

# **Ch. 1: Computer System**

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**And Prakarn Unachak**

# Chapter 1 Computer System

- ❑ Computer Classification
- ❑ Data Representation in Computer System
- ❑ Components of Computer System
  - Hardware
  - Software
  - Peopleware

# Computer Classification

- Classified by data handling
- Classified by work purposes
- Classified by size

# Computer System

## □ Computer

- An electronic device that process and store data.
- A computer works from instructions given by its user.

## □ Evolution of Computer Construction

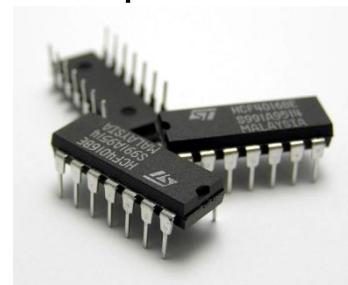
- Electronic computer starts with vacuum tubes, now uses computer chips.
- Components getting smaller and more powerful.



Vacuum Tubes  
1950s



Transistors  
1950s – 1960s



Integrated Circuits  
1960s – 1970s



Silicon Chips  
1970s - Present

# Classified by data handling

## 1. Analog Computer

- continuous (approximate) values
- real time processing



## 2. Digital Computer

*Phillips Hydraulic Computer*

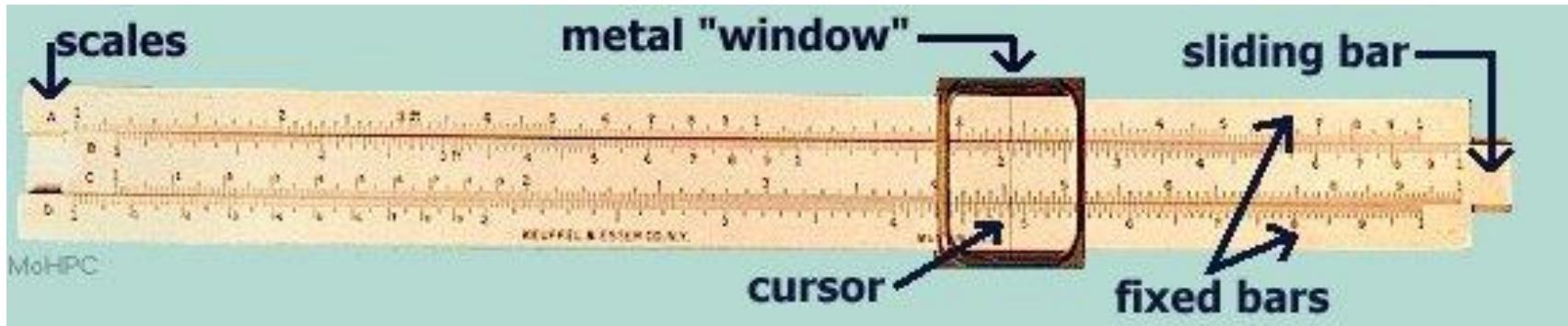
- Discrete Value, usually 2 level of electric signals
- Data are represented as 0 and 1
- More accuracy (precision) than analog computer



*Personal Computer*

# Classified by data handling (cont.)

## □ Another example of analog computer



Slide Rule (source: MIT)

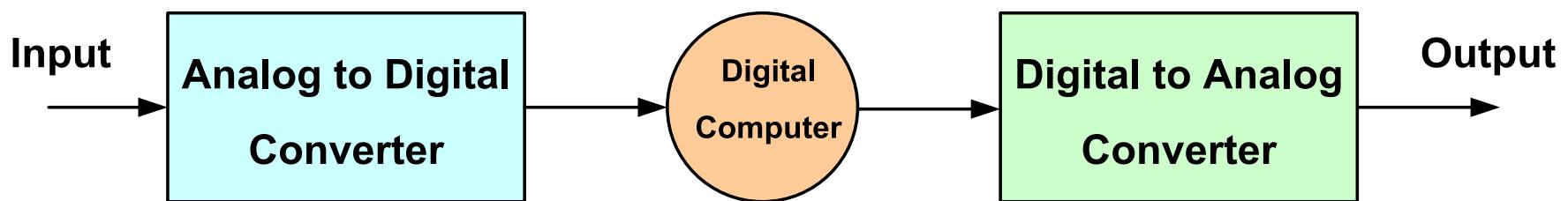
## □ Unusual example of digital computer

- Difference Engine
  - <https://www.youtube.com/watch?v=BlbQsKpq3Ak>

# Classified by data handling

## 3. Hybrid Computer

- A merge between an analog computer and a digital Computer
- Uses Converter b/w analog and digital
- Or having both analog component (which is fast) and digital component (which is precise, less error-prone)



# Classified by work purposes

## 1. General Purpose Computer

- One machine does many types of works: design, gaming, multimedia, productivity, web browsing, etc.
- Desktop computer, notebook computer, mobile devices

