COMPUTER ARCHITECTURE AND ORGANIZATION

Lecture 1: Introduction

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evaluation strategies throughout the semester

- Marks Division (**Theory**):
- 40 sessional marks (Assignments, Quiz, Presentation and Mid Term)
- 60 marks for final exam (Theory based)

- Marks Division (**Practica**l):
- 30 sessional marks
- 20 marks finals (Lab + viva)

Reference books

- William Stallings , **"Computer Organization and Architecture"**(10th Edition)
- David A. Patterson & John L. Hennessy, " **Computer Organization and Design**" (5th Edition)
- David A. Patterson & John L. Hennessy, " **Computer Organization and Design**"

(RISC – V edition)

Computer Architecture:

- Computer Architecture deals with giving operational attributes of the computer or Processor to be specific. It deals with details like physical memory, ISA (Instruction Set Architecture) of the processor, the number of bits used to represent the data types, Input Output mechanism and technique for addressing memories.

Computer Organization:

- Computer Organization is realization of what is specified by the computer architecture .It deals with how operational attributes are linked together to meet the requirements specified by computer architecture. Some organizational attributes are hardware details, control signals, peripherals.

EXAMPLE:

- Say you are in a company that manufactures cars, design and all low-level details of the car come under computer architecture (abstract, programmers view), while making it’s parts piece by piece and connecting together the different components of that car by keeping the basic design in mind comes under computer organization (physical and visible).

Comparison

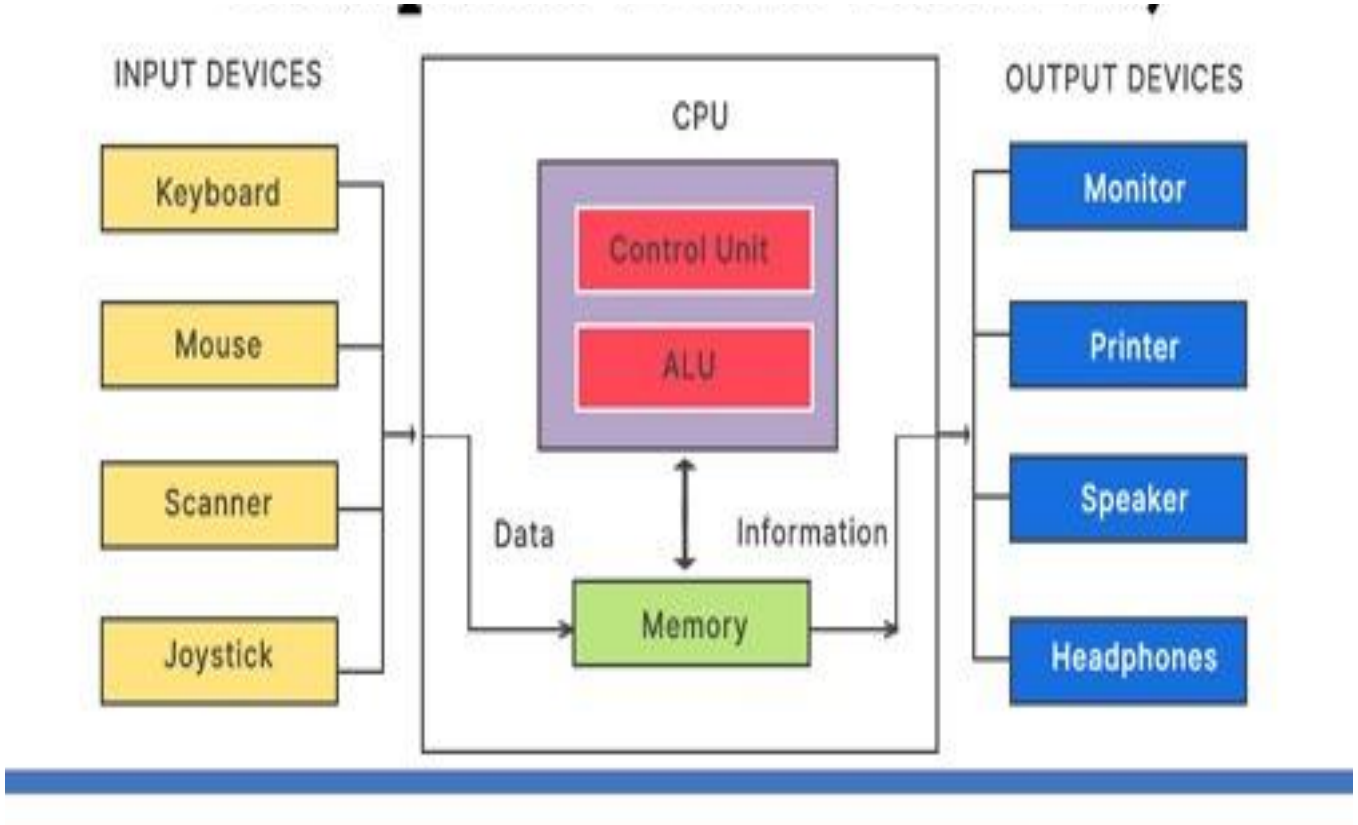
Computer Organization	Computer Architecture
Often called microarchitecture (low level)	Computer architecture (a bit higher level)
Transparent from programmer (ex. a programmer does not worry much how addition is implemented in hardware)	Programmer view (i.e. Programmer has to be aware of which instruction set used)
Physical components (Circuit design, Adders, Signals, Peripherals)	Logic (Instruction set, Addressing modes, Data types, Cache optimization)
How to do ? (implementation of the architecture)	What to do ? (Instruction set)

