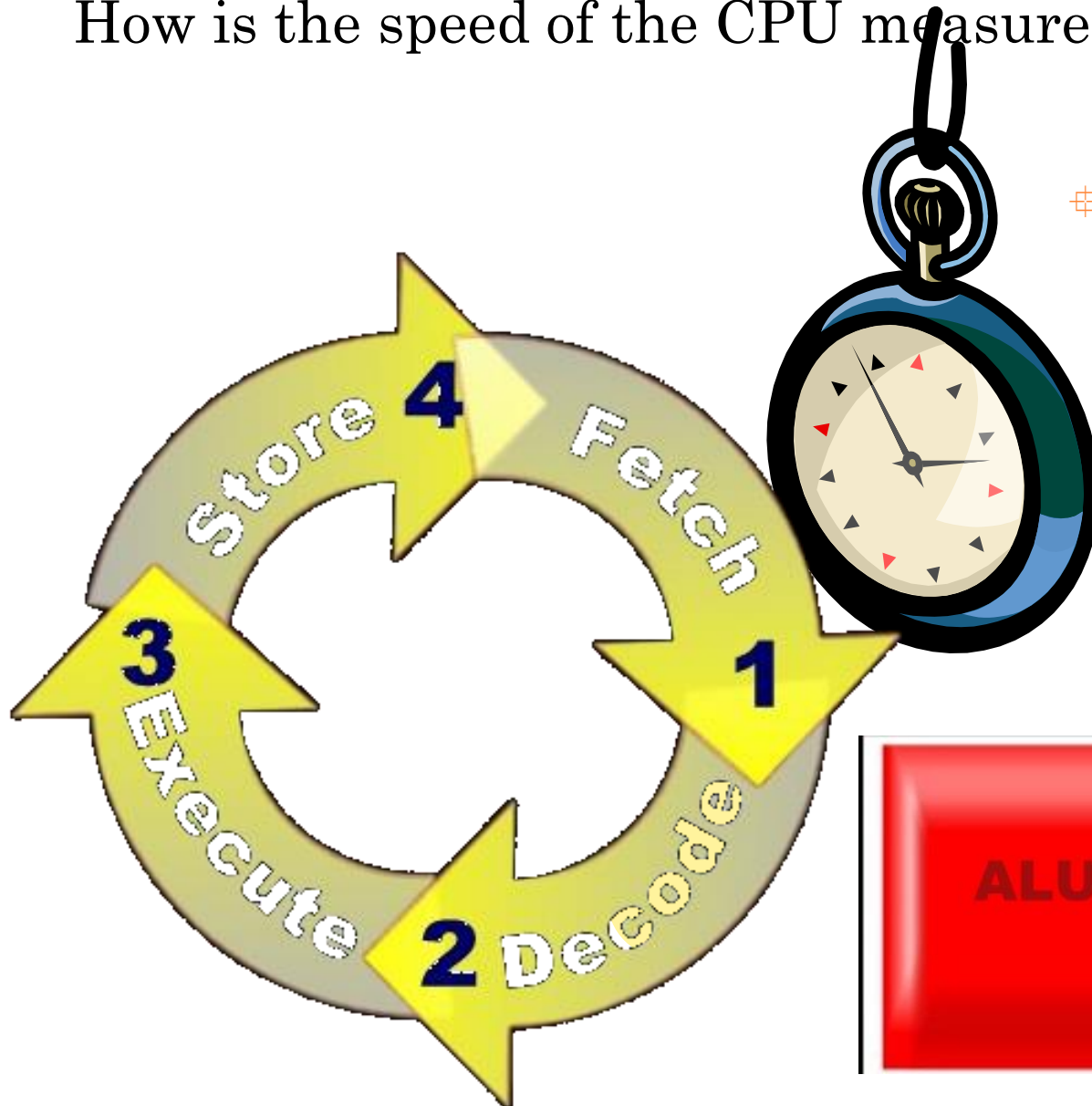
⊹ **According to how many millions of instructions per second (MIPS) it can process**

Store 4 Fetch

3 Execute

2 Decode

1

ALU C P U CONTROL UNIT
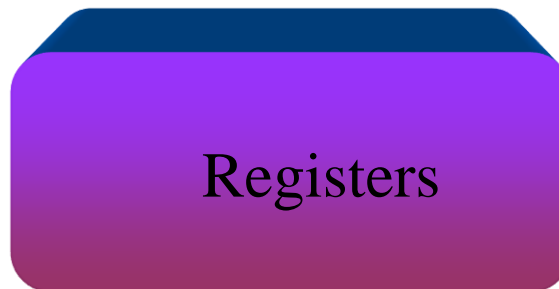
CENTRAL PROCESSING UNIT

What is the arithmetic/logic unit (ALU)?

- **Performs arithmetic, comparison, and logical operations**
- **Performs the execution part of the machine cycle**

Arithmetic/ Logic Unit (ALU)

.and.

.or.

not.

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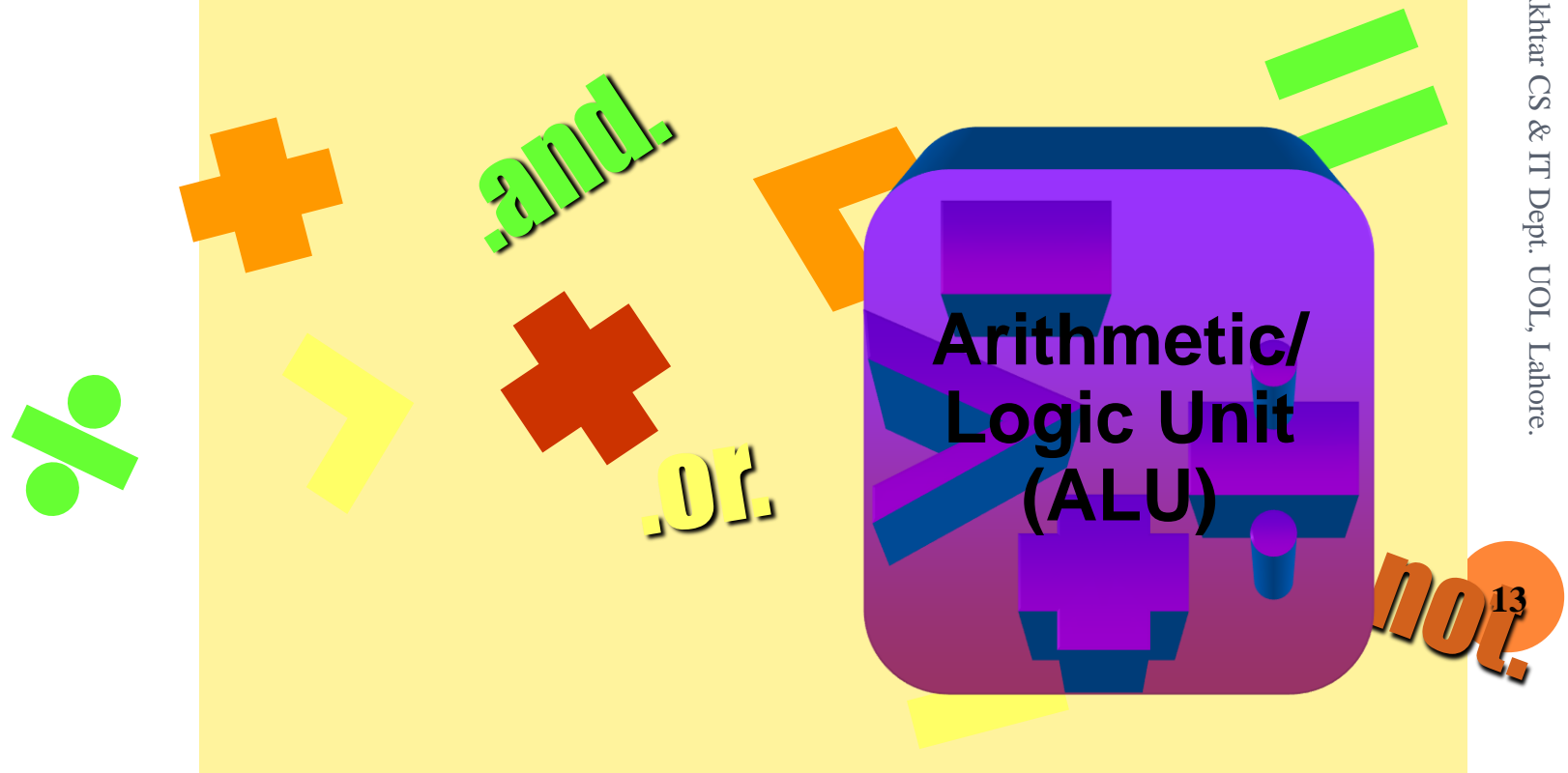
Registers

- A processor has its own memory inside it in the shape of small cells.

- Each memory cell is called a "Register".

- Registers are used to carry data temporarily for performing operations.

- 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 and instruction while the control unit decodes it, storing the data while the ALU computes it, and storing the results of a calculation
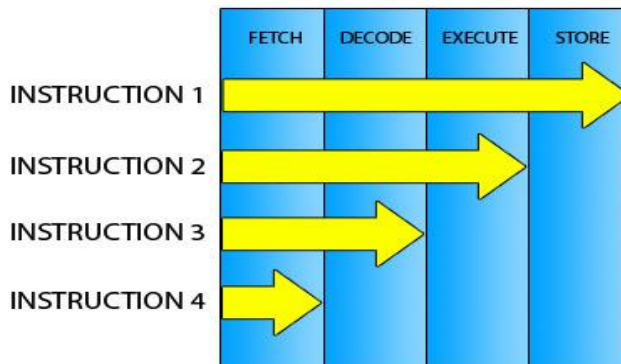
Registers

Pipelining ?