## 2. Special Purpose Computer

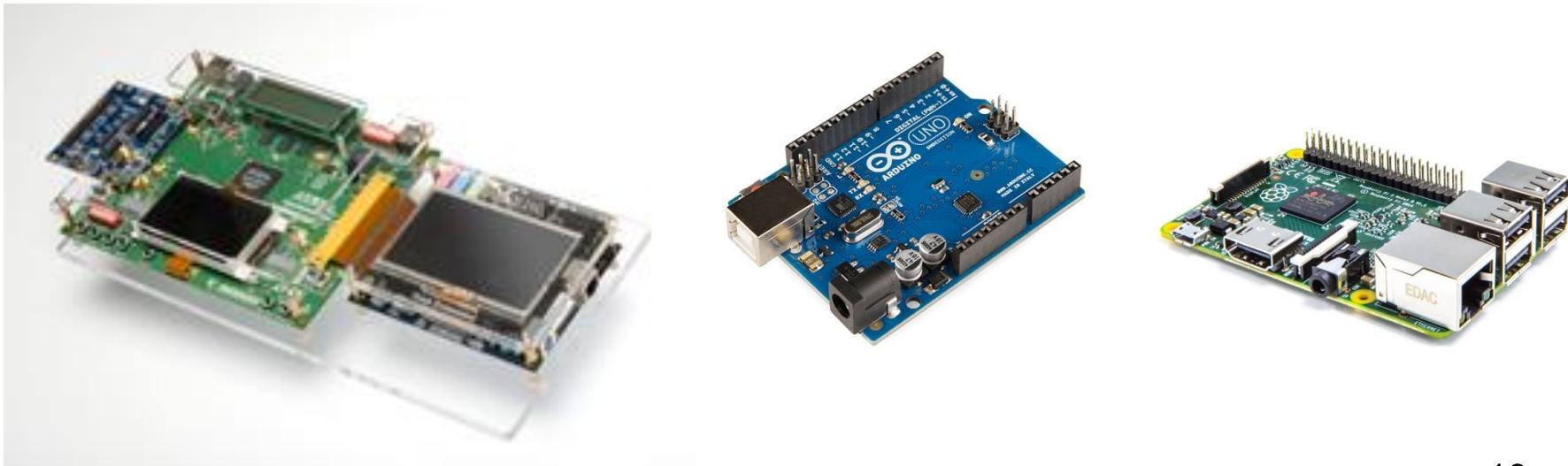
- Do (usually one) specific work
  - For example: controlling elevators, washing machines, or cars
- Usually embedded computer

# **Classified by Capacity**

- 1. Embedded Computer**
- 2. Microcomputer, Personal Computer**
- 3. Workstation, Server**
- 4. Mainframe**
- 5. Supercomputer**

# Embedded Computer

- Computers that are a part of a machine or device
- Execute a program that is stored in non-volatile memory
- Sometime called *microcontroller*.



# Microcomputer, Personal Computer

- Microcomputers are the most common type of computers used by people today
  - Desktop computers, Notebook computers, Game consoles, Mobile devices



# Workstation

- **High-end microcomputer designed for technical or scientific applications.**



- **They are optimized for the visualization and manipulation of different types of complex data and also multitasking**
  - **3D mechanical design, engineering simulation , (e.g. computational fluid dynamics), animation and rendering of images, and mathematical plots**

# Server

□ Powerful computer that performs certain service (request) for client computer, usually over the network. Most of the time residing in **datacenters.**

- File Server
- Game Server
- Mail Server
- Web Server



# Mainframe

- **High reliability and security**
- **Emphasizes on reliable of transactions**
- **High hardware and computational utilization rates to support massive throughput (very large number of transaction)**
- Example: transactions for bank.
- **Run uninterrupted for long periods of time.**



# Supercomputer

- Emphasizes on speed of calculation
- Very powerful.
- Scientific and engineering problems (high-performance computing) with high precision



Fujitsu K Computer, @Kobe, Japan



Cray Titan, @Oak Ridge, USA

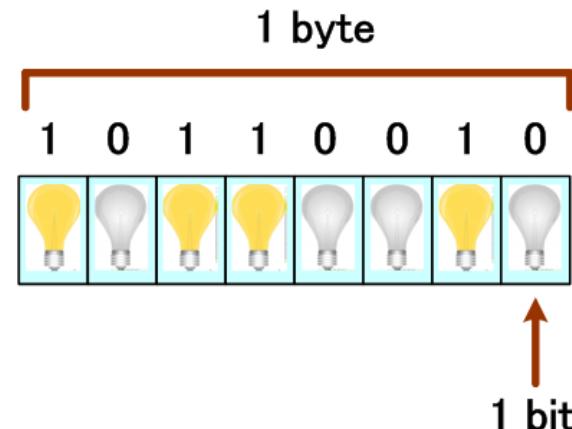
# **DATA REPRESENTATION IN COMPUTER SYSTEM**

# Data representation in Computer System

- **Bit** is the basic unit of information in computing and digital communications (value of 0 or 1)
- **Byte** is a unit of information most commonly consists of eight bits. Historically, the byte was the number of bits used to encode a single character of text in a computer.

## Bit – Byte examples

0	1 bit
1	1 bit
1011	4 bit
10100011	8 bit or 1 byte



# Data representation in Computer System

## □ ASCII (American Standard Code for Information Interchange)

- Standard code originated from USA
- ASCII code will represent alphanumeric characters (English) and a few extra symbols for using in computer system
- Original ASCII uses 7 bits
- Extended ASCII uses 8 bits.

