UNIT 2:

Computer Organization

Introduction to Computer Organization

- **Computer Organization** refer to the operational units and their interconnection that realize the architectural specifications.
- **Computer Architecture** refers to those attributes of a system visible to a programmer.
- Architectural attributes that include instruction set, number of bits used to represent various data types (numbers, characters), I/O mechanism and techniques for addressing memory.
- Organizational attributes that include those hardware details transparent to the programmer, such as control signals, interfaces between the computer and peripherals and the memory technology used.

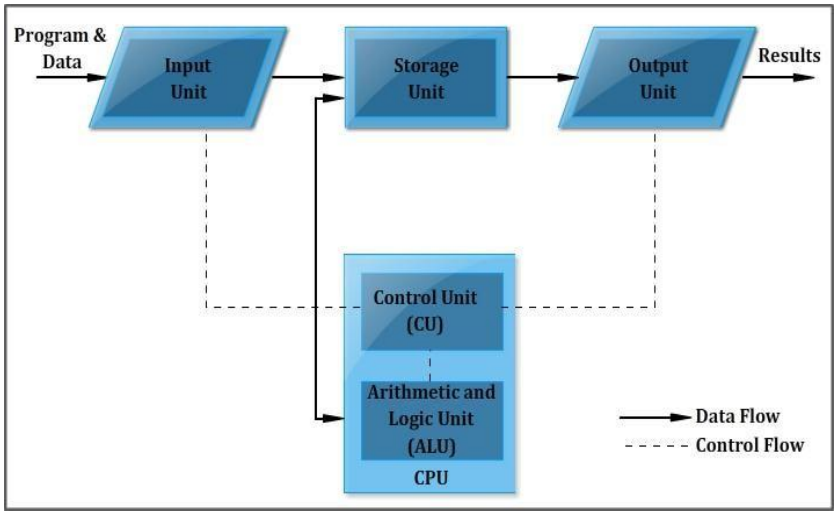


FIG : Processing of computer organization

Central Processing Unit (CPU)

What is CPU?

- CPU stands for Central Processing Unit.

- The Central Processing Unit (CPU) is the brain of the computer, it is a part of computer which interprets and executes instruction.

FIG 2.2: Central Processing Unit

- It is also known as microprocessor or processor.

FIG 2.3: Processor

- The task of performing operations like arithmetic and logical operations is called processing.
- The CPU takes data and instructions from the storage unit and makes all sorts of calculations based on the instructions given and the type of data provided. It is then sent back to the storage unit.
- It processes the instructions that it collects by decoding the code in programs.
- The CPU chip is usually in the shape of a square or rectangle and has one notched corner to help place the chip into the motherboard properly.
- The main functions of CPU are to Fetch, Decode, Execute and Write back.

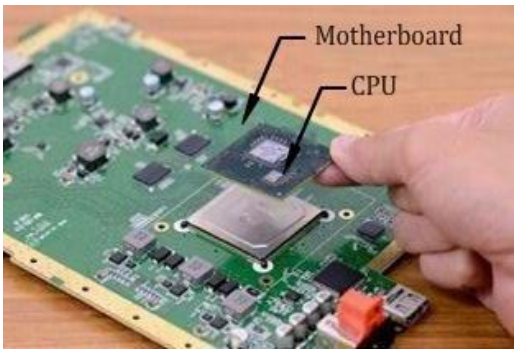


FIG 2 : CPU Processor in Motherboard

- The CPU contains
  - Arithmetic and Logic Unit (ALU)
  - Control Unit (CU)

Arithmetic and Logical Unit

- The Arithmetic and Logic Unit performs arithmetic and logical operations.
- Arithmetic operations include addition, subtraction, multiplication and division.

Operator	Description
+	Addition
-	Subtraction
*	Multiplication
/	Division

FIG : Arithmetic Operations

Logic Unit

- Logic Unit performs following operations such as AND, OR, NOT, XOR, NOR, NAND, etc.