Processors starting from Intel Pentium 3 & 4 support Pipelining.

In some & obsolete computers, the CPU processes only one instruction at one time. i.e., the CPU waits until an instruction completes all four stages of the machine cycle before beginning work on the next instruction.

With Pipelining, the CPU begins executing a second instruction before it completes the first instruction. Pipelining results faster processing because the CPU does not have to wait for one instruction to complete


MACHINE CYCLE (without pipeline):

FETCH	DECODE	EXECUTE	STORE	FETCH	DECODE	EXECUTE	STORE

INSTRUCTION 1   INSTRUCTION 2

MACHINE CYCLE (with pipeline):

	FETCH	DECODE	EXECUTE	STORE
INSTRUCTION 1				
INSTRUCTION 2				
INSTRUCTION 3				
INSTRUCTION 4				

CENTRAL PROCESSING UNIT
What is a personal computer processor?

- **The single processor chip found in personal computers**

- **Sometimes called a microprocessor**

- **Processors identified by**
  - **Manufacturer**
  - **Model name or model number**

Pentium® 4

Athlon™

Celeron™

Duron™

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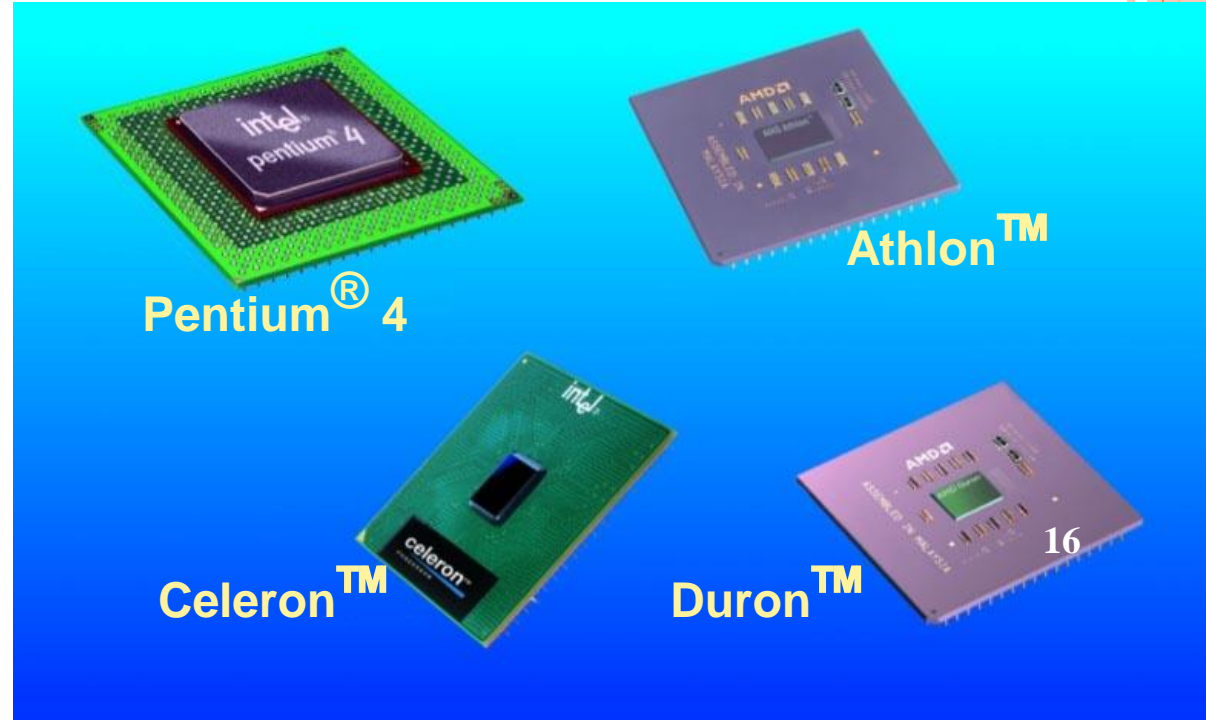
CENTRAL PROCESSING UNIT

Who are the personal computer processor manufacturers?

Intel

Pentium®

Pentium® II with MMX™

Celeron™

Xeon™

Itanium™

Used in PCs

AMD

(Intel-compatible)

Duron™

AMD-K6®

Athlon™ with 3DNow! ™

Used in PCs

Motorola

PowerPC

Used in Apples

Alpha

Used in workstations and high-end servers

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MEMORY

What is memory?

* **Temporary storage place for data, instructions, and information**
* **Consists of one or more chips on the motherboard or some other circuit board**

- **Bytes are the basic storage unit in memory**

- **Each byte is stored at a specific location in memory called an address**
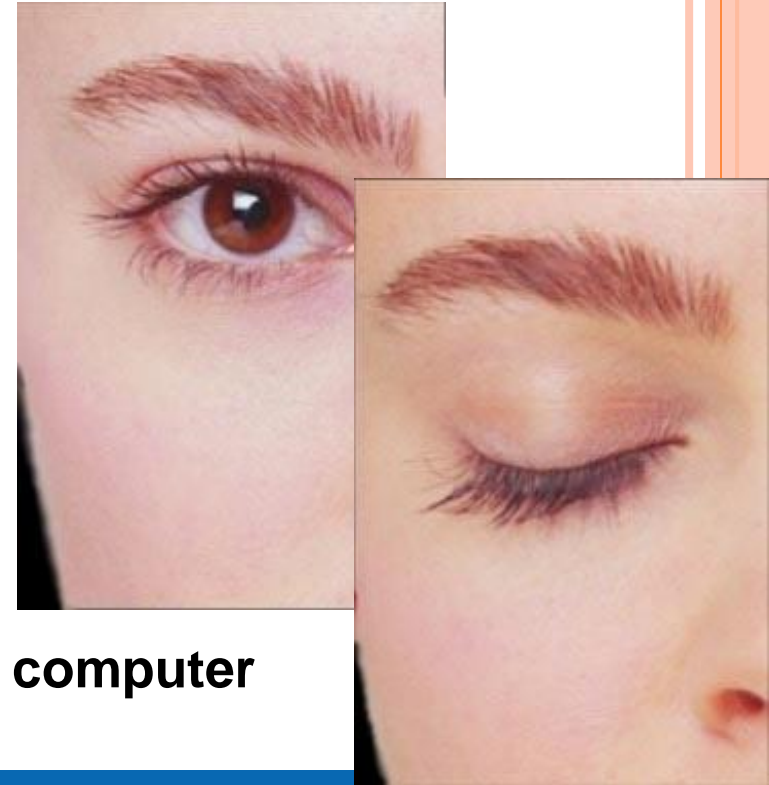
MEMORY

How is memory measured?

- **Size of memory is measured by the number of bytes available**
  - **Kilobyte - 1,024 bytes**
  - **Megabyte - one million bytes**

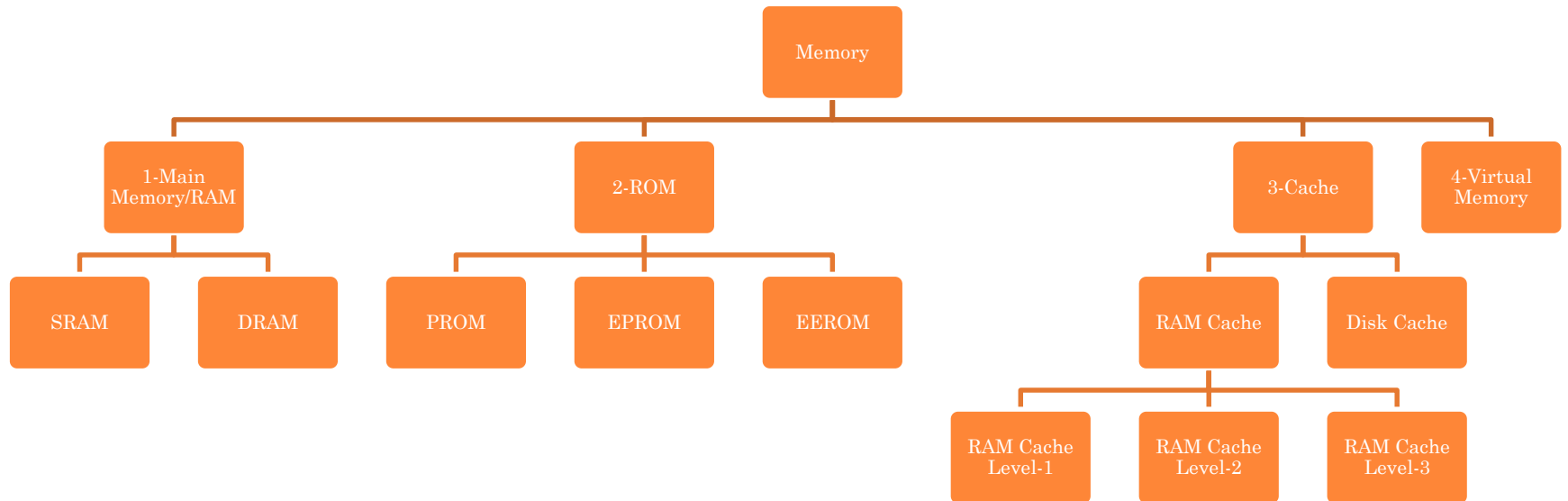| Term	Abbreviation	Approximate Memory Size	Exact Memory Amount	Approximate Number of Pages of Text
Kilobyte	KB or K	1 thousand bytes	1,024 bytes	1/2
Megabyte	MB	1 million bytes	1,048,576 bytes	500
Gigabyte	GB	1 billion bytes	1,073,741,824 bytes	500,000
Terabyte	TB	1 trillion bytes	1,099,511,627,776 bytes	500,000,000

MEMORY

What is memory access time?

