History/ Evolution and the components of the Computer Systems

Computer Generations

- First generation (1944-1955)
- Second generation (1955-1964)
- Third generation (1964-1971)
- Fourth generation (1971-present)
- Fifth generation (1980-present)

1st Generation Computers

The first generation of computers were built from vacuum tubes, which were the only electronic components available at the time. These computers were very large, expensive, and consumed a lot of power. They were also very slow, with speeds of only a few kilohertz.

- Machine language: First generation computers used machine language as their programming language. Machine language is a low-level language that is difficult to program in
- Vacuum tubes: Vacuum tubes were the main electronic components used in first generation computers. Vacuum tubes are large, fragile, and consume a lot of power.
- Batch processing: First generation computers used batch processing to execute programs. Batch processing is a method of processing programs in which a group of programs are submitted to the computer and then executed one at a time.
- Large and expensive: First generation computers were very large and expensive.

2nd generation computers

The second generation of computers were built from transistors, which replaced vacuum tubes as the main electronic component. This made computers smaller, faster, and more energy efficient. Programming languages were also developed during this generation, making it easier to write code for computers.

- Transistors: Transistors were the main electronic components used in second generation computers. Transistors are smaller, more efficient, and less fragile than vacuum tubes.

- High-level languages: Second generation computers used high-level languages, such as FORTRAN and COBOL. High-level languages are easier to program in than machine language.
- Operating systems: Second generation computers used operating systems to manage their resources. Operating systems made it easier to use computers and allowed them to run multiple programs at the same time.

Smaller and more affordable: Second generation computers were smaller and more affordable than first generation computers. This made them more accessible to businesses and individuals.

3rd generation computers

Third generation computers were built using integrated circuits (ICs), which are made up of many transistors on a single chip. This made computers even smaller, faster, and more energy-efficient than second generation computers. ICs also made it possible to build multiple computers on a single chip, leading to the development of minicomputers and mainframes.

- Integrated circuits: Integrated circuits (ICs) were the main electronic components used in third generation computers. ICs are made up of many transistors on a single chip, which makes them smaller, faster, and more energy-efficient than transistors.
- High-level languages: Third generation computers used high-level languages, such as FORTRAN, COBOL, and BASIC. High-level languages are easier to program in than machine language.
- Operating systems: Third generation computers used operating systems to manage their resources. Operating systems made it easier to use computers and allowed them to run multiple programs at the same time.
- Graphical user interfaces: Third generation computers began to use graphical user interfaces (GUIs), which made it easier for users to interact with computers.

4th Generation Computers

Minicomputers and mainframes: Third generation computers saw the development of minicomputers and mainframes. Minicomputers were smaller and less expensive than mainframes, but they were still powerful enough for businesses and universities. Mainframes were larger and more expensive than minicomputers, but they were even more powerful.

- Microprocessors: Microprocessors were the main electronic components used in fourth generation computers. Microprocessors are made up of many transistors on a single chip, which makes them smaller, faster, and more energy-efficient than ICs.
- Personal computers: Fourth generation computers saw the development of personal computers (PCs). PCs were smaller, less expensive, and easier to use than mainframes and minicomputers.
- Operating systems: Fourth generation computers used operating systems to manage their resources. Operating systems made it easier to use computers and allowed them to run multiple programs at the same time.
- Graphical user interfaces: Fourth generation computers began to use graphical user interfaces (GUIs), which made it easier for users to interact with computers.
- Application software: Fourth generation computers saw the development of a wide variety of application software, such as word processors, spreadsheets, and games.

5th Generation Computers

The fifth generation of computers is still in its early stages, but it has the potential to revolutionize computing. Parallel processing, artificial intelligence, and quantum computing are all powerful technologies that can be used to solve complex problems. As these technologies continue to develop, fifth generation computers will become even more powerful and versatile.

- Parallel processing: Parallel processing allows computers to perform multiple tasks at the same time. This is done by using multiple processors that work together to solve a problem.
- Artificial intelligence: Artificial intelligence (AI) allows computers to learn and make decisions on their own. AI is used in a variety of applications, such as speech recognition, machine translation, and fraud detection.
- Quantum computing: Quantum computing is a new technology that is still in development. Quantum computers use quantum bits, or qubits, to store information. Qubits can be in a superposition of states, which means that they can be in multiple states at the same time. This makes quantum computers much more powerful than traditional computers.

