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Evolution of Computers

History of Computing

Early Calculating Aids:

Pre-Mechanical Era – before 1450

Abacus is considered as the first calculating device in the world used by Chinese around 5000 BC.

Mechanical

A mechanical computer is built from mechanical components such as levers and gears, rather than electronic components. The most common examples are adding machines and mechanical counters, which use the turning of gears to increment output displays.

- The Pascaline was introduced by Blaise Pascal in 1642. It could add and subtract two numbers.
- The Stepped Reckoner invented by German scientist Gottfried Wilhelm Leibniz completed in 1694. This device is carried out the operations add, subtract, multiply and divide too.
- The difference engine, the first mechanical computer was developed by Charles Babbage in 1880. He presented the concept of Input, Process and Output that is used in modern computers, for the first time. Therefore, he is considered as the "Father of the computer".

Electromechanical

Electro-mechanical computers. Early electrically powered computers constructed from switches and relay logic rather than vacuum tubes (thermionic valves) or transistors (from which later electronic computers were constructed) are classified as electro-mechanical computers.

- Electronic valve (vacuum tube) invented by Forest in 1906.
- The automatic sequence controller (Mark 1) was the first automatic computer invented by Professor Howard Aiken in 1939.

Electronic

In computer science, a digital electronic computer is a computer machine which is both an electronic computer and a digital computer. Examples of a digital electronic computers include the IBM PC, the Apple Macintosh as well as modern smartphones.

Tabulating machine - Herman Hollerith

GENERATION OF COMPUTERS

1st Generation Computers (1940-1956)

The computers of first generation used vacuum tubes as the basic component.

- ENIAC (Electronic Numerical Integrator and Calculator) was the first electronic digital computer designed by John Mauchly and J. Presper Eckert in 1946.
- EDSAC (Electronic Delay Storage Automatic Calculator) was the first full size stored program computer developed by Maurice Wilkes in 1947. EDSAC was built according to the von Neumann machine principles.
- EDVAC (Electronic Discrete Variable Automatic Computer) is considered as the first digital computer that could store program was built in 1948.
- UNIVAC (Universal Automatic Computer) was an electrical computer containing thousands of vacuum tubes that utilized punch cards and switches to input data and punch cards to output and store data.

2nd Generation Computers (1956 – 1963)

In this generation, transistors were used as the fundamental building block.

IBM 1620, IBM 7094, CDC 1604, CDC 3600, UNIVAC 1108 were some computers developed in this generation.

3rd Generation Computers (1964 – 1975)

The computers of third generation used Integrated Circuits (ICs) in place of transistors. A single IC contains many transistors, resistors, and capacitors along with the associated circuitry.

IBM-360 series, PDP (Personal Data Processor), TDC-316 were the computers of 3rd generation.

4th Generation (1975 – 1989)

In this generation of computers VLSI (Very Large Scale Integrated) circuits were used. VLSI circuits having more transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers.

micro chips

Eg: DEC 10, STAR 1000, PDP 11

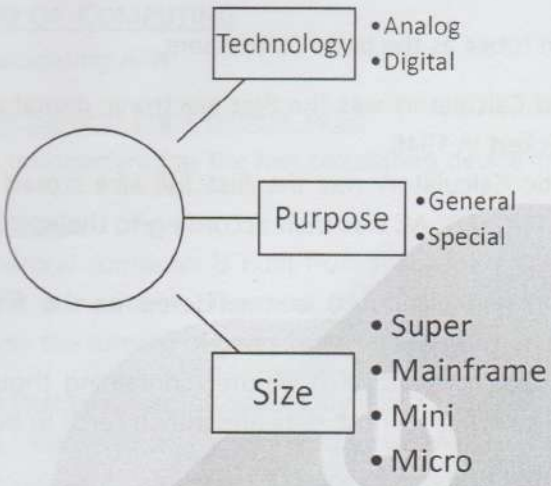
1990

5th Generation Computers (1989 – present)

The ULSI (Ultra Large-Scale Integration) technology is used in this generation resulting in the production of microprocessor chips having millions transistors and other electronic components.