Operator	Description
&&	AND
||	OR
!	NOT

FIG : Logical Operations

Control Unit

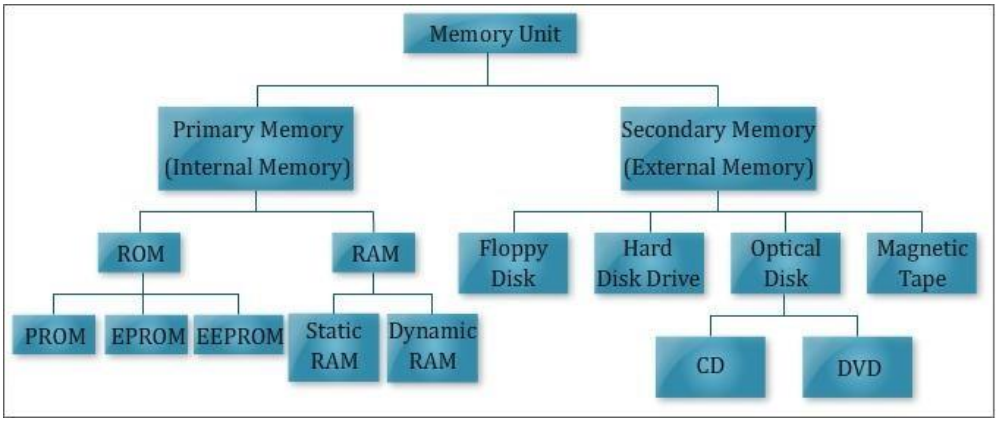
- A Control Unit (CU) handles all processor control signals.
- It generates timing signals such that the coordination among devices take place.
- Control unit is designed in two ways such as
  - Hardwired control
  - Micro-program control
- **Hardwired control**
  - The Design is based on a fixed architecture.
  - The CU is made up of flip-flops, logic gates, digital circuits and encoder & decoder.
- **Micro-programs**
  - Micro-programs are stored in a special control memory and are based on flowcharts.
  - They are replaceable and ideal because of their simplicity.
  - It directs all input and output flow, fetches code for instructions from micro programs and directs other units and models by providing control and timing signals.
  - And also Central Processing Unit includes Arithmetic logic unit and control unit. It has five major operations such as ○ It accepts data as input. ○ It stores data and instruction. ○ It processes data as per instruction.
    - It controls all operations inside a computer.
    - It gives result in the form of output.

Memory

- The Memory Unit is the part of the computer that holds data and instructions for processing.
- It stores program results or any kind of information.
- Memory stores binary information i.e. 0's and 1's.
- Memory is measured in bytes.

Types of Memory

- The computer memory is divided into two types, they are
  - Primary or Main memory
  - Secondary memory (Secondary Storage Device)



Storage Evaluation Criteria

Any storage unit of a computer system is characterized and evaluated based on following properties-

Storage capacity - It is the amount of data, which the storage unit can store, Larger storage capacity is desirable. As compared to secondary storage units, primary storage units have less storage capacity.

Access time - It is the time required to locate and retrieve stored data from the storage unit in response to a program instruction. Faster access time is preferable. As compared to secondary storage units, primary storage units have faster access time.

Cost per bit of storage- It refers to the cost of storage unit for a given storage capacity. Lower cost is desirable. As compared to secondary storage units, primary units have higher cost per bit of storage.

Volatile - If a storage unit can retain data stored in it even in case of power off or interruption of power, it is called non- volatile storage. On the other hand, if a storage unit loses data stored in it in case of power off or interruption of power, it is called volatile storage. Obviously, non-volatile storage is desirable. In almost all computer systems, primary storage units are volatile and secondary storage units are non-volatile.

Random access - If the time taken to access a piece of data from a storage unit is independent of the location of the data in the storage unit, it is called random access storage or random access memory (RAM). Each location of a RAM is as easy to access