* **Speed at which the processor can access data from memory directly**
* **Measured in fractions of a second called nanoseconds (ns) - one billionth of a second**
* **One blink of the eye is 100 million ns; a computer performs some operations in 10 ns**

TERM	ABBREVIATION	SPEED
Millisecond	ms	One-thousandth of a second
Microsecond	µs	One-millionth of a second
Nanosecond	ns	One-billionth of a second
Picosecond	ps	One-trillionth of a second

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MEMORY & ITS TYPES:

```
                              ┌──────────┐
                              │  Memory  │
                              └──────────┘
        ┌──────────────┬─────────────────────────┬──────────────┐
 ┌─────────────┐  ┌──────────┐          ┌──────────┐      ┌──────────┐
 │ 1-Main      │  │ 2-ROM    │          │ 3-Cache  │      │ 4-Virtual│
 │ Memory/RAM  │  └──────────┘          └──────────┘      │ Memory   │
 └─────────────┘                                          └──────────┘
   ┌─────┬─────┐   ┌──────┬──────┬──────┐      ┌──────────┬──────────┐
 ┌──────┐┌──────┐┌──────┐┌──────┐┌──────┐  ┌──────────┐┌──────────┐
 │ SRAM ││ DRAM ││ PROM ││EPROM ││EEROM │  │ RAM Cache││Disk Cache│
 └──────┘└──────┘└──────┘└──────┘└──────┘  └──────────┘└──────────┘
                                      ┌──────────┬──────────┬──────────┐
                                  ┌──────────┐┌──────────┐┌──────────┐
                                  │ RAM Cache││ RAM Cache││ RAM Cache│
                                  │ Level-1  ││ Level-2  ││ Level-3  │
                                  └──────────┘└──────────┘└──────────┘
```

1-Main Memory/RAM

What is random access memory (RAM)?

Memory chips that can be read from and written to by the processor and other devices

When the computer starts, operating system files are loaded from a hard disk into RAM

As additional programs and data are requested, they also load from storage into RAM

Loses its contents when the computer's power is turned off

RAM is volatile

1-Main Memory/RAM

There are two basic types of RAM:

1. **Static RAM (SRAM)**
2. **Dynamic RAM (DRAM)**

- <u>SRAM</u> is a type of memory that is faster and more reliable than the more common DRAM (dynamic RAM).

- The term *static* is derived from the fact that it doesn't need to be refreshed like dynamic RAM

- Access time around 10 nanoseconds (Note: a nanosecond is one billionth of a second)

- Both types of RAM are volatile, meaning that they lose their contents when the power is turned off.

DRAM

- Dynamic RAM needs to be refreshed thousands of times per second.
- The term dynamic indicates that the memory must be constantly refreshed or it will lose its contents.
- Contents are constantly refreshed 1000 times per second
- Access time 60 – 70 nanoseconds
- Dynamic RAM is slower than Static RAM.
- It requires less power and is less expensive.

- SDRAM (Synchronous Dynamic RAM) is much faster than DRAM because they are synchronized to system clock..

- DDR SDRAM (Double Date Rate SDRAM) are faster than SDRAM because they transfer data twice the system cycle.

- 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

- 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 in the gigahertz range. Giga is a prefix that stands for billion, and a *hertz* is one cycle per second. Thus, one **gigahertz**

  (GHz) equals one billion ticks of the system clock per second.

2- NONVOLATILE MEMORY / ROM

- Does not lose its contents when the computer's power is turned off

- Once data has been written onto a ROM chip, it cannot be removed and can only be read.

- Unlike main memory (RAM), ROM retains its contents even when the computer is turned off. ROM is referred to as being nonvolatile, whereas RAM is volatile

- Most personal computers contain a small amount of ROM that stores critical programs such as the program that boots the computer.

- In addition, ROMs are used extensively in calculators and peripheral devices such as laser printers, whose fonts are often stored in ROMs.

Read Only Memory(ROM)

- The contents of ROM are permanent for example BIOS which is a sequence of instructions the computer follows to lead the operating system & other files when you first turn on the computer.

- The content is written onto the ROM when it is first made.

- ROM keeps its contents even when the computer is turned off and so is known as **Non-Volatile Memory**.

Types of ROM

ROM is further divided in to three types

- PROM (Programmable Read-Only Memory)
- EPROM (Erasable Programmable Read-Only Memory)
- EEPROM (Electronically Erasable Programmable
  Read-Only Memory)

PROM

- A variation of a ROM is a PROM (programmable read-only memory). PROMs are manufactured as blank chips on which data can be written with a special device called a PROM programmer

- For this reason, developers created a type of ROM known as programmable read-only memory (PROM). Blank PROM chips can be bought inexpensively and coded by the user with a programmer.

EPROM

- Erasable programmable read-only memory (EPROM) addresses this issue. EPROM chips can be rewritten many times.

- Erasing an EPROM requires a special tool that emits a certain frequency of ultraviolet (UV) light.

- EPROMs are configured using an EPROM programmer that provides voltage at specified levels depending on the type of EPROM used.

- A rewritable memory chip that holds its content without power.

- EPROM chips are written on an external programming device before being placed on the mother board.

EEPROM

- The chip does not have to removed to be rewritten.
- The entire chip does not have to be completely erased to change a specific portion of it.
- Changing the contents does not require additional dedicated equipment.
- A rewritable memory chip that holds its content without power.
- EEPROMs are typically used on circuit boards to store small amounts of instructions and data.

3-CACHE MEMORY

What is memory cache?

- ⊞ **Helps speed the processes of the computer by storing frequently used instructions and data**

- ⊞ **When the processor needs an instruction or data, it first searches cache. If it cannot locate the item in cache, then it searches RAM.**

3-Cache

- A cache is a smaller, faster memory which stores copies of the data from the most frequently used main memory locations

- A cache is a component that transparently stores data so that future requests for that data can be served faster.

- The data that is stored within a cache might be values that have been computed earlier or duplicates of original values that are stored elsewhere.

3-CACHE:

Cache Memory is of two types:

(1)RAM Cache/ Memory Cache:

(a) Level-1 Primary cache or Internal Cache

is built directly into processor chip, has a small capacity ranging from 8 Kb to 64 Kb. Most common size is 16Kb.

Cache that is closest to the processor: typically located inside the CPU chip. Also referred to as primary cache or internal cache. often accessed in just a few cycles, usually tens of kilobytes

(b) Level-2 or External cache

Has much larger capacity, ranging from 64Kb to 4 Mb.

In older computers L 2 was not in processor, instead it was on separate chip on board. Current processors include "Advance Transfer Cache " a type of L 2 built directly on Processor chip.

- cache may be on chip or nearby (external)

- Cache that is second closest to the processor; typically located on the system board. Also referred to as secondary cache and external cache.

(c) Level-3 cache

If processor has L2 advance Transfer Cache , It also can use L3 cache. L3 cache is separate from the processor Chip on the mother board.
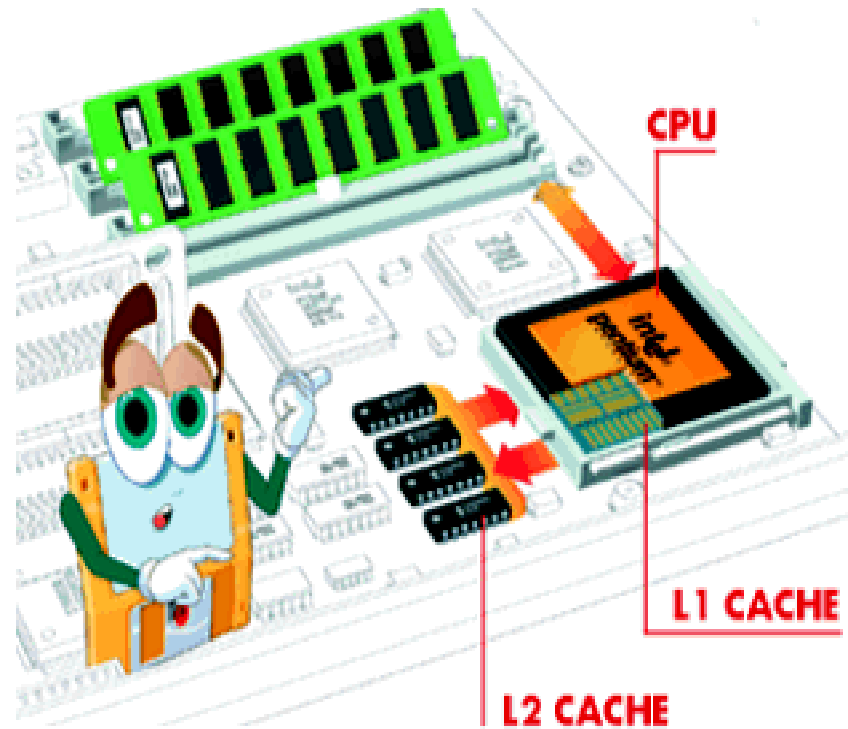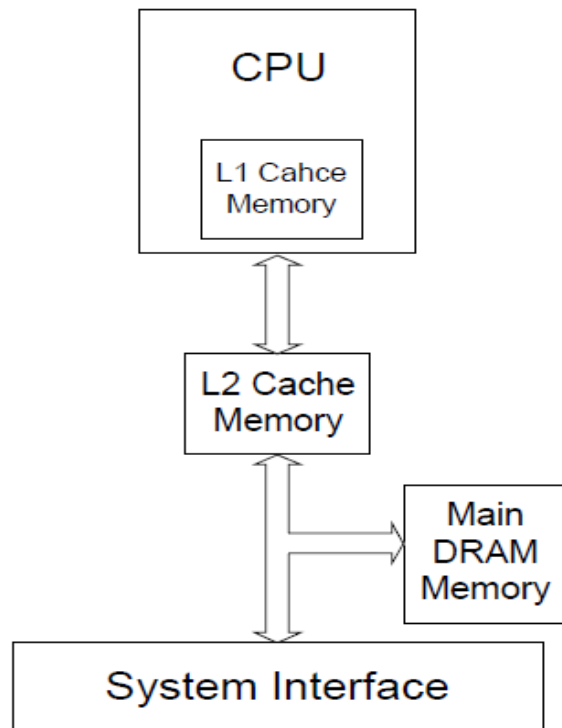
Note: when Processor needs an instruction or data it searches memory in this order: L1 Cache, then L2 Cache then L3 Cache (If it exists) , them RAM