ASCII Character Code

Character	Binary code	Character	Binary code
A	100 0001	0	011 0000
B	100 0010	1	011 0001
C	100 0011	2	011 0010
D	100 0100	3	011 0011
E	100 0101	4	011 0100
F	100 0110	5	011 0101
G	100 0111	6	011 0110
H	100 1000	7	011 0111
I	100 1001	8	011 1000
J	100 1010	9	011 1001
K	100 1011		
L	100 1100		
M	100 1101	space	010 0000
N	100 1110	.	010 1110
O	100 1111	(	010 1000
P	101 0000	+	010 1011
Q	101 0001	\$	010 0100
R	101 0010	*	010 1010
S	101 0011	)	010 1001
T	101 0100	-	010 1101
U	101 0101	/	010 1111
V	101 0110	,	010 1100
W	101 0111	=	011 1101
X	101 1000		
Y	101 1001		
Z	101 1010		

# Other Character Encodings

## ❑ Unicode

- Use additional bytes to encode non-ASCII characters
- For example U+2F08 = 人
  - $2F08_{16}$  is a hexadecimal number

## ❑ GB 2312

- For Chinese Characters

## ❑ Shift JIS

- For Japanese

# Data Capacity

We use prefix for easier size description

- Kilo-, Mega-, Giga-, Tera-, Peta-

1 Kilobyte (KB)	=	1024 Bytes ( $2^{10}$ Bytes)
1 Megabyte (MB)	=	1024 Kilobytes
1 Gigabyte (GB)	=	1024 Megabytes
1 Terabyte (TB)	=	1024 Gigabytes
1 Petabyte (PB)	=	1024 Terabytes

# **COMPONENTS OF COMPUTER SYSTEM**

- **Hardware**
- **Software**
- **Peopleware**

# Components of Computer Systems

A computer system consists of 3 main components

## **Hardware**

- Physical components of the system

## **Software**

- List of instructions written in programming language for controlling the working of the computer

## **Peopleware**

- People working in the system in various capacity (managing, building/maintaining, or just using them)

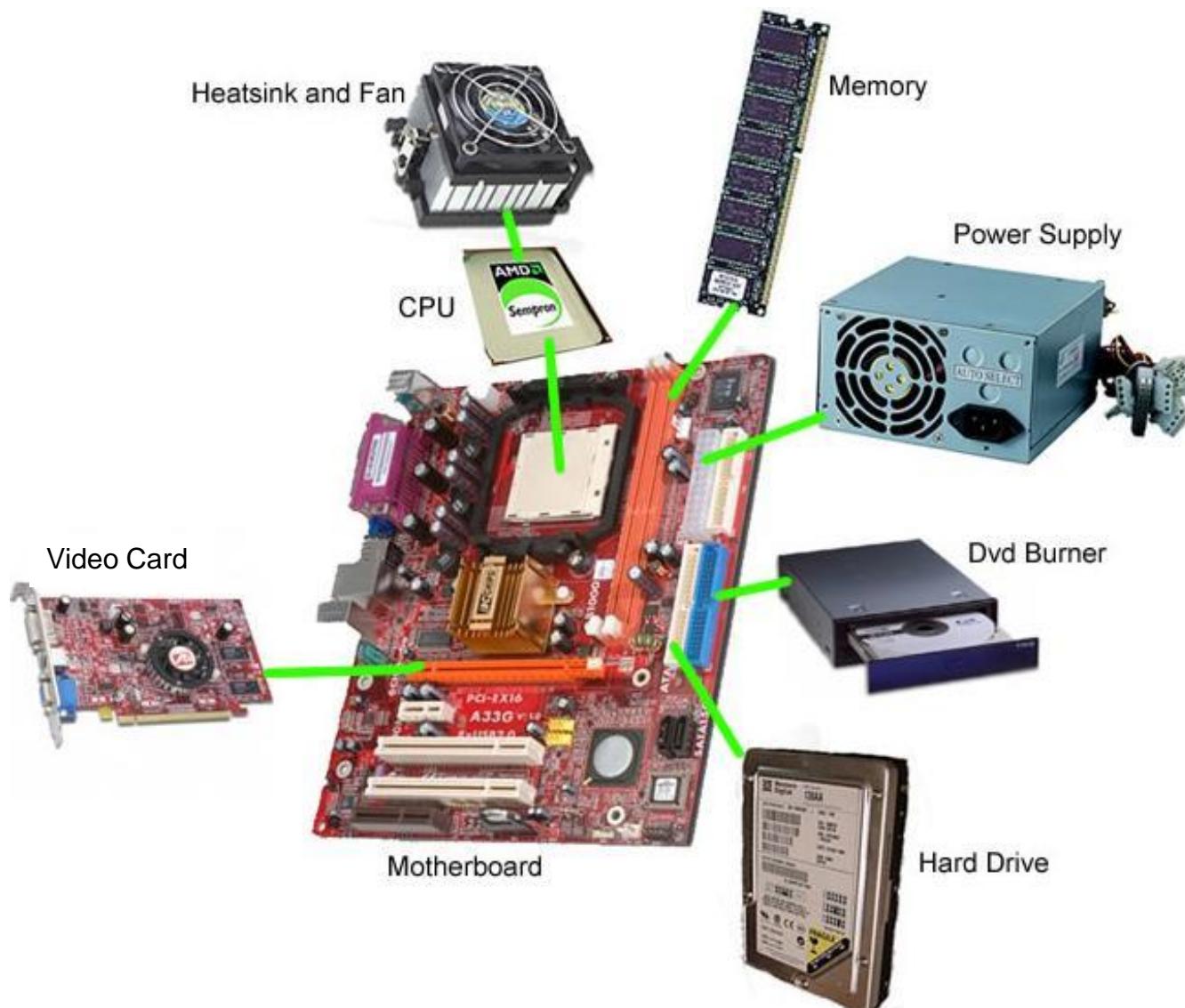
# **Hardware**

- ❖ **The collection of physical elements that constitute a computer system**
  - 1. Input Unit**
  - 2. Central Processing Unit**
  - 3. Output Unit**
  - 4. Memory, Storage**
    - Primary Storage, Main Memory
    - Secondary Storage