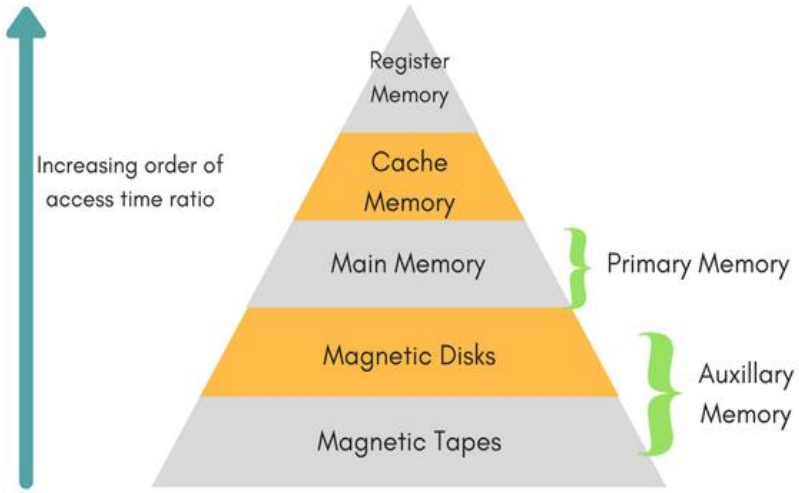
as any other location and takes the same amount of time. In almost all computer systems primary storage units have random access property and secondary storage unit have either pseudo-random access (access time is nearly same for all locations but not exactly same) or sequential access(access time depends on the location of the data) property.

Memory Organization

A memory unit is the collection of storage units or devices together. The memory unit stores the binary information in the form of bits. Generally, memory/storage is classified into 2 categories:

- **Volatile Memory**: This loses its data, when power is switched off.
- **Non-Volatile Memory**: This is a permanent storage and does not lose any data when power is switched off.

Memory Hierarchy



The total memory capacity of a computer can be visualized by hierarchy of components. The memory hierarchy system consists of all storage devices contained in a computer system from the slow Auxiliary Memory to fast Main Memory and to smaller Cache memory.

Auxillary memory access time is generally **1000 times** that of the main memory, hence it is at the bottom of the hierarchy.

The **main memory** occupies the central position because it is equipped to communicate directly with the CPU and with auxiliary memory devices through Input/output processor (I/O).

When the program not residing in main memory is needed by the CPU, they are brought in from auxiliary memory. Programs not currently needed in main memory are transferred into auxiliary memory to provide space in main memory for other programs that are currently in use.

Memory Access Methods

Each memory type, is a collection of numerous memory locations. To access data from any memory, first it must be located and then the data is read from the memory location. Following are the methods to access information from memory locations:

1. **Random Access**: Main memories are random access memories, in which each memory location has a unique address. Using this unique address any memory location can be reached in the same amount of time in any order.
2. **Sequential Access**: This methods allows memory access in a sequence or in order.
3. **Direct Access**: In this mode, information is stored in tracks, with each track having a separate read/write head.

Primary memory

- Primary Memory is used for immediate access of data by the processor.
- Most computer systems around the world use primary memory.
- Primary memory can be divided into two types.

- RAM (Random Access Memory)
- ROM (Read Only Memory)

• RAM (Random Access Memory)

- Random Access Memory is the central storage unit in a computer system.
- The information stored in the RAM is typically loaded from the computer's hard disk, and includes data related to the operating system and certain applications.

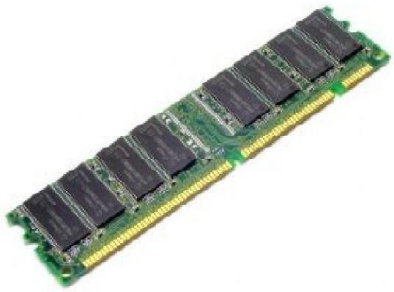


FIG : RAM

- There are primarily two forms of RAM
  - Static RAM (SRAM)
  - Dynamic RAM (DRAM)

Static RAM (SRAM)

- In SRAM, a bit of data is stored using the state of a flip-flop. This is most expensive among other forms of RAMs, but is generally faster and requires less power than DRAM and, in modern computers, is often used as cache memory for the CPU.

Dynamic RAM (DRAM)

- Widely used in modern computers as primary memory, DRAM is slower than SRAM, but is inexpensive due to its one transistor-one capacitor paired assembly of memory storage.

ROM (Read Only Memory)

- ROM stands for Read Only Memory.
- The CPU can only fetch or read instructions from ROM.
- ROM comes with instructions permanently stored inside.

FIG 2.10: ROM

- And these instructions cannot be over-written by the computer's CPU.

Types of ROM

- PROM – Programmable Read Only Memory
- EPROM – Erasable Programmable Read Only Memory
- EEPROM – Electrically Erasable Programmable Read Only Memory

PROM

- PROM Stands for "**Programmable Read-Only Memory**," and is pronounced "p-rom," not "prom".
- PROM is a type of **ROM** that is programmed after the memory is constructed.
- PROM chips have several different applications, including cell phones, video game consoles, medical devices, and other electronics.
- They provide a simple means of programming electronic devices.