(2) Disk Cache

The operation of cache memory

Main Memory (DRAM)

1. Cache fetches data from next to current addresses in main memory

2. CPU checks to see whether the next instruction it requires is in cache

Cache Memory (SRAM)

CPU

4. If not, the CPU has to fetch next instruction from main memory - a much slower process

3. If it is, then the instruction is fetched from the cache – a very fast position

= Bus connections
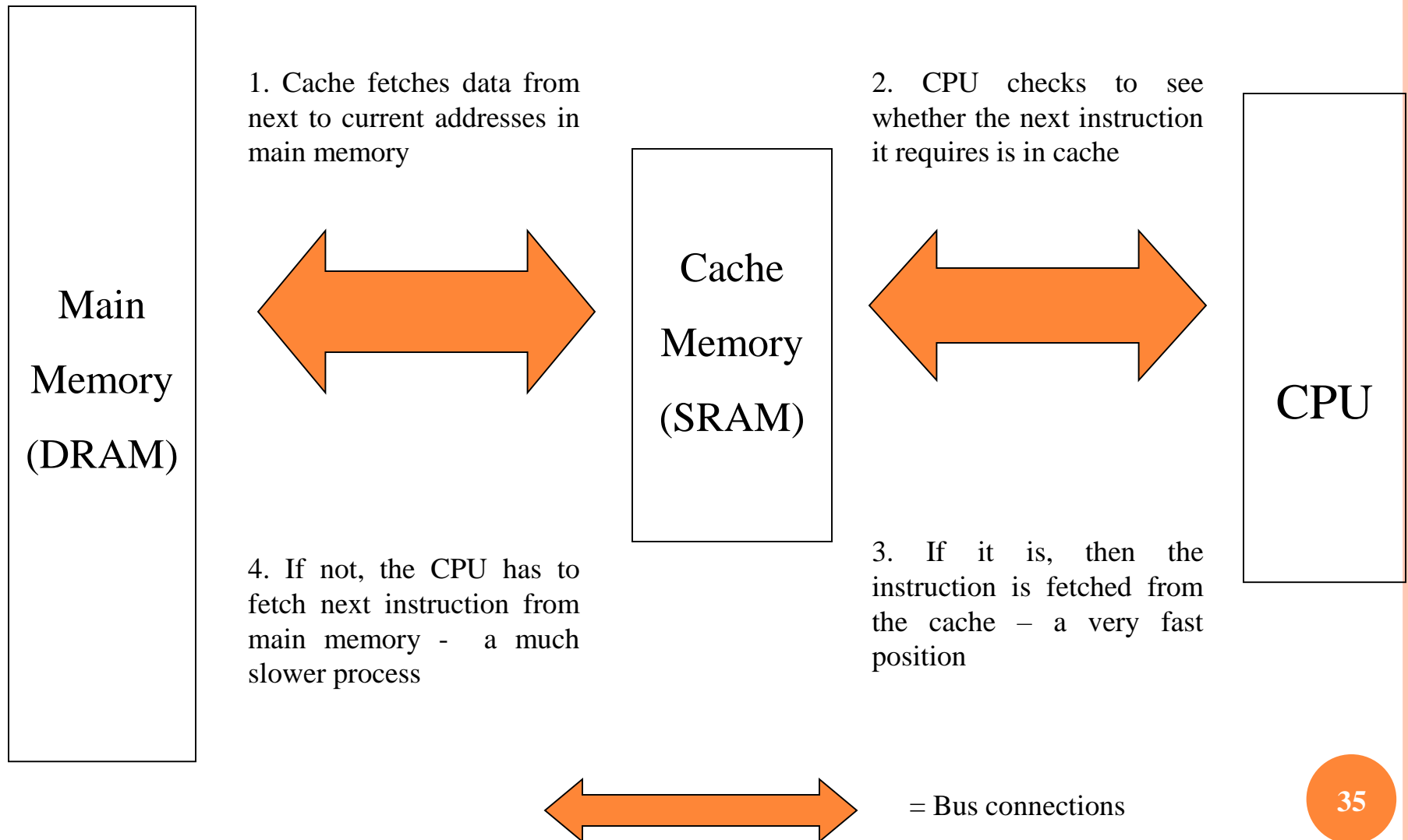
L2 Cache Structure

Cache Hits

- When the cache contains the information requested, the transaction is said to be a cache hit.

Cache Miss

- When the cache does not contain the information requested, the transaction is said to be a cache miss.

DISK CACHE:
What is a disk cache?

- A portion of memory that the processor uses to store frequently accessed items.

⊞ **A cache controller manages cache and thus determines which items cache should store**

processor

disk cache

hard disk

first request for data — to disk cache

second request for data — to hard disk

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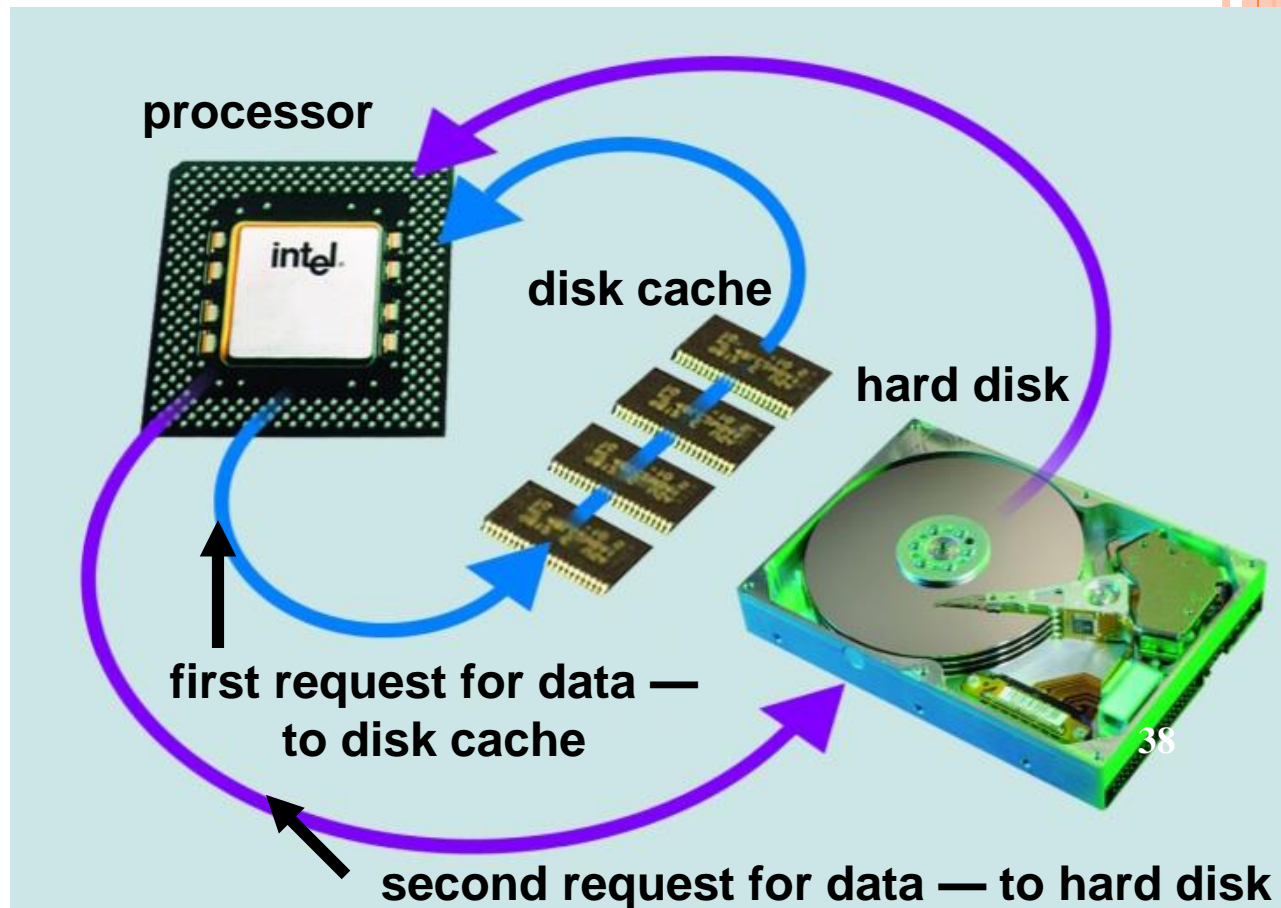
4-What is virtual memory (VM) management?