Examples of Computer Architectures and organization

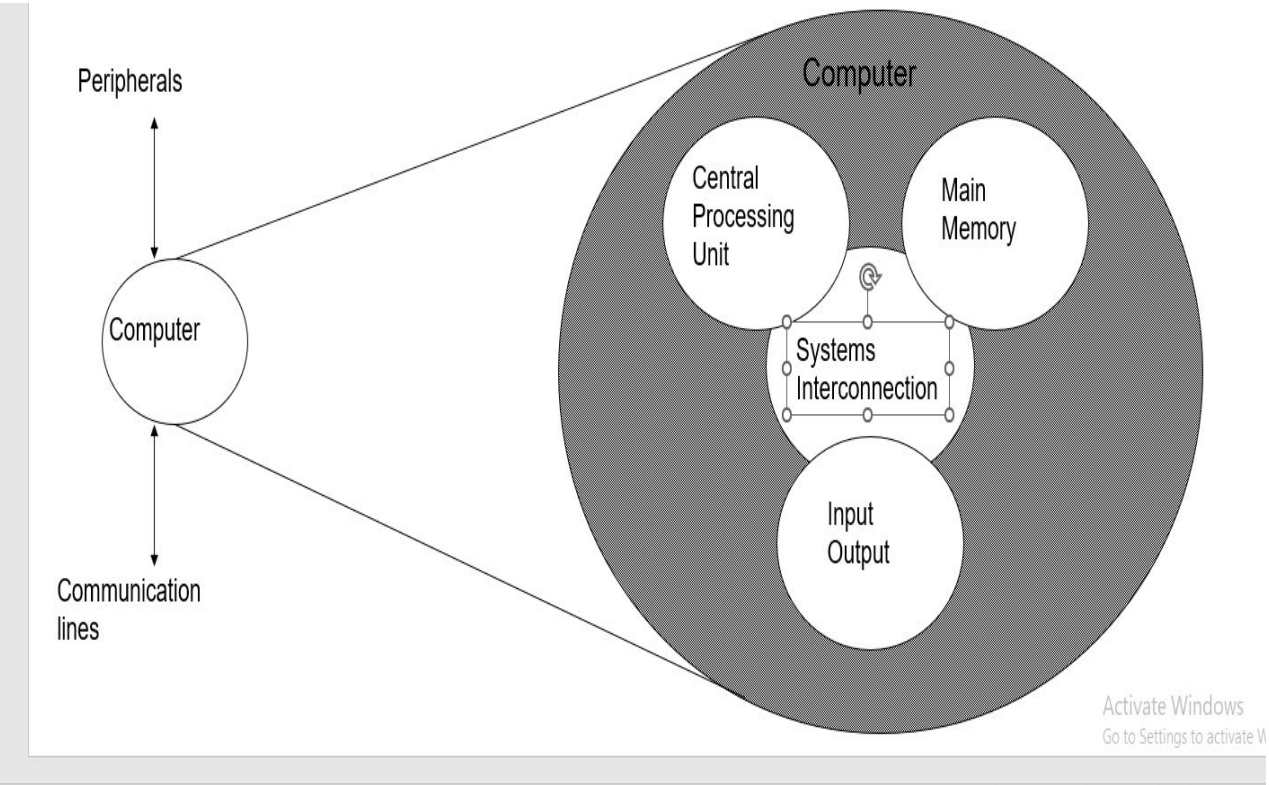
- **Examples of Computer Architectures**
- Von-Neumann Architecture
- Harvard Architecture
- Instruction Set Architecture
- Micro-architecture
- System Design