- While **PROM** cannot be erased, two other versions of PROM have been developed that can be erased and reprogrammed.

EPROM

- EPROM stands for **Erasable Programmable Read-Only Memory**.
- This type of memory uses floating-gate transistors and can be erased by strong ultraviolet light.

EEPROM

- EEPROM stands for **Electrically Erasable Programmable Read-Only Memory**.
- EEPROM can be erased with an electrical charge and is used in flash memory.

Secondary Memory (Secondary Storage Device)

- Secondary Memory refers to storage devices, such as hard drives and Solid State Drives (SSD).
- It may also refer to removable storage media, such as USB flash drives, CDs, and DVDs.
- Secondary memory is much slower than primary memory, it typically offers a far greater storage capacity.
- Secondary memory includes
  - Floppy disk
  - Hard disk drive
  - Optical disk
  - USB thumb drive

Floppy disk

These are small removable disks that are plastic coated with magnetic recording material.

This portable storage device is a rewritable media and can be reused a number of times.

Hard disk drive

Another form of auxiliary storage is a hard disk.

A hard disk consists of one or more rigid metal plates coated with a metal oxide material that allows data to be magnetically recorded on the surface of

- **Optical disk**

  - An Optical disk is any storage media that hold content in digital format and is read using a laser assembly is considered as optical media.
  - The most common types of optical media are Blu-ray, CDs, and DVDs.
  - **CDs** can store up to 700 megabytes (MB) of data.
  - **DVDs** can store up to 8.5 GB of data.
  - **Blu-ray** discs, which are the newest type of optical media, can store up to 50 GB of data.

Blu-ray **CD** **DVD**

FIG : Types of Optical Disk

- **CD**
  - **CD** is an abbreviation of compact disk, and is a form of data storage that can transfer data up to the speed of 7800 KB/s.
  - A standard 120 mm CD holds up to 700 MB of data, or about 70 minutes of audio.
  - There are two types of CD: CD-ROM and CD-RW.
  - **CD-ROM** are stands for CD-Read Only Memory and they function in the same way as Read Only Memory does.
  - **CD-RW** Stands for CD-Rewritable, these disks can be erased and rewritten at any time.

DVD

- DVD is an abbreviation of Digital Versatile Disc, and is an optical disc storage media format that can be used for data storage.
- The DVD supports disks with capacities of 4.7 GB to 17 GB and access rates of 600 KBps to 1.3 MBps.
- A standard DVD disc store up to 4.7 GB of data. ➢ There are two types of DVD's
  - DVD-ROM
  - DVD-RW ➢ **DVD-ROM**
  - DVD-ROM stands for DVD-Read Only Memory and they function in the same way as Read Only Memory does. ➢ **DVD-RW**
  - DVD-RW stands for DVD-Rewritable, these disks can be erased and rewritten at any time.

USB Thumb Drive

- A USB flash drive is a data storage device that includes flash memory with an integrated Universal Serial Bus (USB) interface.
- USB flash drives are typically removable and rewritable, physically much smaller than an optical disc.

FIG : USB Drive

- USB drives that are often used for floppy disks were used, i.e., for storage, back-up and transfer of computer files.
- They are smaller, faster and have thousands of times more capacity, durable and reliable.

Cache Memory

- A CPU cache is a cache used to reduce the average time to access memory.
- The cache is a smaller, faster memory which stores the copies of the data from frequently used main memory locations.
- Most CPUs have different independent caches, including instruction and data caches, where the data cache is usually organized as a hierarchy of more cache levels (L1, L2 etc.).