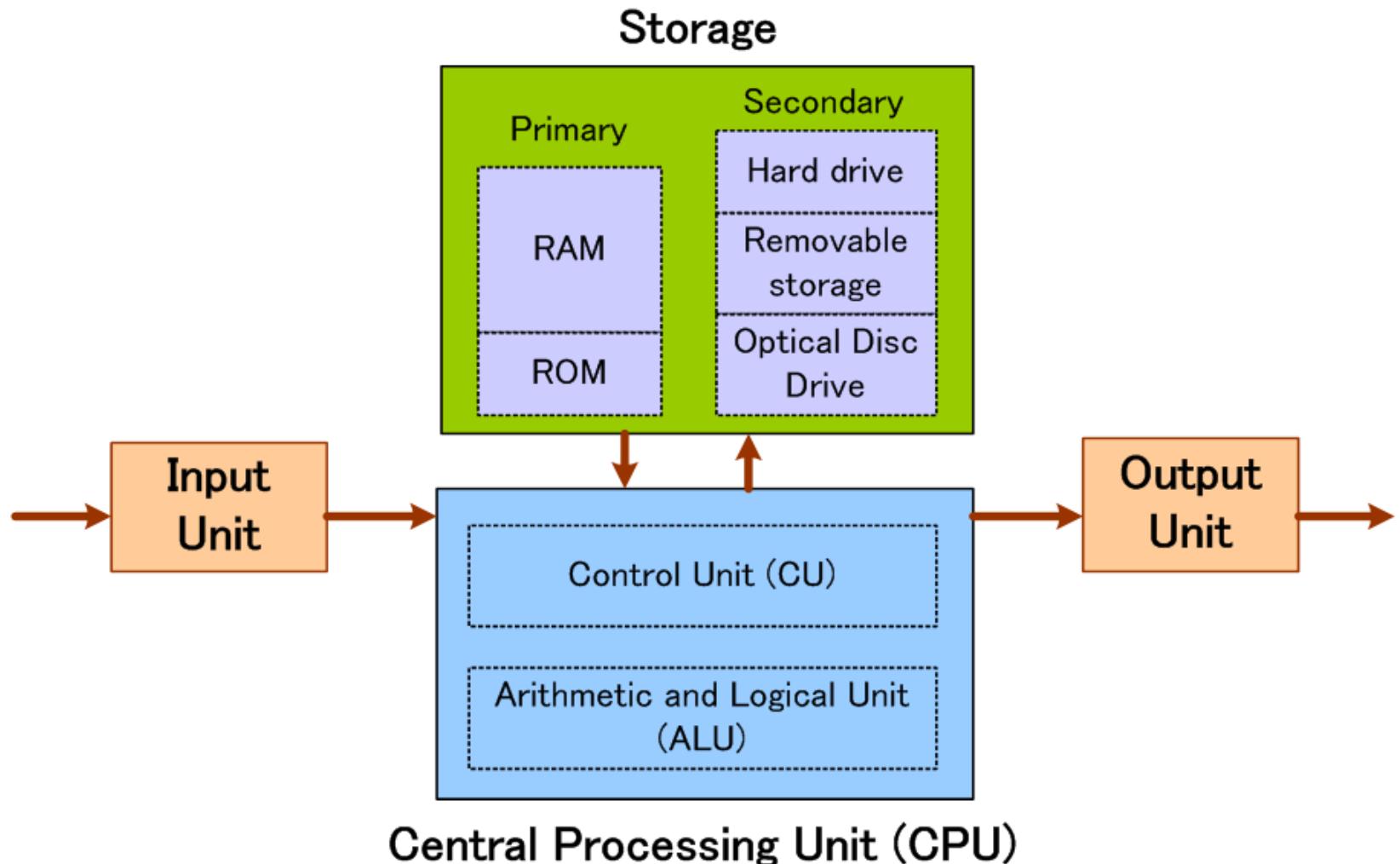
# Hardware Examples



# Inside the Computer



# Computer Components



# Input Units

1. **Keyboard**



2. **Mouse**



3. **Touch pad**



4. **Scanner**



5. **Microphone**



6. **Fingerprint reader**



7. **Barcode reader**

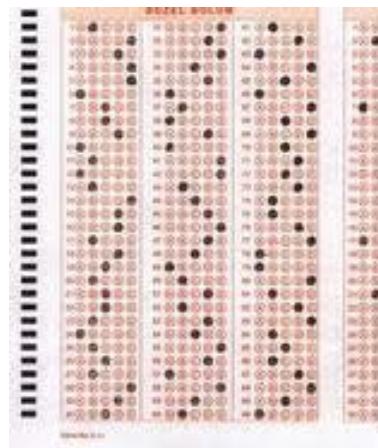


# Input Units

## 8. Magnetic Ink Character Recognition: MICR



## 9. Optical Mark Reader: OMR



# Input Units

## 10. QR code reader



## 11. Contactless smart card reader



# Other Input Units

## ❑ Motion sensing



## ❑ Input with your mind

- <https://www.youtube.com/watch?v=ogBX18maUiM>

# Central Processing Unit

## Central Processing Unit (CPU)

- The hardware within a computer that carries out the instructions of a computer program**
- Performing the basic**
  - Arithmetical,
  - Logical, and
  - Input/output
- Microprocessor**
  - More than one processor in a chip, multiprocessor.