- **Examples of Computer Organization**
- CPU organization is classified into three categories based on the number of address fields:
- Organization of a single Accumulator.
- Organization of general registers
- Stack organization

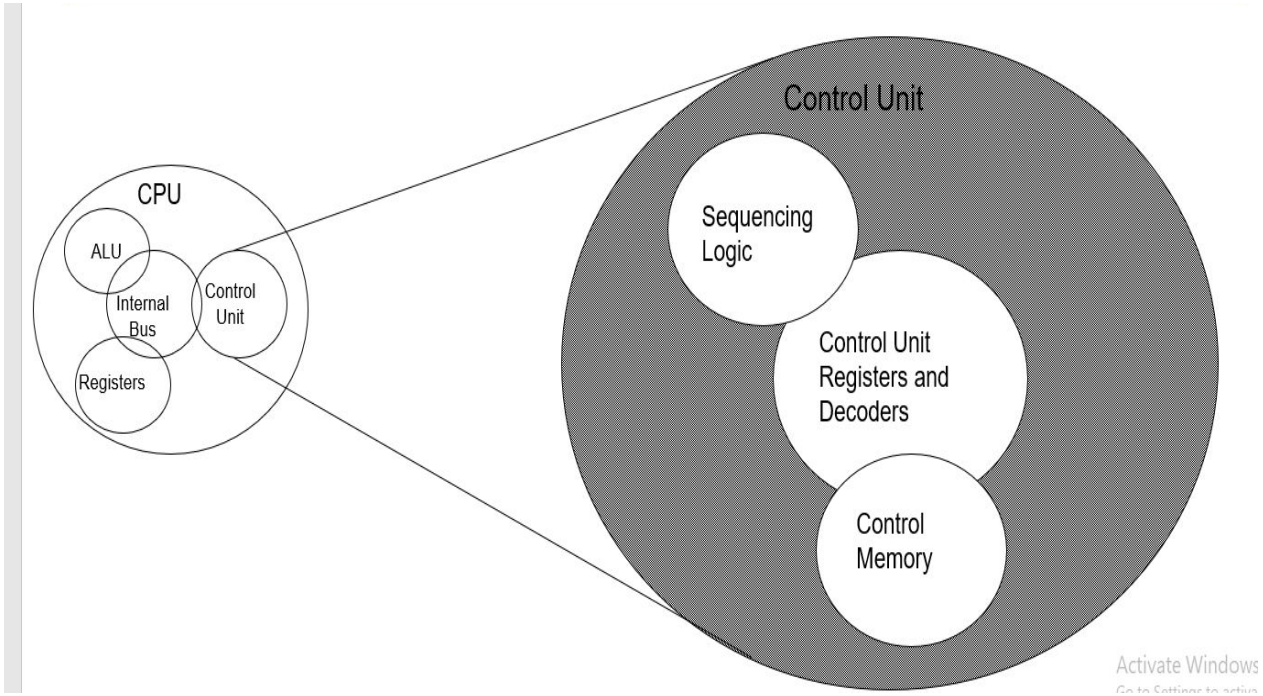
Basic computer architecture



Structure - *simple single-processor computer*



Structure - The Control Unit of single processor



GENERATIONS OF A COMPUTER

- Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. But nowadays, generation includes both hardware and software, which together make up an entire computer system. There are totally five computer generations known till date. Each generation has been discussed in detail along with their time period and characteristics. Here approximate dates against each generations have been mentioned which are normally accepted. Following are the main five generations of computers

S.N.	Generation & Description
1	**First Generation** The period of first generation: 1946-1959. Vacuum tube based.
2	**Second Generation** The period of second generation: 1959-1965. Transistor based.
3	**Third Generation** The period of third generation: 1965-1971. Integrated Circuit based.
4	**Fourth Generation** The period of fourth generation: 1971-1980. VLSI microprocessor based.
5	**Fifth Generation** The period of fifth generation: 1980-onwards. ULSI microprocessor based

First generation

- The period of first generation was 1946-1959. The computers of first generation used vacuum tubes as the basic components for memory and circuitry for CPU (Central Processing Unit). These tubes, like electric bulbs, produced a lot of heat and were prone to frequent fusing of the installations, therefore, were very expensive and could be afforded only by very large organizations. In this generation mainly batch processing operating system were used. Punched cards, paper tape, and magnetic tape were used as input and output devices. The computers in this generation used machine code as programming language.