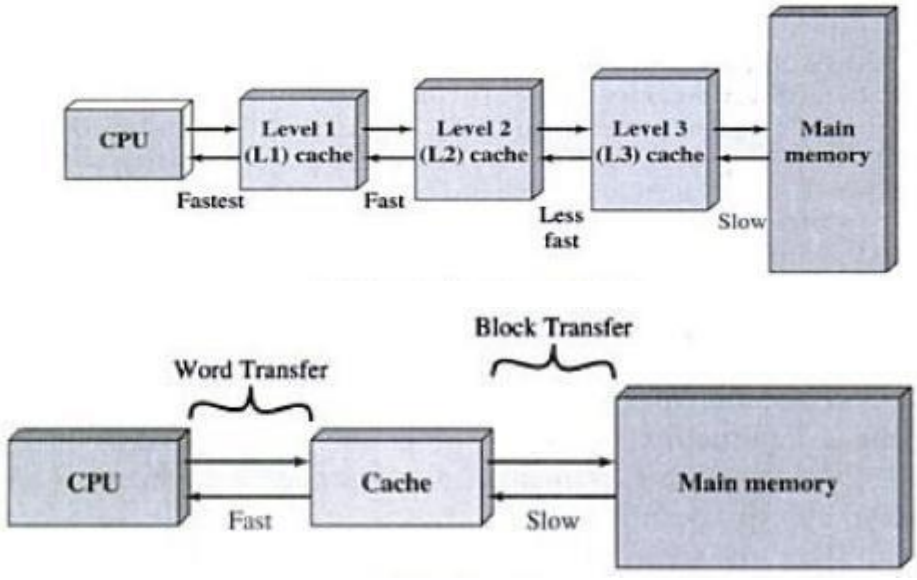


FIG : Cache Memory Processing

- When the processor needs to read from or write to a location in main memory, it first checks whether a copy of that data is in the cache or not.
- If so, the processor immediately reads from or writes to the cache, which is much faster than reading from or writing to main memory.

File System Input Devices

- **Keyboard-** The keyboard looks like a typewriter. Most common and very popular input device is **keyboard.**

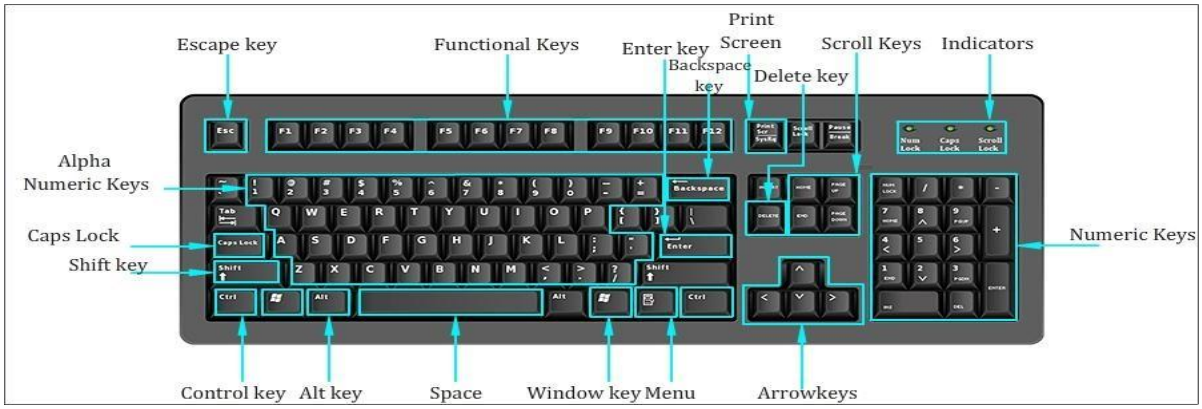


FIG : Keyboard

The keyboard helps in inputting the data to the computer.

- Most of the keyboards have 80 to 110 keys.
- **Key types**
  - Typing (Alphanumeric keys)
  - Function keys
  - Control keys
  - Cursor keys
- **Typing (Alphanumeric keys)**
  - The typing keys include the letters of the alphabet, generally laid out in the same pattern used for typewriters.
  - These include same letter, number, punctuation, and symbol keys.

Standard Laptop size Handheld Thumb-sized

FIG : Types of Keyboard

Mouse input device-

- Mouse is a pointing device which contains an optical in its base.
- The mouse is an input device (control station) for computers.
- The mouse is a device that allows you to control the movement of the insertion point on the screen.

FIG : Mouse

- The movement of the mouse, run with the hand on the table or a suitable base (flat surface) such as the mouse pad is received via a sensor in the mouse, digitized and transmitted via an interface to the connected computer.