Eg: Desktop, Laptop, Notebook, Ultrabook

CLASSIFICATIONS OF COMPUTERS



1. Based on the Technology

- **Analog Computer** - An analog computer is a form of computer that handles continuous values such as electrical, mechanical, or hydraulic quantities.
- **Digital Computer** - A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system.

2. Based on the Purpose

- **Special purpose computer** - Computers are designed to handle a specific problem or to perform a specific task.
- **General purpose computer** – These are designed to perform a range of tasks.

3. Based on Size

- **Super Computer** - The fastest and most powerful type of computers Supercomputers are very expensive and are employed for specialized applications that require immense amounts of computing power. (Eg: TIANHE-1)
- **Mainframe Computer** - A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously
- **Mini Computer** – Mid size computers mainly used as small or mid-range servers operating business and scientific applications.
- **Micro Computer** –
  - Desktop – A personal computer sufficient to fit on a desk
  - Laptop – A portable computer
  - Palmtop – A hand size computer
  - Notebook - A portable computer small and thinner than Laptop.
  - Smart phone – This is a mobile phone used for mobile communication with an operating system and other advanced facilities.
  - Tablet - A tablet is a wireless, portable personal computer with a touch screen interface. The tablet is typically smaller than a notebook computer, but larger than a smartphone.
  - Phablet - A phablet is a small pocket sized mobile device that is a bit larger than the size of an average smartphone and smaller than tablet. (Eg: Apple 6Plus, Galaxy Note, etc)

Hardware and Interfaces

Major Hardware Components

Input Devices

Mainly are of two types: keyboard entry and direct entry e.g.: keyboard, pointing devices, touch pad, remote control, touch screen, magnetic strip reader, barcode reader, smart card reader, chip and pin reader, scanner, digital camera, microphone, sensors, graphic tablets, MICR, OMR and OCR readers, video camera, digitizer, web cam.

Direct input devices do not require much human interaction to get their data into a computer system.

Output Devices

Commonly used output devices are CRT monitor, TFT monitor, LED monitor, dot matrix printer, inkjet printer, laser printer, 3D printer, graph plotter, speakers, etc.

How Monitor Displays

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Different Types of Displays

Cathode Ray Tube (CRT), the technology used in most televisions and computer display screens. A CRT works by moving an electron beam back and forth across the back of the screen. Each time the beam makes a pass across the screen, it lights up phosphor dots on the inside of the glass tube, thereby illuminating the active portions of the screen. By drawing many such lines from the top to the bottom of the screen, it creates an entire screen full of images.

Thin Film Transistor (TFT), a type of LCD flat-panel display screen, in which each pixel is controlled by from one to four transistors. The TFT technology provides the best resolution of all the flat-panel techniques, but it is also the most expensive. TFT screens are sometimes called active-matrix LCDs.

Liquid Crystal Display (LCD): LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light. This shutter along with the others provides the color which you want.

Light Emitting Diode (LED), an electronic device that lights up when electricity is passed through it. LEDs are usually red. They are good for displaying images because they can be relatively small, and they do not burn out. However, they require more power than LCDs. It consists of tiny bulbs which emit light and these bulbs give a more realistic display as compared to others. It is more power consuming. Local dimming LED display consumes more power than LCD display. Therefore, the tradeoff seems to be between economizing your energy bill and better picture quality. But the edge lit LED displays use less power than an LCD of the same size. Sony, Samsung and Philips have launched LED display models. Similar to LCD monitors, LED screens do not have screen burn-in problem, and are therefore, suitable for computer use.

Different Types of Printers

1. Dot matrix printer – Impact

It uses a print head that moves back-and-forth, or in an up-and-down motion, on the page and prints by striking an ink ribbon against the paper, much like the print mechanism on a typewriter.

2. Inkjet printer / Bubble Jet / Desk Jet [Non Impact]

In the inkjet printing mechanism, the print head has several tiny nozzles, also called jets. As the paper moves past the print head, the nozzles spray ink onto it, forming the characters and images.

3. Laser printer – Non Impact

When a document is sent to the printer, a laser beam draws the document on a selenium-coated drum using electrical charges. After the drum is charged, it is rolled in toner, a dry powder type of ink. The toner adheres to the charged image on the drum. The toner is then transferred onto a piece of paper and fused to the paper with heat and pressure.