Cont.

The main features of first generation are:

- Vacuum tube technology
- Unreliable
- Supported machine language only
- Very costly
- Generated lot of heat
- Huge size
- Need of A.C.
- Non-portable
- Consumed lot of electricity

Cont.

- Some computers of this generation were: ▫
- ENIAC
- EDVAC
- UNIVAC
- IBM-701
- IBM-650

Second generation

- The period of second generation was 1959-1965. In this generation transistors were used that were cheaper, consumed less power, more compact in size, more reliable and faster than the first generation machines made of vacuum tubes. In this generation, magnetic cores were used as primary memory and magnetic tape and magnetic disks as secondary storage devices. In this generation assembly language and high-level programming languages like FORTRAN, COBOL were used. The computers used batch processing and multiprogramming operating system.

Cont.

- The main features of second generation are: ▫
- Use of transistors
- Reliable in comparison to first generation computers
- Smaller size as compared to first generation computers
- Generated less heat as compared to first generation computers
- Consumed less electricity as compared to first generation computers
- Faster than first generation computers
- Still very costly
- A.C. needed
- Supported machine and assembly languages

Cont.

- Some computers of this generation were:
- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

Third generation

- The period of third generation was 1965-1971. The computers of third generation used integrated circuits (IC's) in place of transistors. A single IC has many transistors, resistors and capacitors along with the associated circuitry. The IC was invented by Jack Kilby. This development made computers smaller in size, reliable and efficient. In this generation remote processing, time-sharing, multi-programming operating system were used. Highlevel languages (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68 etc.) were used during this generation

Cont.

- The main features of third generation are:
- IC used
- More reliable in comparison to previous two generations
- Smaller size
- Generated less heat
- Faster
- Lesser maintenance
- Still costly
- A.C needed
- Consumed lesser electricity
- Supported high-level language

Cont.

- Some computers of this generation were:
- IBM-360 series
- Honeywell-6000 series
- PDP(Personal Data Processor)
- IBM-370/168
- TDC-316

Fourth generation

- The period of fourth generation was 1971-1980. The computers of fourth generation used Very Large Scale Integrated (VLSI) circuits. VLSI circuits having about 5000 transistors and other circuit elements and their associated circuits on a single chip made it possible to have microcomputers of fourth generation. Fourth generation computers became more powerful, compact, reliable, and affordable. As a result, it gave rise to personal computer (PC) revolution. In this generation time sharing, real time, networks, distributed operating system were used. All the high-level languages like C, C++, DBASE etc., were used in this generation

Cont.

- The main features of fourth generation are:
  - VLSI technology used
  - Very cheap
  - Portable and reliable
  - Use of PC’s
  - Very small size
  - Pipeline processing
  - No A.C. needed
  - Concept of internet was introduced
  - Great developments in the fields of networks
  - Computers became easily available

Cont.

- Some computers of this generation were:
- DEC 10
- STAR 1000
- PDP 11 ▫ CRAY-1(Super Computer)
- CRAY-X-MP(Super Computer)

Fifth Generation

- The period of fifth generation is 1980-till date. In the fifth generation, the VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components. This generation is based on parallel processing hardware and AI (Artificial Intelligence) software. AI is an emerging branch in computer science, which interprets means and method of making computers think like human beings. All the high-level languages like C and C++, Java, .Net etc., are used in this generation.
- AI includes:
- Robotics
- Neural Networks
- Game Playing
- Development of expert systems to make decisions in real life situations.
- Natural language understanding and generation

- The main features of fifth generation are:
  - ULSI technology
  - Development of true artificial intelligence
  - Development of Natural language processing
  - Advancement in Parallel Processing
  - Advancement in Superconductor technology
  - More user friendly interfaces with multimedia features
  - Availability of very powerful and compact computers at cheaper rates

Cont.