# Central Processing Unit

- Currently, CPU are created in the form of Integrated Circuit Chip, which can includes some memory (cache) and peripheral interfaces (to talk with components)
- CPU can be divided to:
  - CU: Control Unit
    - Extracts instructions from memory and decodes and executes them calling on the ALU when necessary
  - ALU: Arithmetic Logic Unit
    - Performs arithmetic and logical operations

# Output Unit

## □ Soft Copy (Non-physical)

- **Monitor**

- Cathode Ray Tube (CRT)



- Liquid Crystal Display (LCD)



- **Speaker**



# Output Unit



# Output Unit

## □ Hard Copy (Physical)

- **Printer**

- Impact Printer : *Dot matrix printer*



- Non-impact Printer : *Laser, Inkjet printer*



- **Plotter**



# Memory or Storage Unit

## ❖ Primary / Main Memory

- Faster, connected directly to CPU
- ROM: Read Only Memory
- RAM: Random Access Memory

## ❖ Secondary Memory

- SAS: Sequential Access Storage
- DAS: Direct Access Storage

# Primary / Main Memory

## □ ROM (Read Only Memory)

- Read Only (sort of)
- Non-volatile (Requires no power to maintain data)

## □ RAM (Random Access Memory)

- Allows stored data to be accessed directly in any random order.
- Store data and instruction temporarily to be calculated by CPU
- Speed ~ 2,000 MB/s
- Volatile (Requires power to maintain data)

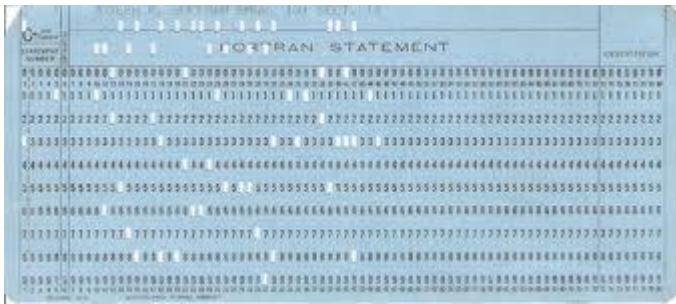
# SAS: Sequential Access Storage

- A class of data storage devices that read their data in sequence.
  - Slower access to non sequential data.
- 

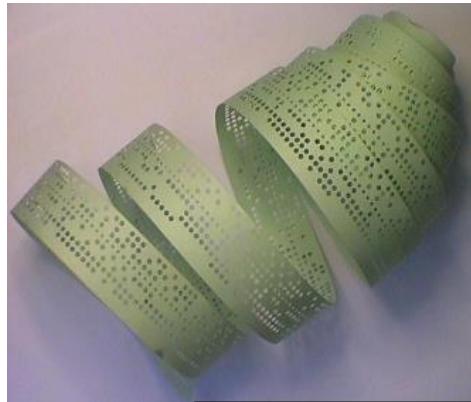
## Examples

- Paper Tape
- Punch Card
- Magnetic Tape

# SAS: Sequential Access Storage



Punch Card



Paper Tape



Magnetic Tape

# DAS: Direct Access Storage

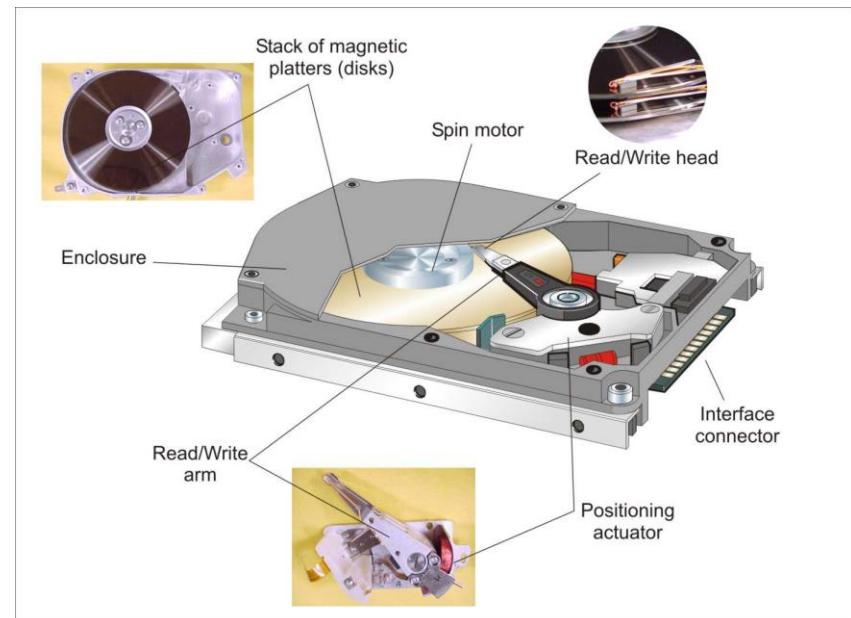
- Relatively low access time relative to its capacity
  - The access methods: Sequential, Indexed and Direct.
- 

- Magnetic
  - Hard Disk
  - Speed ~100 MB/s
  - Diskette or Floppy Disk
- Solid State
  - USB Flash Drive
  - Solid State Drive (SSD)
  - Speed ~700 MB/s
- Optical
  - Compact Disc (CD)
  - Digital Versatile Disc (DVD)
  - Blu-ray Disc (BD)

# DAS: Hard Disk

## □ Hard Disk (HDD)

- Use magnetic disks to store data
- Consists of stacks of magnetic disks (platter)
- Has read/write head
- Sensitive to movement