4. Graphic plotter

A plotter is a printer that interprets commands from a computer to make line drawings on paper with one or more automated pens.

3D printing

The 3D printing process turns a whole object into thousands of tiny little slices, then makes it from the bottom-up, slice by slice. Those tiny layers stick together to form a solid object. Each layer can be very complex, meaning 3D printers can create moving parts like hinges and wheels as part of the same object.

Storage Devices

Most commonly used are: fixed internal disk, portable external hard disk, magnetic tape, Optical discs(CD Rom/DVD Rom, CD-R/DVD-R, CDRW/ DVD-RW, DVD-RAM, Blu-Ray), flash memory card, mini disk.

CPU AND ITS COMPATIBILITY WITH MOTHERBOARD

1. Socket support.

The CPU has to be compatible with your motherboard's socket.

2. Chipset support.

Need to know about the chipset to find the CPUs compatible with that chipset. Chipset manufacturers include AMD, Intel and Nvidia.

3. Motherboard wattage support must support the Thermal Design Power (TDP) of a given CPU. Need to find out the wattage of the motherboard to determine the support from that to the CPU.

4. BIOS support.

If necessary BIOS need to be upgraded to support the CPU

PARALLEL AND GRID COMPUTING

In traditional (serial) programming, a single processor executes program instructions in a step-by-step manner. Some operations, however, have multiple steps that do not have time dependencies and therefore can be separated into multiple tasks to be executed simultaneously. For example, adding a number to all the elements of a matrix does not require that the result obtained from summing one element be acquired before summing the next element. Elements in the matrix can be made available to several processors, and the sums performed simultaneously, with the results available faster than if all operations had been performed serially.

Parallel computations can be performed on shared-memory systems with multiple CPUs, distributed-memory clusters made up of smaller shared-memory systems, or single-CPU systems. Coordinating the concurrent work of the multiple processors and synchronizing the results are handled by program calls to parallel libraries; these tasks usually require parallel programming expertise.

The following example displays the difference between single processor and parallel processor

- $Y = (4 \times 5) + (1 \times 6) + (5 \times 3)$

On a single processor, the steps needed to calculate a value for Y might look like:

- Step 1: Y = 20 + (1 x 6) + (5 x 3)
- Step 2: Y = 20 + 6 + (5 x 3)
- Step 3: Y = 20 + 6 + 15
- Step 4: Y = 41

In a parallel computing scenario, with three processors or computers, the steps look something like:

- Step 1: Y = 20 + 6 + 15
- Step 2: Y = 41

The main performance characteristic is the increase in speed. If you use a single computer, and it takes X amount of time to perform a task, then using two similar computers should cut the time taken to perform that same task in half. If you use three, then it should take a third of the time for the same task, and so on.
However, in practical terms, this is not always true. Because:

- Some task might not be divisible.
- Some task may not be able divide equally.
- It is necessary to take overhead associated with splitting the task up also into account.

Grid Computing

Grid computing is a distributed architecture of large numbers of computers connected to solve a complex problem. In the grid computing model, servers or personal computers run independent tasks and are loosely linked by the Internet or low-speed networks. Computers may connect directly or via scheduling systems. In Grid computing inter-connected computer systems utilize the same resources collectively. Grid computing usually consists of one main computer that distributes information and tasks to a group of networked computers to accomplish a common goal. Grid computing is often used to complete complicated or tedious mathematical or scientific calculations.

Examples of Grid Applications

- Application partitioning that involves breaking the problem into discrete pieces
- Discovery and scheduling of tasks and workflow
- Data communications distributing the problem data where and when it is required
- Provisioning and distributing application codes to specific system nodes
- Results management assisting in the decision processes of the environment
- Autonomic features such as self-configuration, self-optimization, self-recovery, and self-management

Schedulers

Schedulers are types of applications responsible for the management of jobs, such as allocating resources needed for any specific job, partitioning of jobs to schedule parallel execution of tasks, data management, event correlation, and service-level management capabilities. These schedulers then form a hierarchical structure, with meta-schedulers that form the root and other lower level schedulers, while providing specific scheduling capabilities that form the leaves.