- The most conventional mouse has two buttons, the left one is used most frequently for clicking.
- The left click lets the user click once to send a "Select" indication that provides the user with feedback that a particular position has been selected for further action.
- The next click on a selected position or two quick clicks on it causes a particular action to take place on the selected object.
- The right click, usually provides some less-frequently needed capability.
- Use of right click.

Joystick input device-

 A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction of the device it is controlling.

FIG : Joystick

- Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer.

Types of Joystick

- The five types of joystick are
  - Digital joystick
  - Paddle joystick
  - Analog joystick
  - PC Analog joystick
  - Joy pads

Scanner

- A scanner is an input device that scans any documents such as photographs and pages of text.

- Scanners are used to import a picture or document into the computer for sending or printing.

FIG : Scanner

- Scanner works by placing the object to be scanned on the glass surface.
- While scanning a camera moves across the object, capturing the image and storing it on the computer.
- When a document is scanned, it is converted into a digital format.
- Scanners have become an important part of the home office over the last few years, where file can be sent over the internet at a faster speed. The most commonly used scanners are
  - Flat-bed scanner
  - Sheet-fed scanner/ Auto feeder
  - Hand held scanner
  - Drum scanner

Web Cam

A webcam is a video camera that feeds its image to the computer.

FIG : Web Cam

- When the image is captured by the computer, the video stream may be saved or viewed or sent to other network via system such as the internet and email as an attachment.

- A webcam is connected by a USB Cable, FireWire cable or built into the computer hardware such as laptop.

Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony.

Output Devices-

Monitors

- A monitor or display (sometimes called a visual display unit) is an electronic visual display for computers.
- The monitor comprises the display device, circuitry, and an enclosure. The display device in modern monitors is typically a thin film transistor liquid crystal display (TFT-LCD) thin panel, while older monitors use a cathode ray tube about as deep as the screen size.
- Monitors available in 14", 15", 17" and even 21 to 30" in size.
- It is used to get the data in the form of soft copy. Their functioning is exactly similar to the television.
- It contains a Cathode-Ray Tube (CRT) which emits the electrons to trace a regular pattern of horizontal lines on the screen.
- There are two kinds of viewing screen used for monitors such as
  - CRT Monitor
  - Flat-Panel Display

FIG : CRT Monitor

FIG : Flat-Panel Display

Printers

- A printer is an electromechanical device which converts the text and graphical documents from electronic form to the physical form and it used to print information on paper.

- Generally they are the external peripheral devices which are connected with the computers or laptops through a cable or wirelessly to receive input data and print them on the papers.
- A wide range of printers is available with a variety of features ranging from printing black and white text documents to high quality colored graphic images.
- Quality of printer is identified by its features like color, quality, speed of printing, resolution etc.
- Modern printers come with multipurpose function i.e. they are combination of printer, scanner, photocopier, fax, etc.
- **Types of printer** -There are different types of printers and most commonly used printers are
  - Dot matrix printer
  - Inkjet printer
  - Laser printer
- **Dot matrix printer**
  - Dot Matrix Printer is a popular computer printer that prints text and graphics on the paper by using tiny dots to form the desired shapes.
  - It is a 2D matrix of dots that can represent images, symbols, or characters.

FIG : Dot Matrix Printer

  - They are used for electronic displays, such as computer monitors and LED screens, as well as printed output.
  - In a dot matrix display, the images are estimated using a discrete set of dots instead of lines and shapes.
  - If enough dots are used, the image will appear as a contiguous display rather than a group of dots.

Inkjet printer

- Inkjet printing is a type of computer printer that creates a digital image by propelling droplets of ink onto paper, plastic, or other substrates.

FIG : Inkjet Printer

- The inkjet technology works by spraying very fine drops of ink on a sheet of paper.
- These droplets are "ionized" which allows them to be directed by magnetic plates in the ink's path.
- As the paper is fed through the printer, the print head moves back and forth, spraying thousands of these small droplets on the page.

Laser printer

- Laser printing is an electrostatic digital printing process that rapidly produces high quality text and graphics by passing a laser beam over a charged drum to define a differentially charged image.

FIG : Laser Printer

- A laser printer is a printer that uses a focused beam or light to transfer text and images onto paper.
- Instead, as paper passes through the printer, the laser beam fires at the surface of a cylindrical drum called a photoreceptor.

- A laser printer utilizes laser technology to print images on the paper. It is often used in school, corporate and other environment.