- The operating system allocates a portion of a storage medium, usually the hard disk, to function as additional RAM

Step 1: Operating system transfers least recently used data and program instructions to disk because memory is needed for other functions

Step 2: Operating system transfers data and program instructions from disk to memory when they are needed

page swapped out

disk (virtual memory)

RAM (physical memory)

page swapped in
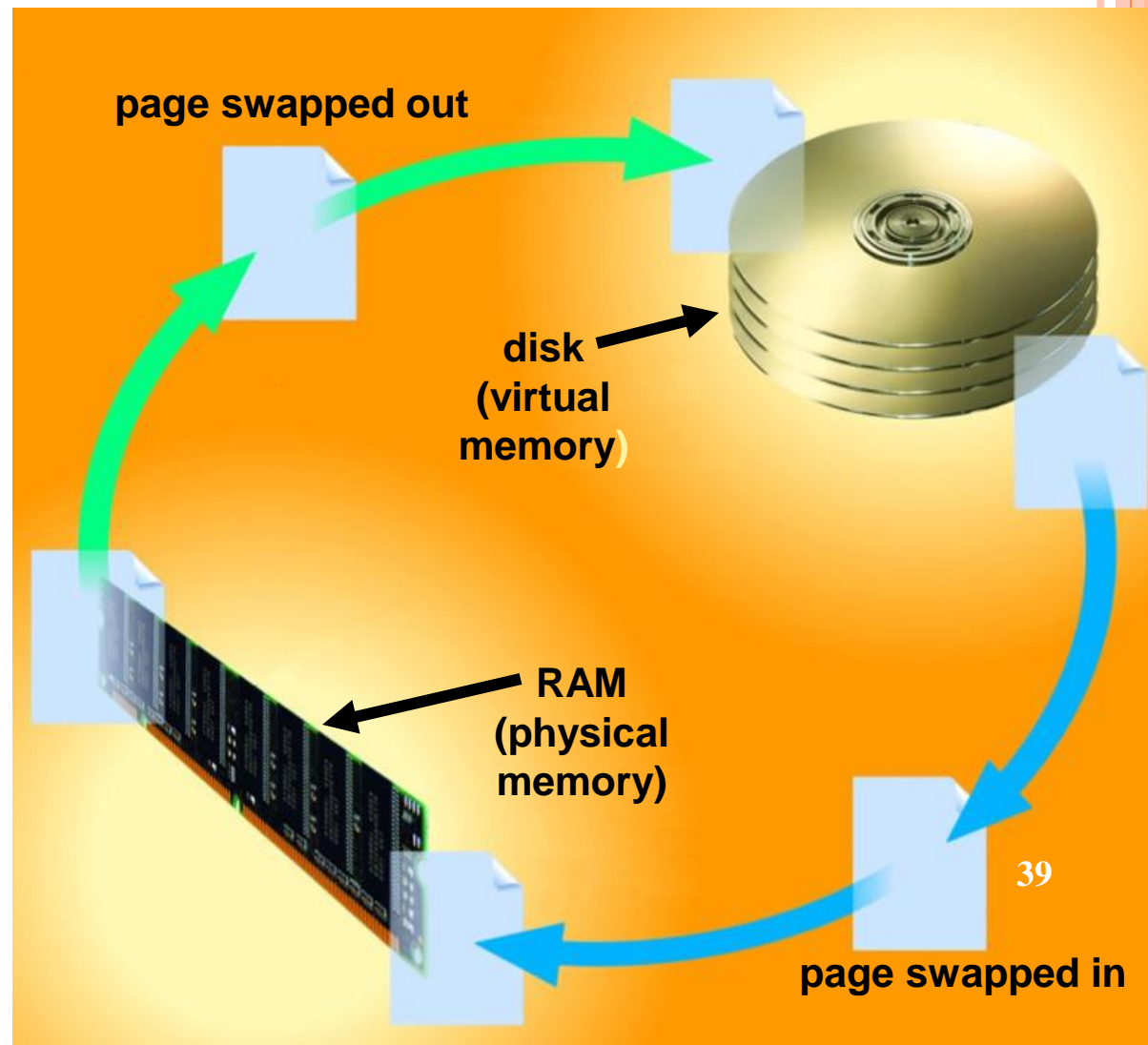
EXPANSION SLOTS AND EXPANSION CARDS

What is an expansion slot?

⊞ **An opening, or socket, where a circuit board can be inserted into the motherboard**

⊞ **Used to add new devices or capabilities to the computer**

EXPANSION SLOTS AND EXPANSION CARDS

What are four common types of expansion cards?

Video card also called video adapter or graphics card

Sound card

Network interface card (NIC) also called a network card

Modem card also called an internal modem

PORTS ?

What is a port?

- **Used to connect external devices to the system unit**
- **Port is the interface, or point of attachment, to the system unit**

keyboard

USB

serial port

monitor

game port

network

telephone line in

video out

mouse

USB

printer (parallel port)

speaker

microphone

telephone line out

FM reception

cable TV

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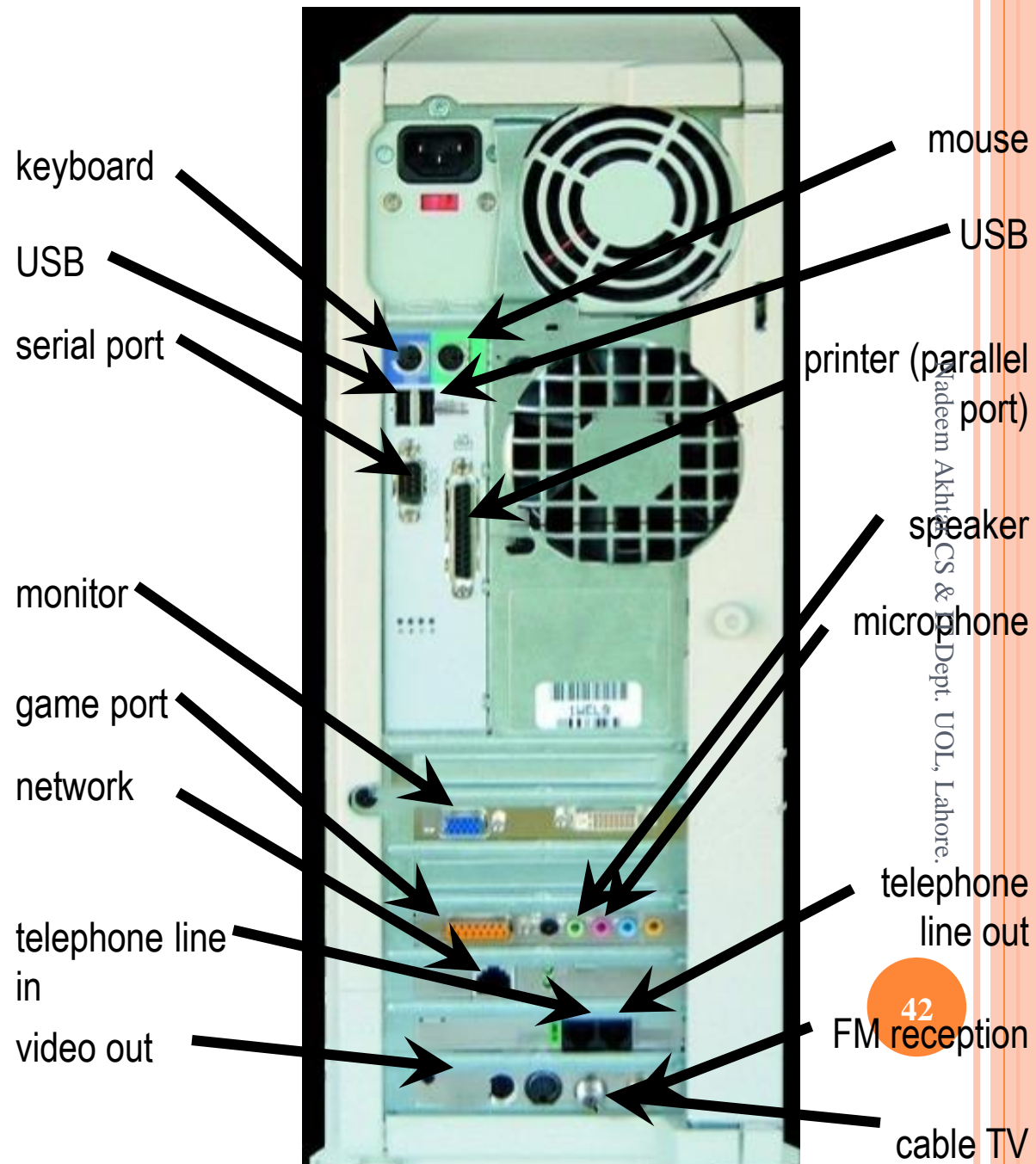
PORTS

What are Types of ports:

- Serial
- Parallel
- PS/2 Port
- KB-AT Port
- RGB Display Port
- Auxiliary Port
- USB Port
- Twin Pair Ethernet Port
- Coaxial Ethernet Port
- A/V Port

PORT TYPES:

What is a serial port?