Von Neuman Architecture

Von Neumann architecture is a computer architecture model that was first proposed by John von Neumann in 1945. It is the most common architecture used in modern computers.

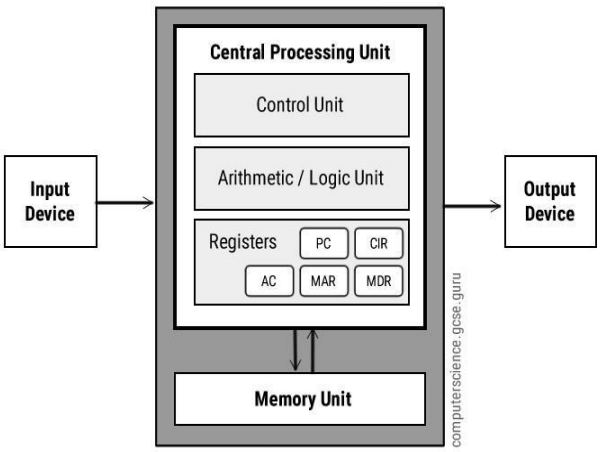

Figure 1: Von Neuman Architecture

- The key features of von Neumann architecture are:

    1. Programs and data are stored in the same memory. This means that the computer's central processing unit (CPU) can access both programs and data directly, without having to move them between different memory locations.
    2. The CPU is a sequential processor. This means that the CPU can only execute one instruction at a time, in a linear fashion.
    3. The CPU uses a fetch-decode-execute cycle to execute instructions. In this cycle, the CPU first fetches an instruction from memory, then decodes it, and then executes it.

- Here are some of the other key components of von Neumann architecture:

    1. Control unit: The control unit is responsible for fetching instructions from memory and decoding them.
    2. Arithmetic and logic unit (ALU): The ALU is responsible for performing arithmetic and logical operations on data.
    3. Registers: Registers are small, fast memory units that are used to store data that is being processed by the CPU.
    4. Input/output (I/O): I/O devices allow computers to interact with the outside world.

Von Neumann architecture is still the most common architecture used in modern computers. However, there are other architectures that are being developed, such as Harvard architecture and cache-coherent multiprocessing (CCMP). These architectures offer some advantages over von Neumann architecture, such as improved performance and security.

Components of a computer

- Input and output devices

Input and output devices are the hardware components that allow computers to interact with the outside world. Input devices allow users to enter data into the computer, while output devices allow the computer to display information to the user.

Some common input devices include:

1. Keyboard: The keyboard is the most common input device. It allows users to enter text and numbers into the computer.
2. Mouse: The mouse is a pointing device that allows users to control the cursor on the screen.
3. Scanner: A scanner allows users to scan images and documents into the computer.
4. Microphone: A microphone allows users to record audio into the computer.
5. Webcam: A webcam allows users to capture video and audio into the computer.

Some common output devices include:

1. Monitor: The monitor is the main output device. It displays information to the user, such as text, images, and video.
2. Printer: A printer allows users to print documents and images from the computer.
3. Speakers: Speakers allow users to hear audio from the computer.
4. Headset: A headset allows users to hear audio and speak into the computer.
5. Projector: A projector allows users to display information from the computer onto a larger screen.

Input and output devices are essential for computers to function. They allow users to interact with the computer and to see the results of their actions. Without input and output devices, computers would be useless.

- Processing device

This is known as the Central Processing Unit (CPU). The CPU is a chip that contains millions of transistors. These transistors are arranged in a way that allows the CPU to perform a variety of operations, such as adding, subtracting, multiplying, and dividing numbers.

- Storage devices

Computer storage devices are the hardware components that store data permanently. They allow users to save files, applications, and operating systems on the computer so that they can be accessed later.