- Some computer types of this generation are:
- Desktop
- Laptop
- Notebook
- Ultrabook
- Chromebook

COMPUTER TYPES

Classification based on Operating Principles Based on the operating principles, computers can be classified into one of the following types: -

1) Digital Computers

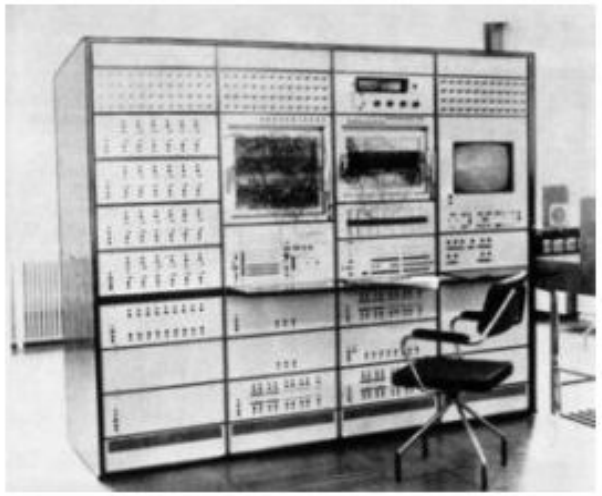
2) Analog Computers

3) Hybrid Computers

Digital Computers: - Operate essentially by counting. All quantities are expressed as discrete or numbers. Digital computers are useful for evaluating arithmetic expressions and manipulations of data (such as preparation of bills, ledgers, solution of simultaneous equations etc).

- Analog Computers:- An analog computer is a form of computer that uses the continuously changeable aspects of physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved. In contrast, digital computers represent varying quantities symbolically, as their numerical values change

- Hybrid Computers:- are computers that exhibit features of analog computers and digital computers. The digital component normally serves as the controller and provides logical operations, while the analog component normally serves as a solver of differential equations



Classification digital Computer based on size and Capability

Based on size and capability, computers are broadly classified into

Micro Computers(Personal Computer) :

A microcomputer is the smallest general purpose processing system. The older pc started 8 bit processor with speed of 3.7MB and current pc 64 bit processor with speed of 4.66 GB. Examples: - IBM PCs, APPLE computers

Microcomputer can be classified into 2 types:

1. Desktops

2. Portables

The difference is portables can be used while travelling whereas desktops computers cannot be carried around.

The different portable computers are: -

1) Laptop
2) 2) Notebooks
3) 3) Palmtop (hand held)
4) 4) Wearable computers

Classification based on number of microprocessors

- Based on the number of microprocessors, computers can be classified into

a) Sequential computers

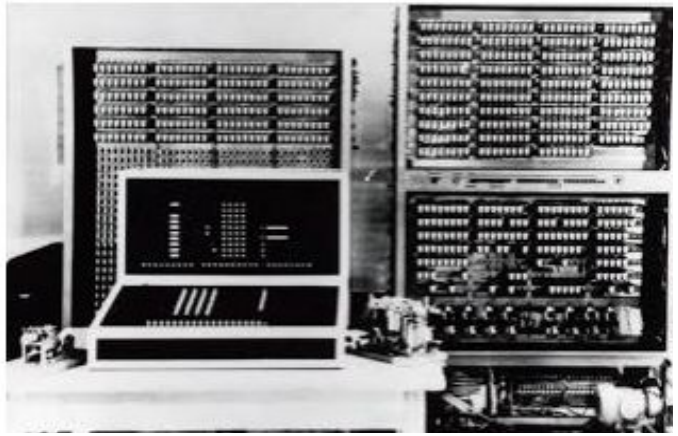
b) b) Parallel computers

Sequential computers: - Any task complete in sequential computers is with one microcomputer only. Most of the computers (today) we see are sequential computers where in any task is completed sequentially instruction after instruction from the beginning to the end.

Parallel computers: - The parallel computer is relatively fast. New types of computers that use a large number of processors. The processors perform different tasks independently and simultaneously thus improving the speed of execution of complex programs dramatically. Parallel computers match the speed of supercomputers at a fraction of the cost.

Classification based on word-length

- A binary digit is called “BIT”. A word is a group of bits which is fixed for a computer. The number of bits in a word (or word length) determines the representation of all characters in these many bits. Word length leis in the range from 16-bit to 64-bitsf or most computers of today



Classification based on number of users.