- **Serial port are bi directional**
- **connecting devices such as Digital Cameras or PALM Host**
- **Syncs sent one bit after another with some extra bits like start bit, stop bit and parity bit to detect errors**
- **Connect devices that do not require fast transmission rates**
  - **mouse**
  - **Keyboard**
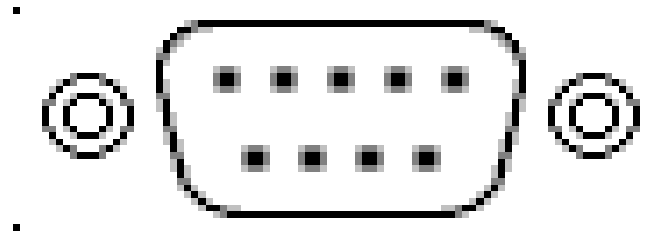
PORT TYPES:

What is a Parallel port

- **But in parallel port, all the 8 bits of a byte will be sent to the port at a time and a indication will be sent in another line**
- **Used to connect Printers and Scanners to the computer**
- **Connects devices that can transfer more than one bit at a time**
- **Usually used for printers**
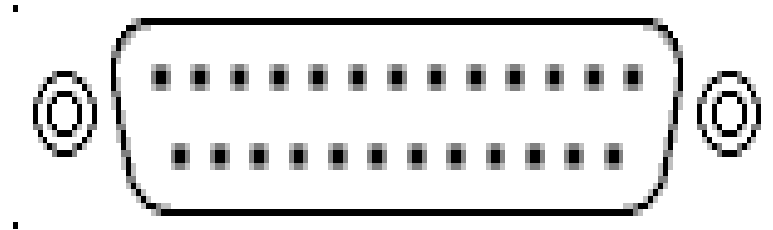
Port Types:

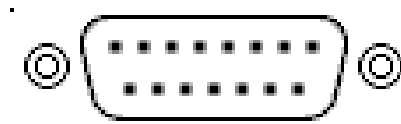## KB-AT Port

USED TO CONNECT OLDER STYLE KEYBOARDS TO THE COMPUTER

RGB Display Port

- USED TO THE MONITOR TO THE COMPUTER
- (RGB STANDS FOR RED/GREEN/BLUE)
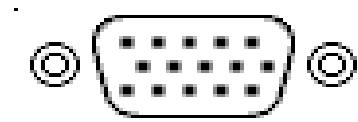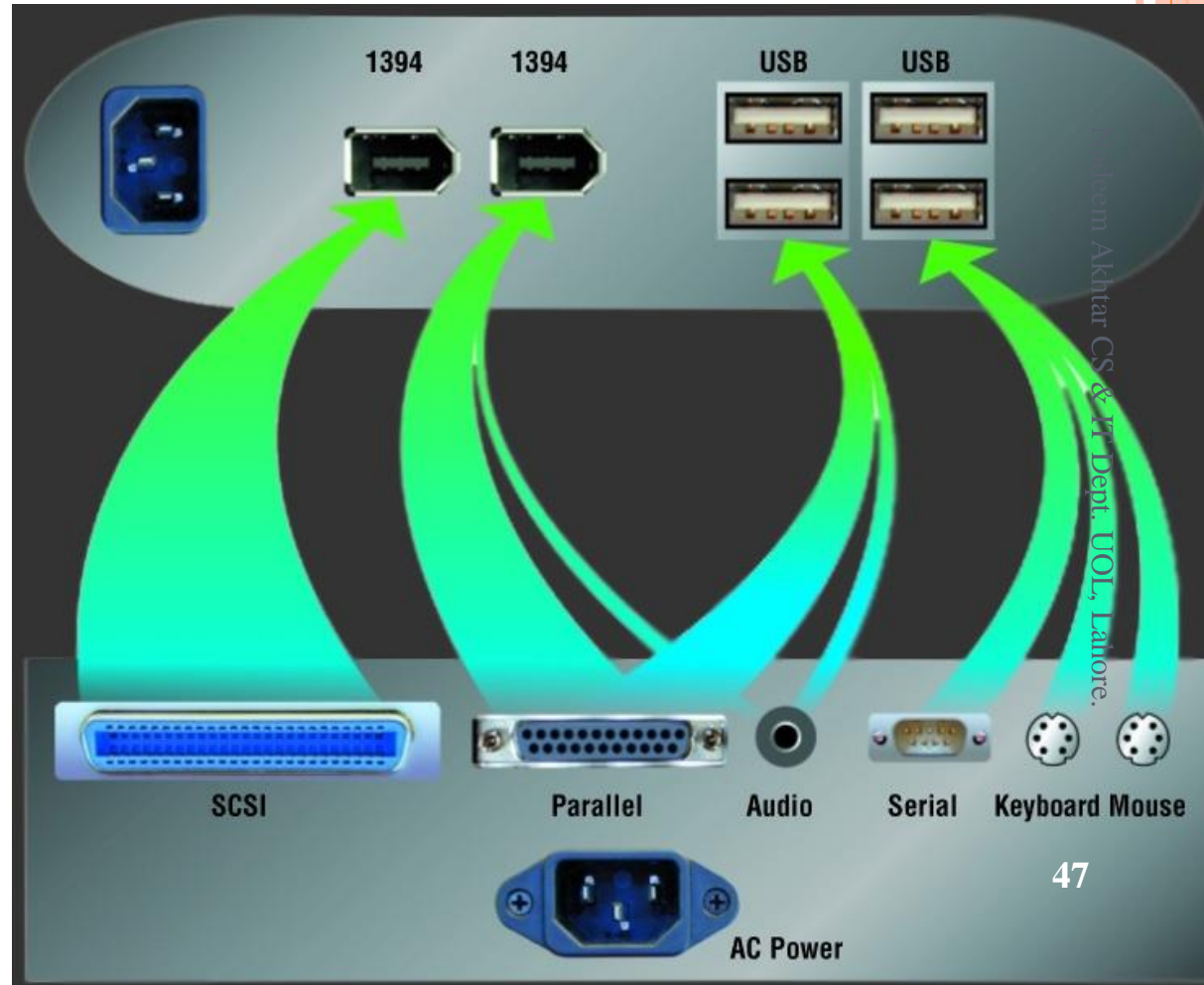
AUXILIARY PORT

USED TO CONNECT JOYSTICKS, GAME CONTROLLERS, AND MIDIS (MUSICAL INSTRUMENT DATA INTERFACE) TO THE COMPUTER

PORTS

What is a universal serial bus port (USB)?

- **Can connect up to 127 different peripheral devices with a single connector type**
- **Supports newer peripherals**
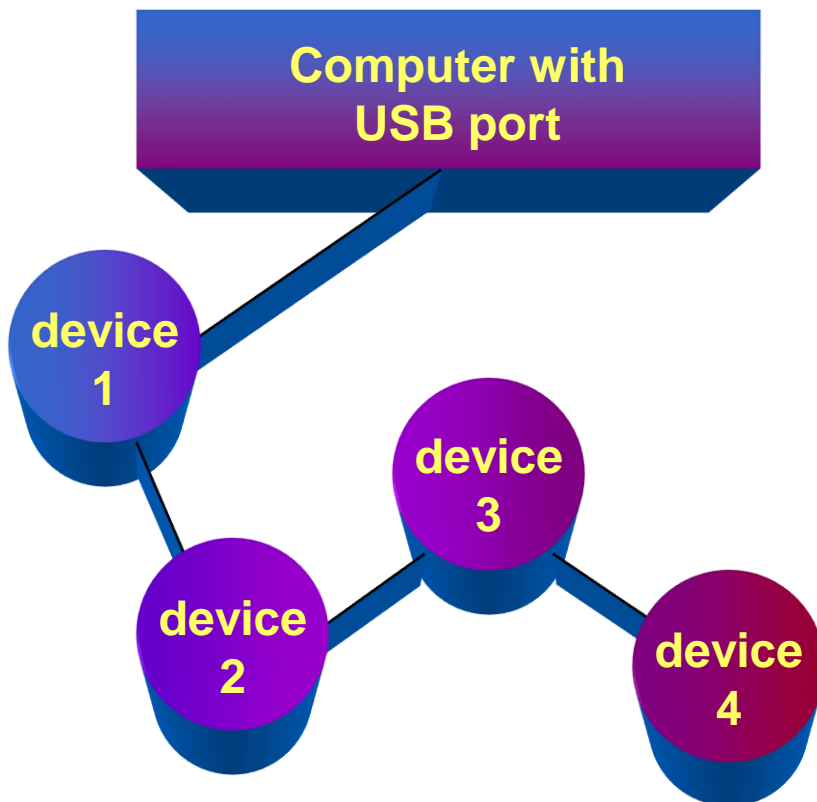- **Supports hot plugging and Plug and Play**