# CD and DVD

- ❑ The data is stored on the disc with a laser or stamping machine, and can be accessed when the data path is illuminated with a laser while spinning.
- ❑ CD storage capacity: 650 – 870 MB
- ❑ DVD storage capacity: 4.7 – 17 GB

# Types of CD, DVD

**CD-ROM , DVD-ROM** : Read only

**CD-R , DVD-R, DVD+R** : Can write data (once)

**CD-RW, DVD-RW,  
DVD+RW** : Can write data more  
than once.



# Blu-ray Disc

- ❑ Optical disc storage medium designed to supersede the DVD format.
  - ❑ Blu-ray Disc uses a 405 nm "blue" laser diode.
- Single layer: 25 GB
  - Double layer: 50 GB
  - Triple layer (BDXL): 100 GB
  - BD-R (Blu-ray Disc Recordable)
  - BD-RE (Blu-ray Disc Rewritable)



# Solid State Storage

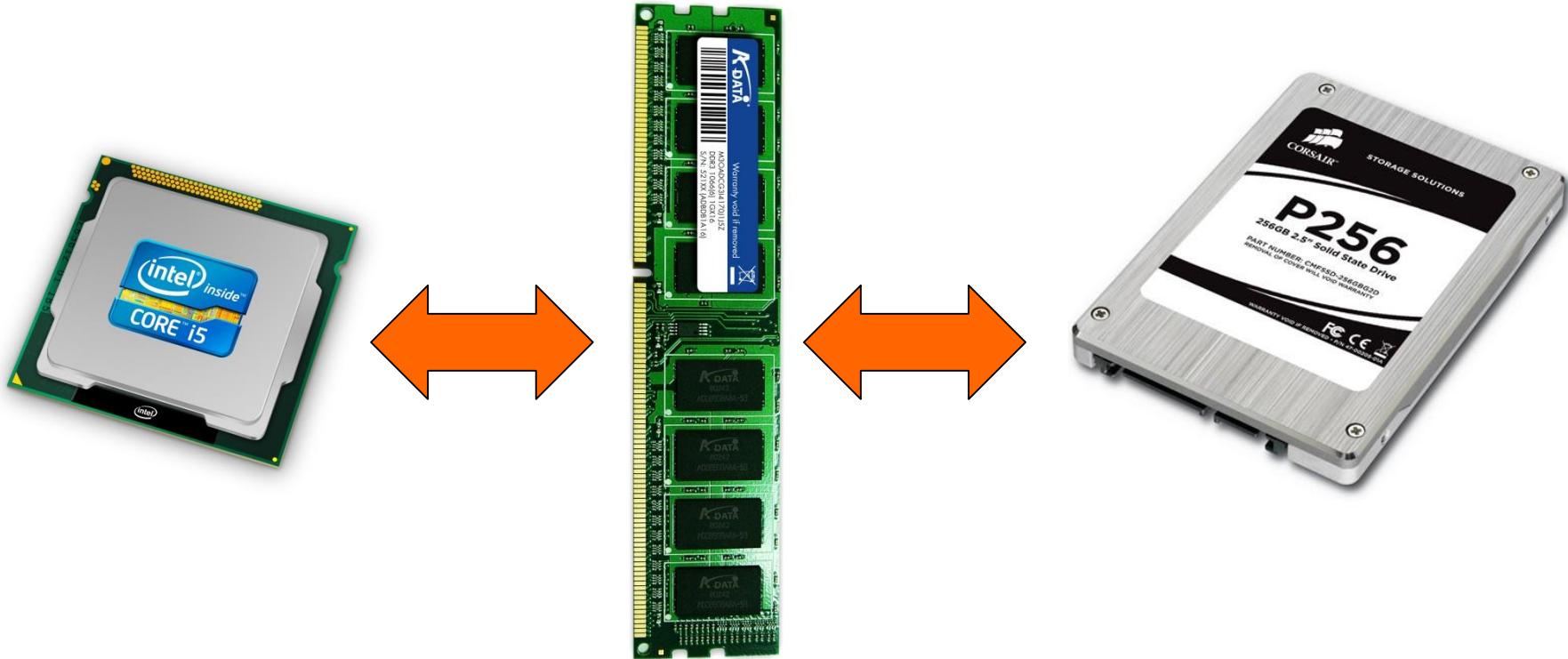
- Electronics Circuit: no moving part
- Can work properly under movement/impact
- Faster as data can be retrieved directly from various locations
- More expensive per unit of storage than HDDs.
- i.e. USB Memory, SD Card, Solid State Drive (SSD)



# A Motherboard (Mainboard)

- The **Motherboard** is the primary circuit board of a personal computer containing the circuitry for the central processing unit, keyboard, mouse and monitor, together with slots for other devices.

# RAM and HDD



- CPU cannot read data from secondary storage directly, the data has to be put in RAM first.
- If your PC don't have enough RAM, it will need to read data from secondary storage more often, making the task slower.

# **SOFTWARE**

# Software Classification

## Application Software

**“What users directly want out of computers”**

- Special Purpose Software
- Package Software

## System Software

**“What helps application software works”**

- Operating System
- (Programming) Language Translator
- Utility Software

# Software

- ❑ Computer software, or just software, is any set of machine-readable instructions (most often in the form of a computer program) that directs a computer's processor to perform specific operations.
- ❑ Software are written in **programming languages**.