There are many different types of computer storage devices, but the most common ones are:

- Registers: Registers are small and faster access memory units built into the central processing unit (CPU) of a computer. They are used to store data and instructions that are being used immediately by the CPU.
- Hard drives: Hard drives are the most common type of storage device. They are large and can store a lot of data.
- Solid-state drives (SSDs): SSDs are a newer type of storage device that is faster than hard drives. They are also smaller and more power efficient.
- Cash: The cache of the computer is a smaller, faster type of memory that is located closer to the CPU. This means that data stored in the cache can be accessed more quickly than data stored in main memory.
- Optical disc drives: Optical disc drives are used to read and write data to optical discs, such as CDs, DVDs, and Blu-ray discs.
- Flash drives: Flash drives are small, portable storage devices that can be connected to a computer via a USB port.
- Main Memory: This is known as primary memory or random-access memory (RAM). It is the part of a computer's memory that is directly accessible by the central processing unit (CPU). It is where the operating system, programs, and data are stored while the computer is running. The data stored in main memory is lost when the computer is turned off (volatile). The main memory of a computer is an important part of its overall performance. The more main memory a computer has, the more programs and data it can store at the same time, which can lead to faster performance.

    1. Main memory is used to store the operating system, programs, and data that are currently being used by the computer.
    2. Main memory is much faster than other types of computer memory, such as hard drives and solid-state drives.
    3. The amount of main memory in a computer can vary depending on the model and the price.

4. The more main memory a computer has, the more programs and data it can store at the same time, which can lead to faster performance.

The table 1 summarizes the differences between primary and secondary memory.

Table 1: Primary Vs Secondary Storages

Feature	**Primary memory (RAM)**	**Secondary memory**
Speed	Fastest	Slowest
Volatility	Volatile	Non-volatile
Use	Store data and instructions that are currently being used	Store data that is not currently being used

The amount of memory in a computer is measured in bytes. A byte is the smallest unit of data that can be stored in a computer. There are 8 bits in a byte.

The amount of memory that a computer needs depends on the tasks that it will be used for. For example, a computer that will be used for gaming will need more memory than a computer that will be used for word processing.

Here are some of the factors that affect the amount of memory that a computer needs:

- Operating system: The operating system is the software that controls the computer. Different operating systems require different amounts of memory.
- Applications: The applications that are installed on the computer will also use memory. More demanding applications will require more memory.
- Data: The amount of data that is stored on the computer will also affect the amount of memory that is needed.

If a computer does not have enough memory, it will not be able to run applications or store data. In some cases, the computer may even crash.

There are two types of memory allocations used in computers.

- Static memory
- Dynamic memory

Static memory: Static memory is allocated at compile time of a program. The amount of static memory that is allocated is fixed and cannot be changed. Static memory is used to store variables that are known at compile time, such as the size of an array.

Dynamic memory: Dynamic memory is allocated when the program is running. The amount of dynamic memory that is allocated can change during the execution of the program. Dynamic memory is used to store variables that are not known at compile time, such as the number of elements in a list.

Table 2 lists the advantages and disadvantages of static and dynamic memory.

Table 2: Static Vs Dynamic Memory

	Static Memory	Dynamic Memory
Advantages	• Faster access • Less overhead	• Can be changed • More flexible
Disadvantages	• Cannot be changed • Can lead to memory leaks	• Slower access • More overhead • Can lead to memory errors

The best type of memory to use depends on the specific needs of the program. If the program needs to access variables quickly, then static memory is a good choice. If the program needs to be able to change the amount of memory that it uses, then dynamic memory is a good choice.

The type of storage device that is best for a particular user depends on their needs. For example, if a user needs to store a lot of data, then a hard drive may be the best option. If a user needs a fast storage device, then an SSD may be the best option. If a user needs a portable storage device, then a flash drive may be the best option.

Here are some of the factors to consider when choosing a storage device:

1. Capacity: The capacity of a storage device is the amount of data that it can store.
2. Speed: The speed of a storage device is how fast it can read and write data.
3. Portability: The portability of a storage device is how easy it is to carry around.
4. Price: The price of a storage device is how much it costs.

Storage devices are an essential part of any computer system. They allow users to save files, applications, and operating systems on the computer so that they can be accessed later. When choosing a storage device, it is important to consider the user's needs and budget.