- Based on number of users, computers are classified into: -

Single User: - Only one user can use the resource at any time.

Multi User: - A single computer shared by a number of users at any time

Network: - A number of interconnected autonomous computers shared by a number of users at any time.

- COMPUTER TYPES

A computer can be defined as a fast electronic calculating machine that accepts the (data) digitized input information process it as per the list of internally stored instructions and produces the resulting information. List of instructions are called programs & internal storage is called computer memory.

The different types of computers are

1. Personal computers: - This is the most common type found in homes, schools, Business offices etc., It is the most common type of desk top computers with processing and storage units along with various input and output devices.
2. 2. Note book computers: - These are compact and portable versions of PC
3. 3. Work stations: - These have high resolution input/output (I/O) graphics capability, but with same dimensions as that of desktop computer. These are used in engineering applications of interactive design work.
4. 4. Enterprise systems: - These are used for business data processing in medium to large corporations that require much more computing power and storage capacity than work stations. Internet associated with servers have become a dominant worldwide source of all types of information.
5. 5. Super computers: - These are used for large scale numerical calculations required in the applications like weather forecasting etc.,

BASIC TERMINOLOGY

•Input: Whatever is put into a computer system.

•Data: Refers to the symbols that represent facts, objects, or ideas.

•Information: The results of the computer storing data as bits and bytes; the words, umbers, sounds, and graphics.

•Output: Consists of the processing results produced by a computer. •Processing: Manipulation of the data in many ways.

•Memory: Area of the computer that temporarily holds data waiting to be processed, stored, or output. •Storage: Area of the computer that holds data on a permanent basis when it is not immediately needed for processing.

•Assembly language program (ALP) –Programs are written using mnemonics

•Mnemonic –Instruction will be in the form of English like form

•Assembler –is a software which converts ALP to MLL (Machine Level Language)

•HLL (High Level Language) –Programs are written using English like statements

•Compiler -Convert HLL to MLL, does this job by reading source program at once

•Interpreter –Converts HLL to MLL, does this job statement by statement

•System software –Program routines which aid the user in the execution of programs eg: Assemblers, Compilers

•Operating system –Collection of routines responsible for controlling and coordinating all the activities in a computer system

Defining Performance

- When trying to choose among different computers, performance is an important attribute.

- If you were running a program on two different desktop computers, you'd say that the faster one is the desktop computer that gets the job done first.

- If you were running a datacenter that had several servers running jobs submitted by many users, you'd say that the faster computer was the one that completed the most jobs during a day.

Defining Performance (Contd..)

- As an individual computer user, you are interested in reducing **response time**; the time between the start and completion of a task , also called **execution time.**

- The total time required for the computer to complete a task, including:
- disk accesses
- memory accesses
- I/O activities
- operating system overhead
- CPU execution time, and so on.

Basic Measures of Computer Performance

- **Processor speed:** The speed of the processor, measured in GHz (gigahertz), determines how quickly the computer can execute instructions and process data.
- **Memory:** The amount and speed of the memory, including RAM (random access memory) and cache memory, can impact how quickly data can be accessed and processed by the computer.
- **Storage:** The speed and capacity of the storage devices, including hard drives and solid-state drives (SSDs), can impact the speed at which data can be stored and retrieved.

Basic Measures of Computer Performance

- **I/O devices:** The speed and efficiency of input/output devices, such as keyboards, mice, and displays, can impact the overall performance of the system.
- **Software optimization:** The efficiency of the software running on the system, including operating systems and applications, can impact how quickly tasks can be completed.

Basic Measures of Computer Performance

- **Throughput** is the total amount of work done in a given time.
- **CPU execution time** is the total time a CPU spends computing on a given task. It also excludes time for I/O or running other programs. This is also referred to as simply CPU time.
- Performance is determined by execution time as performance is inversely proportional to execution time.

Performance = (1 / Execution time)

Basic Measures of Computer Performance

Clock speed

- Operations performed by a processor, such as fetching an instruction, decoding the instruction, performing an arithmetic operation, and so on, are governed by a system clock.
- 1-GHz processor receives 1 billion pulses per second.
- The rate of pulses is known as the **clock rate,** or **clock speed.** One increment, or pulse, of the clock is referred to as a **clock cycle**, or a **clock tick.**
- The time between pulses is the **cycle time.**

Thank you ☺️

- That’s all about Performance of a system.