Von-Neumann Architecture

Von Neumann Architecture consists of a CPU, memory and input output devices. The program is stored in the memory. The CPU fetches an instruction from the memory at a time and executes it.

MAJOR COMPONENTS OF THIS ARCHITECTURE:

1. Central processing unit

- Control unit (CU) - This unit controls signals of all devices of a computer system.
- Arithmetic and logic unit (ALU) - It carries out mathematical and logical operations.
- Memory register - A CPU register is one of a small set of data holding places which is part of the computer processor. A register may hold an instruction, a storage address, or any kind of data

2. Memory

- Primary memory
- Secondary memory

3. Input device

4. Output device

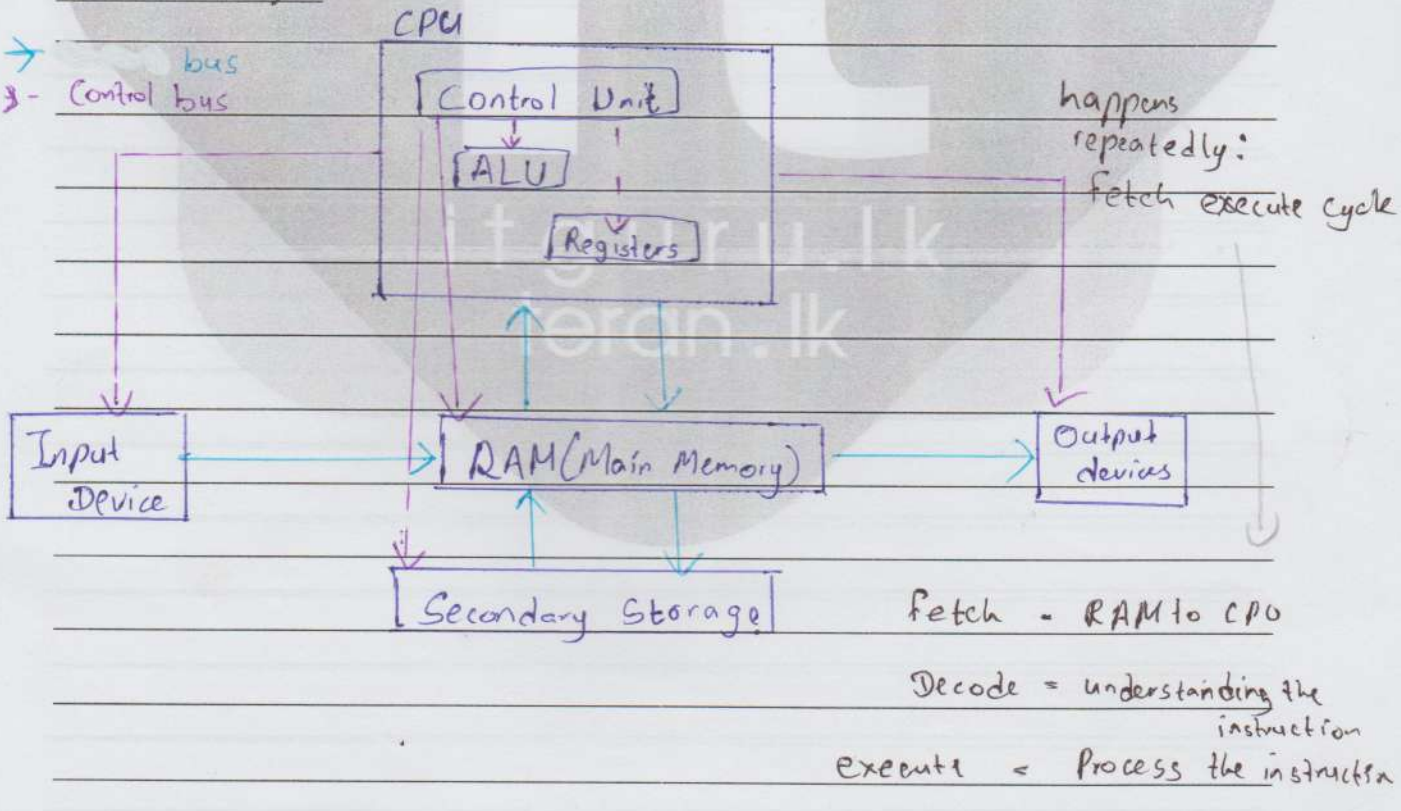
Data bus

A data bus is a system within a computer or device, consisting of a connector or set of wires, that provides transportation for data.