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PORTS
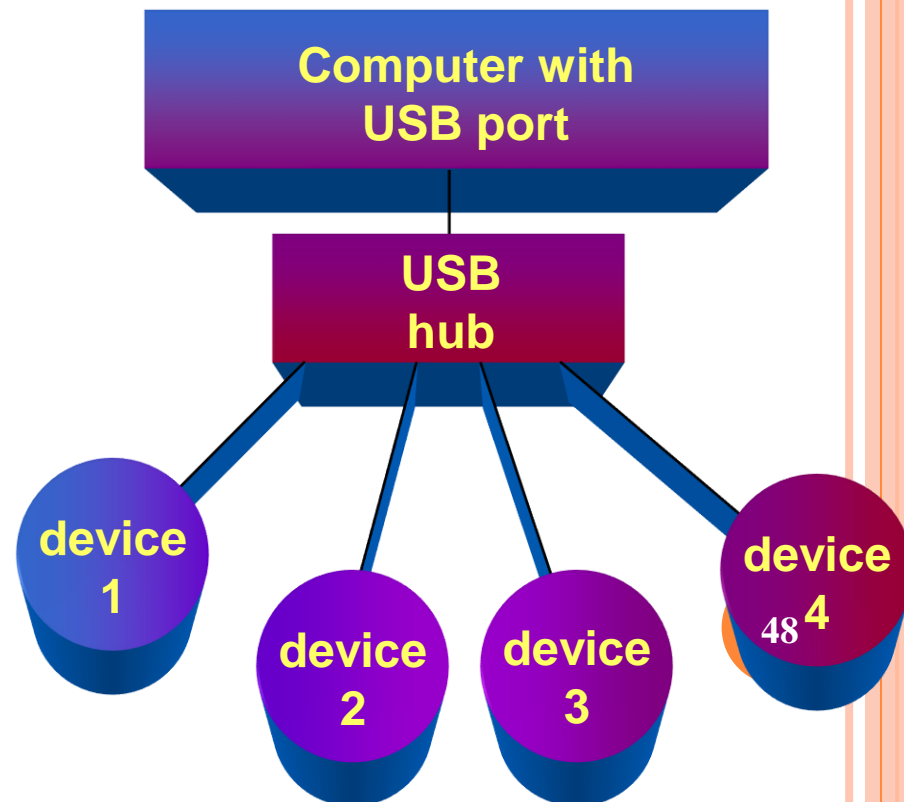
How are multiple USB devices connected?

Daisy Chain

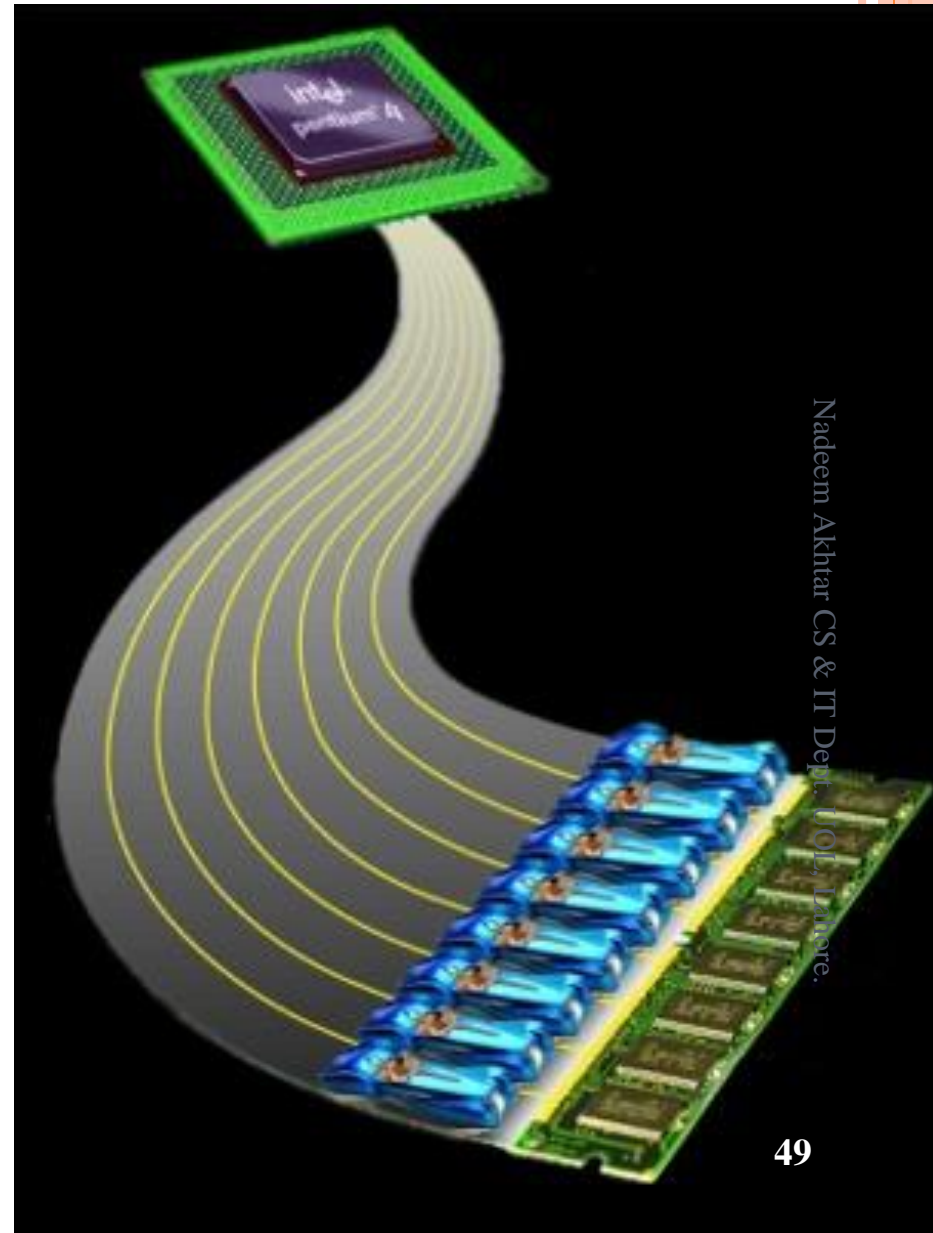- **Devices connected together outside the system unit in a chain**

USB hub

- **Plugs into the USB port on the computer**
- **Contains multiple USB ports**

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BUSES

What is a bus?

- **Electrical channels that allow various devices inside the computer to communicate with each other**
- **Bus width determines the number of bits transmitted at one time**

Buses

- In computer architecture, a **bus** is a subsystem that transfers data between components inside a computer, or between computers

Types of Buses

- System bus
- Expansion bus

System Bus

- System bus connects processor and RAM. It is also called internal bus.
- it is subdivided in to two types:
1. Address bus
2. Data bus

1-ADDRESS BUS

The address bus is a unidirectional pathway that carries addresses generated by the microprocessor to the memory.

2-DATA BUS

- In contrast to the address bus, the data bus is bi-directional in nature.
- Data flows along the data bus from the microprocessor to memory during a Write operation.
- Conversely, data moves from memory to the microprocessor during a Read operation.

Power Supply

- It supply electric supply to all components of system unit.
- It Converts alternating current (AC) to direct current (DC).

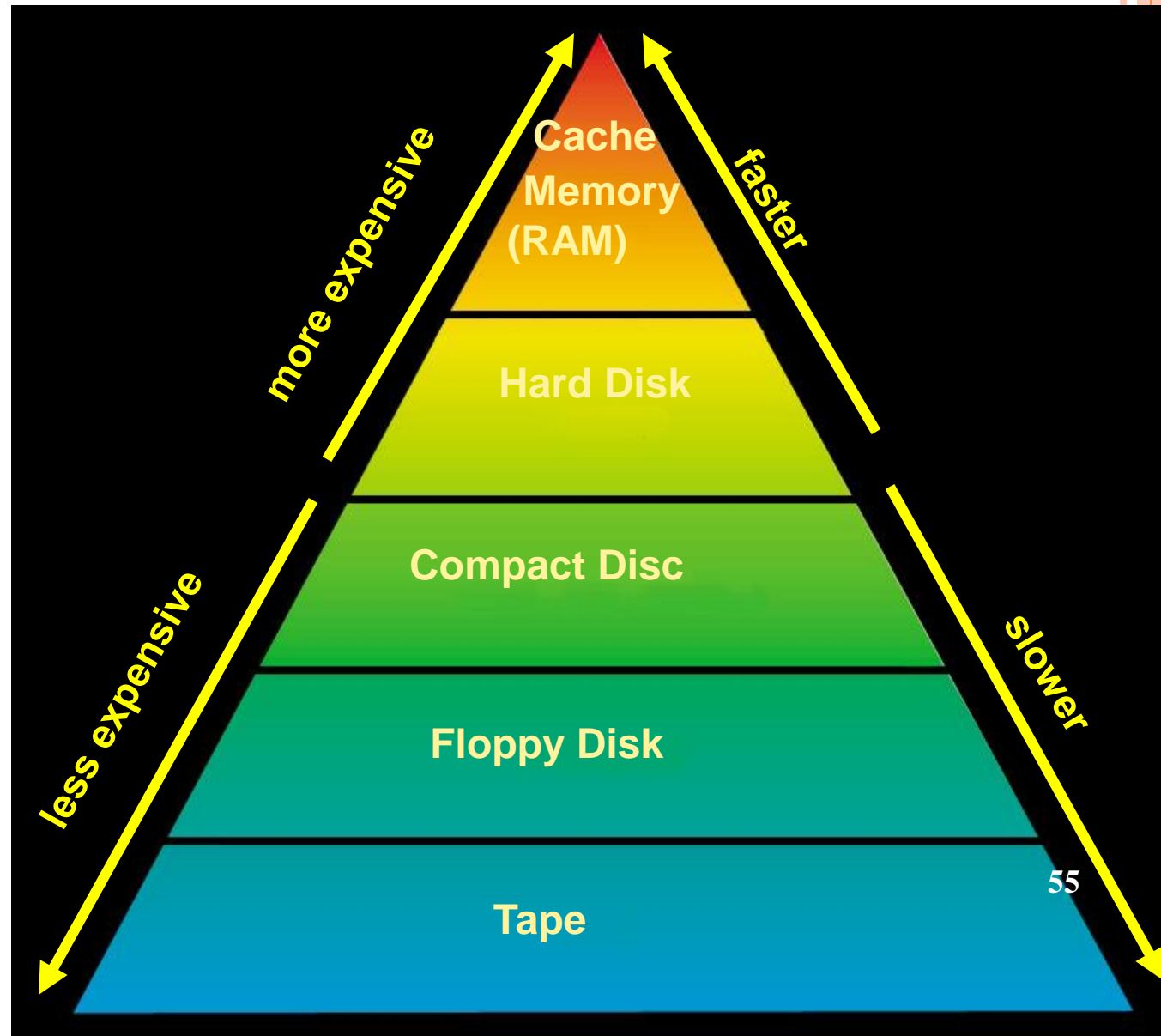# Storage
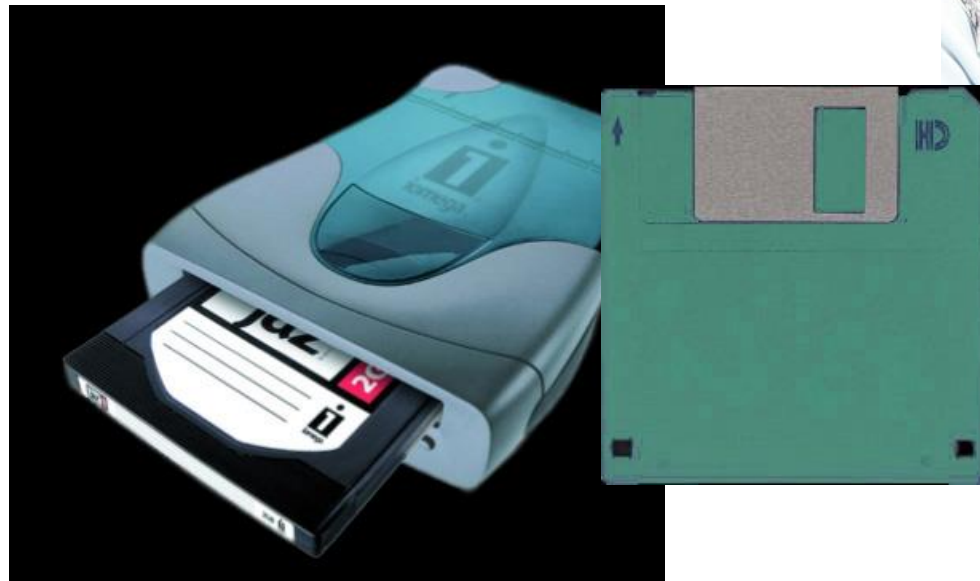
Memory Versus Storage