# Programming Language

- A programming language is an artificial language designed to communicate instructions to a machine, particularly a computer.
- Programming language generations
  - First Generation Language
  - Second Generation Language
  - Third Generation Language
  - Fourth Generation Language
  - Fifth Generation Language

# 1st Generation Language (1GLs)

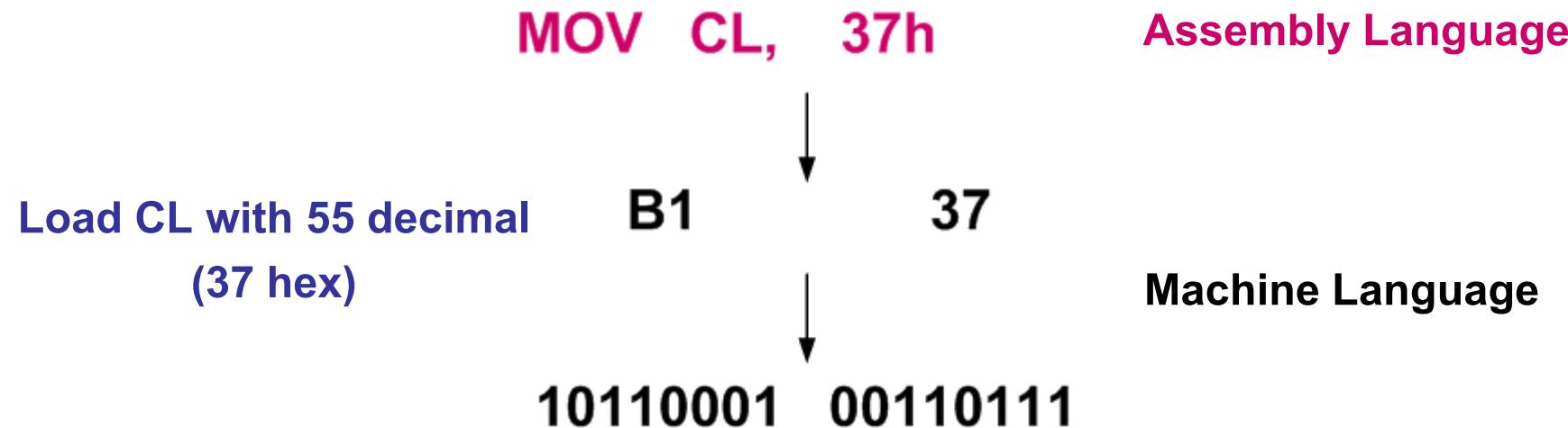
- Machine Languages
- In binary form (digital code).

**11110000      11000111**

- The only language which CPU (Machine) can execute (understand),
- Referring to any memory location in RAM.
- Very detailed instructions.
- Machine(CPU) Dependent

# Second Generation Languages (2GLs)

- ❑ Assembly Languages
- ❑ A symbolic programming language. One symbol represents a group of binary codes
- ❑ Translated into machine language by an **Assembler**



# Example of Assembly Language Code

```
01 DATA SEGMENT
02     MESSAGE DB "HELLO WORLD!!!$"
03 ENDS
04
05 CODE SEGMENT
06     ASSUME DS:DATA CS:CODE
07 START:
08     MOU AX,DATA
09     MOU DS,AX
10     LEA DX,MESSAGE
11     MOU AH,9
12     INT 21H
13     MOU AH,4CH
14     INT 21H
15 ENDS
16 END START
```

# Third Generation Languages (3GLs)

- ❑ **Meaningful language and more programmer-friendly.**
- ❑ **it may use natural language elements**
  - e.g. include, case, do, if, else, for, goto
- ❑ **To be translated by a Compiler or an Interpreter**
- ❑ **For example, FORTRAN, BASIC, Pascal, C, Java**

# Example of 3GL Code: C++

```
#include <iostream>
```

```
int main()
```

```
{
```

```
    std::cout << "Hello, world!\n";
```

```
}
```

# Fourth Generation Languages

- **Designed to reduce**
  - programming effort
  - the time it takes to develop software,
  - and the cost of software development.
- User specify **what** needs to be done without having to specify **how** it is to be done
- **Example:** SQL

# 4GL Example – SQL Query

```
SELECT MONTH, DAYLIGHT, TEMP  
FROM STATS  
ORDER BY TEMP DESC;
```

“Pick MONTH, DAYLIGHT, and TEMP data from  
table STATS, sorting them in descending order”

# Fifth Generation Language

## ❑ Constraint-based Programming

- Programmers specify the problem and the constraint of the problem, without having to program the specific problem-solving steps themselves.

## ❑ Used a lot in developing Artificial Intelligence

## ❑ Examples: Prolog, OPS5 and Mercury

# 5GL Example – Prolog

- Prolog “codes” – logic clauses

```
has(jack,apples).  
has(ann,plums).  
has(dan,money).  
fruit(apples).  
fruit(plums).
```

- User uses the codes by asking questions

```
?- listing(fruit). /* lists the clauses */  
fruit(apples).  
fruit(plums).  
?- has(jack,X). /* what Jack has? */  
X = apples  
?- has(dan,X),fruit(X). /* has Dan  
fruits? */  
no
```

# **System Software**

**□ Software designed to operate the computer hardware and to provide a platform for running application software. Examples are:**

- 
- 1. Operating System (OS)**
  - 2. Language Translator**
  - 3. Utility Software**

# Operating System

- A collection of software that manages computer hardware resources
- Provides common services for computer programs.
- The operating system acts as an intermediary between programs and the computer hardware
- For example, **Microsoft Windows, OS X, Solaris, Linux**



# Language Translator

**Program translator translates source code of programming language into machine language-instruction code**

## 1. Assembler

- An assembler translates the symbolic codes of programs of an assembly language into machine language instructions

# Language Translator

## 2. Interpreter

- Interpreter directly executes the program from its source code. Due to this, every time the source code should be inputted to the interpreter. In other words, each line is converted into the object codes.