Control bus

Control bus is used to transmit a variety of control signals to components and devices.

Fetch Execute Cycle



Multi-core processors

A multi-core processor is a single computing component with two or more independent actual processing units (cores), which are units that read and execute program instructions. Therefore, the single processor can run multiple instructions on separate cores at the same time.

Need of multi-core processor

- Can be run a program by dividing some parts. So, it gets executed fast.
- It enables parallel programming.
- To get the high performance from a single machine.

Computer Memory

Computer memory can be identified in two main categories: Volatile and Non-Volatile

Volatile Memory

Volatile memory is a computer storage that only holds the data while the device is powered.
Eg: Register, Cache memory, RAM

Cache memory

The cache memory is used to store program instructions that are frequently accessed by software during operation.

Types of cache memories

- **Level 1 (L1)** cache is extremely fast but relatively small, and is usually embedded in the processor chip (CPU).
- **Level 2 (L2)** cache is often more capacity than L1. It may be located on the CPU or on a separate.
- **Level 3 (L3)** cache is typically specialized memory that works to improve the performance of L1 and L2. It can be significantly slower than L1 or L2, but is usually double the speed of RAM.

RAM

RAM is the main memory of the computer that holds data for running applications and required data for a computer.

Types of RAM

- **SRAM – Static RAM**
  SRAM is random access memory that retains data bits in its memory as long as power is being supplied. SRAM is used for cache memory and register memory.
- **DRAM – Dynamic RAM**
  This type of RAM is continuously refreshed or it will lose its contents.
- **SDRAM - Synchronous DRAM**
  It is a type of memory that synchronizes itself with the computer's system clock.

Non-volatile memory

This is a type of computer memory that has the capability to hold saved data even if the power is turned off. Eg: ROM, Hard disk etc.

ROM – Read Only Memory

ROM retains its contents even when the computer is turned off. ROM stores essential programs such as the program that boots the computer.

Types of ROM

- **PROM (Programmable ROM)**
  It is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it remains there forever.
- **EPROM (Erasable PROM)**
  EPROM is a special type of memory that retains its contents until it is exposed to ultraviolet light. The ultraviolet light clears its contents, making it possible to reprogram the memory.
- **EEPROM (Electrically Erasable PROM)**
  It can be erased by exposing it to an electrical charge.

Secondary storage

Magnetic storage device

Magnetic storage is the manipulation of magnetic fields on a medium in order to record audio, video or other data. In main computer storage mechanisms have generally involved a spinning disc or platter and read write heads on an armature. Many types of magnetic storage involve a tape medium ether on a real or in a cassette that is moved by read and write heads.

Eg: Hard disk, Floppy disk, Magnetic tape

Optical storage device

Optical storage is any storage method in which data is written and read with a laser for archival or backup purposes. Typically, data is written to optical media, such as CDs and DVDs. For several years, proponents have spoken of optical storage as a near-future replacement for both hard drives in personal computers and tape backup in mass storage. Optical media is more durable than tape and less vulnerable to environmental conditions. On the other hand, it tends to be slower than typical hard drive speeds, and to offer lower storage capacities.

Eg: CD, DVD, Blu-Ray disc

Solid state storage

Solid-state storage (SSS) is a type of computer storage media made from silicon microchips. SSS stores data electronically instead of magnetically, as spinning hard disk drives (HDDs) or magnetic oxide tape do. Solid-state storage can be found in three form factors: solid-state drives (SSD), solid-state cards (SSC) and solid-state modules (SSM). An important advantage of solid-state storage is that it contains no mechanical parts, allowing data transfer to and from storage media to take place at a much higher speed and providing a more predictable lifespan for the storage media. Because there are no moving parts, SSDs produce far less heat than HDDs.

Eg: Flash drive, Memory card

Memory Access Methods

Following are the memory access methods

- **Sequential access**
  Start at the beginning and read through in order. Eg: Tape
- **Random access**
  Individual addresses identify directly and access the data immediately. Eg: RAM

Computer Memory Hierarchy