What is storage?

- The media on which data, instructions, and information are kept, as well as the devices that record and retrieve these items

Storage

Next

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MEMORY VERSUS STORAGE
What is access time?

- The amount of time it takes the device to locate an item on a disk
- Defines the speed of a disk storage device

more expensive

less expensive

faster

slower

Cache Memory (RAM)

Hard Disk

Compact Disc

Floppy Disk

Tape

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Next

p. 7.4 Fig. 7-4

ACCESS TYPES

What is sequential access vs. direct access?

Sequential access

Method used for tape

Reading and writing data consecutively

You must forward or rewind the tape to a specific point to access a specific piece of data

Much slower

Utilized most often for long-term storage and backup

Direct access

Method used for floppy disks, hard disks, and compact discs

Also called random access

You can locate a particular data item or file immediately, without having to move consecutively through items stored in front of the desired data item or file

Faster

Used as the primary method of storage

HARD DISKS

Hard disk installed in system unit

- Consists of several inflexible, circular platters that store items electronically

- Also called a hard disk drive or a fixed disk

Nadeem Akhtar CS & IT Dept. UOL, Lahore.

Hard Disks

What is a removable hard disk?

- A disk drive in which a plastic or metal case surrounds the hard disk so you can remove it from the drive
- A popular, reasonably priced, removable hard disk is the Jaz® disk by Iomega
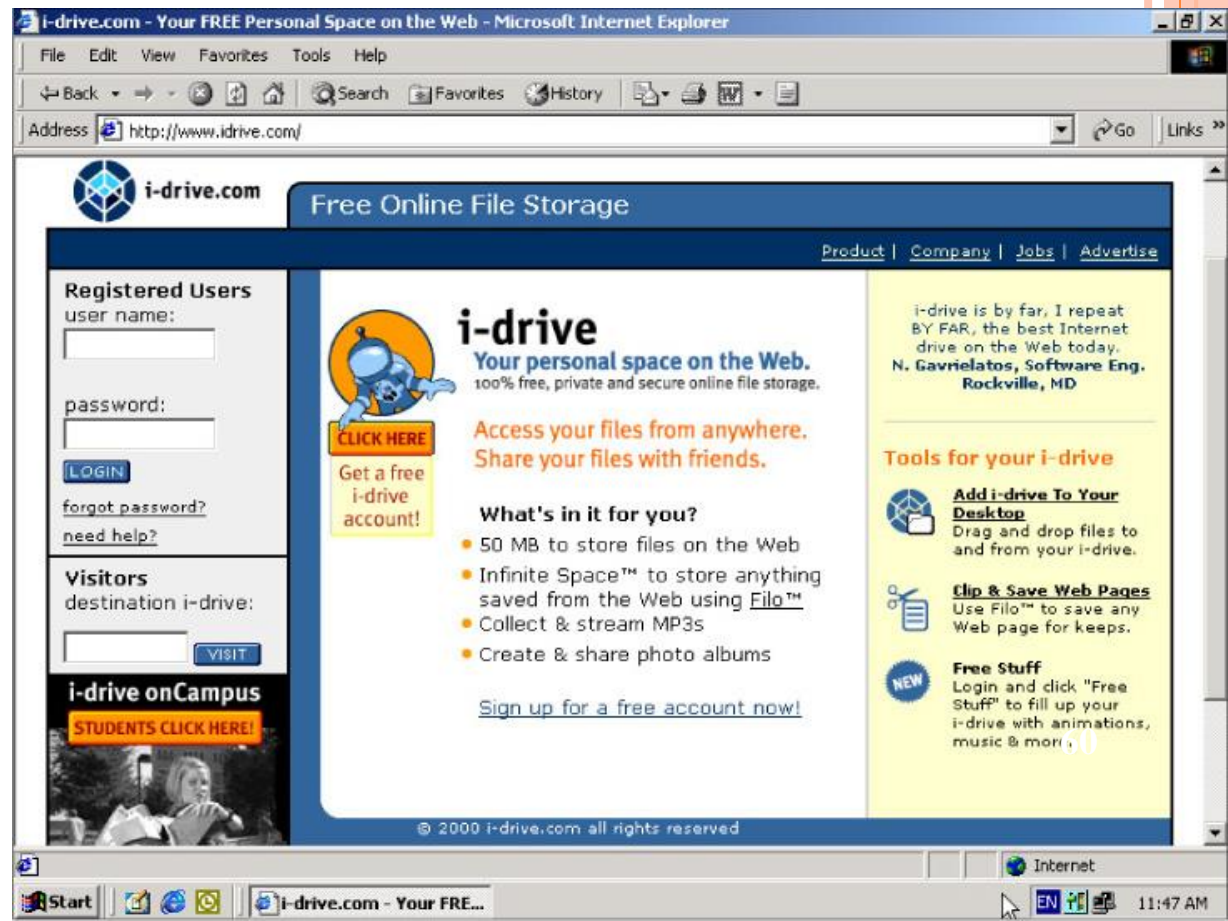
HARD DISKS

What is RAID?

- Redundant array of independent disks
- A type of hard disk system that connects several smaller disks into a single unit that acts like a single large hard disk
- More reliable than a traditional disk system but quite expensive

Next

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HARD DISKS

What is an Internet hard drive?

- A service on the Web that provides storage to computer users
- Sometimes called online storage
- Many offer storage free of charge
- Revenues come from advertisers

HARD DISKS
What are advantages of an Internet hard drive?

Large audio, video, and graphics files can be downloaded to an Internet hard drive instantaneously

Files can be accessed from any computer or device that has Web access

Others can be authorized to access data from your Internet hard drive

Next

What is a compact disc (CD)?

COMPACT DISCS

- A flat, round, portable, metal storage medium. CD: 650MB; DVD:4.7-17GB

- Also called an optical disc

- Available in a variety of formats

CD-ROM

CD-RW

CD-R

DVD-ROM

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PC CARDS

What is a PC Card?

- A thin, credit card-sized device

- Fits into a PC Card slot on a notebook other personal computer

- Different types and sizes add storage, additional memory, communications, and sound capabilities to a computer

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MINIATURE MOBILE STORAGE MEDIA

What is a smart card?

- Stores data on a thin microprocessor embedded in the card

- Similar in size to a credit card

- Read smart card with a specialized card reader

- Information on the smart card can be read and updated

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MINIATURE MOBILE STORAGE MEDIA

What are the types of smart cards?

- Intelligent smart card contains a processor and has input, process, output, and storage capabilities

- Memory card has only storage capabilities

Store data such as photographs, music, books, and video clips

Store a prepaid dollar amount that is updated when the card is used

Store patient records, vaccination data, and other healthcare information

Store tracking information such as customer purchases or employee attendance

Next