## 3. Compiler

- Compilers are the translators, which translate all the instructions of the program into machine codes, which can be used again and again

# Utility Software

□ Small, powerful programs with a limited capability, they are usually operated by the user to maintain a smooth running of the computer system



Deleting data



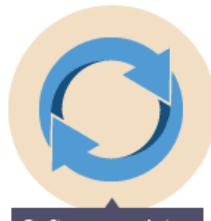
Disk defragmentation



User accounts and security



Anti-virus software



Software updates



System cleanup



Encryption/decryption



Formatting



be free



Microsoft®

Security Essentials



Examples of Utility Software

Examples of Anti-virus Software

# Application Software

□ **Application software is all the computer software that causes a computer to perform useful tasks**

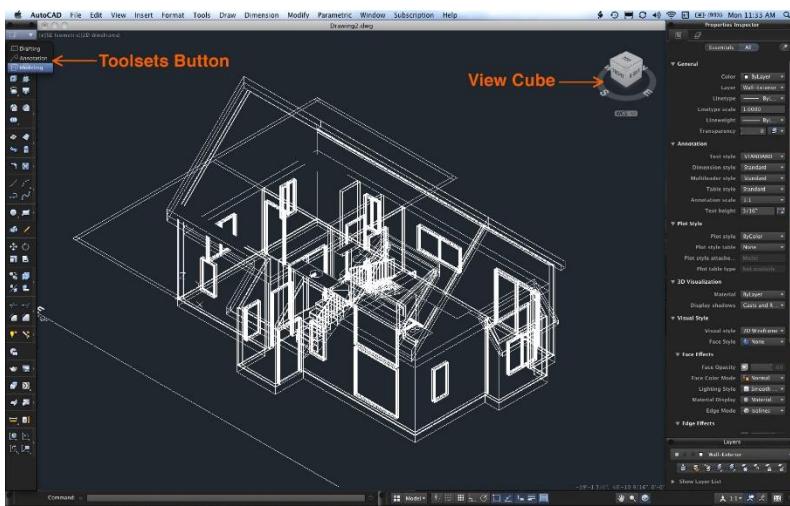
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➤ **Special Purpose Software**

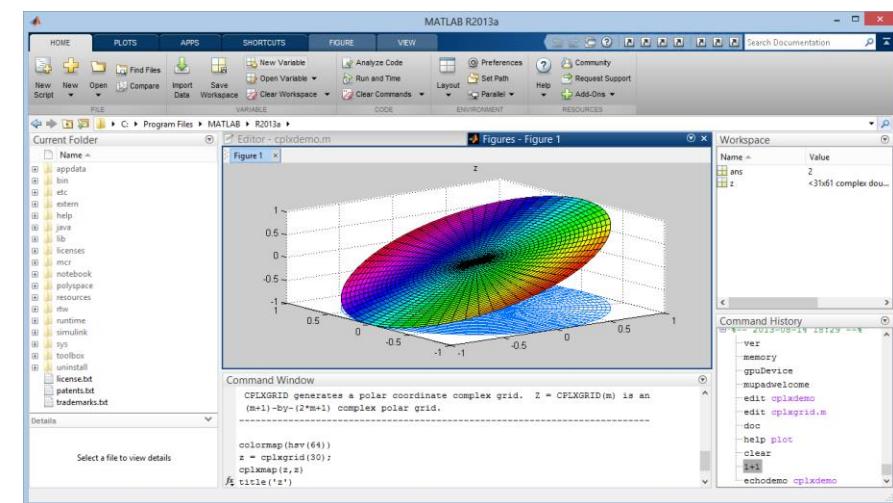
- Special Purpose application software is very specific in its use for example engineering related application.

➤ **Package Software**

- A collection of computer programs —usually application software or programming software— of related functionality
- For example MS office Suite



source: macworld



source: wikipedia



source: mspoweruser



source: play.google.com

# **PEOPLEWARE**

# **Peopleware**

- ❖ **Peopleware can refer to anything that has to do with the role of people in the development or use of computer software and hardware systems**

## **Peopleware classification**

- Administrative staff**
- Technical staff**
- Operational staff**

# Peopleware

## Administrative Staff

- Manage resources to maximize benefits to the organization**
- Determine planning & standards within the organization**
- Example**
  - Manager
  - Chief Officer

# Peopleware

## Example of Administrative Staffs

### ❑ Chief Information Officer (CIO)

- Manage IT in an organization (purchase, planning, organizing, etc.)

### ❑ Chief Technology/Technical Officer (CTO)

- Managing technologies in an organization, including developing new ones.

# Peopleware

## Technical staff

- Use technical knowledge to analyze, design, create, and maintain computer system.

### Responsibilities

- System Analysis & Design
- Problem Solving
- Program Design and Coding
- Technical Support

### Example:

- System Analyst
- Programmer
- Software Engineer
- Network Administrator
- Computer Technician

# Peopleware

## Operational staff

- Uses provided software or packages**
- Technical knowledge not required**
- Perform non-technical tasks in an organization**
  - User / End User
  - Computer Operator
  - Data Entry Operator