8086 Microprocessor

↳ 10^{-6} size
(8 and 16)

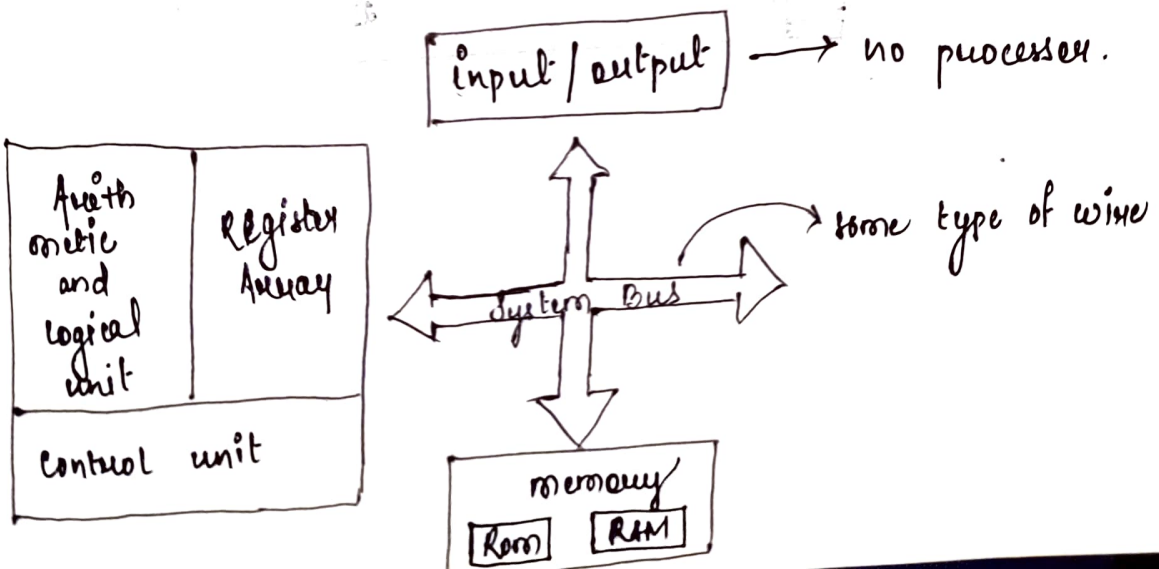
→ Register organization of 8086
→ Architecture
→ Addressing modes of 8086.
→ Instruction set of 8086.

Assembler Assmb language → low level
Machine level
Binary level.

Compiler high language to low.

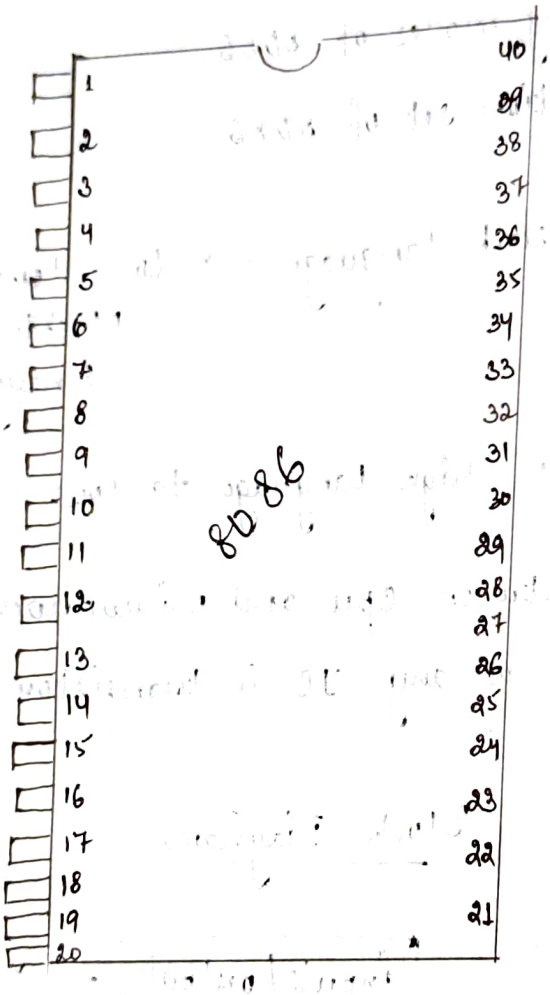
① difference between cpu and microprocessor.
② Basic unit of any IC is transistor.

Block Diagram



dual inline package — both side connected
even no.

How
IC are
placed in
motherboard?



Features of 8086

The most prominent features of a 8086 microprocessor are as follows:

→ It is a 40 pin dual inline package IC.

→ It is a 16-bit microprocessor.

→ 8086 has a 20-bit address bus and can access up to 2726 (1MD) memory location.

→ It can support up to 64kI/O

→ It provides 14, 16-bit registers.

→ Word size is 16 bits and double word size is 4 bytes.

It has multiplexed address and data

Computer architecture refers to those attributes of a system i.e visible to a programmer or that have a direct impact on the logical execution of a program.

eg. instruction sets
IO Mechanisms
Memory addressing techniques.

Computer organization refers to the operational units and their interconnections that realise the architectural specification.

eg. • Hardware Details.
• Interface between the computer and the peripherals and the Memory technology used.

Computer Architecture	Computer Organization
(1) Architecture describes what the computer does.	Organization describes how it does.
(2) It deals with the functional behaviour of the computer systems.	It deals with the structural relationship.
(3) It deals with the high level design issues.	It deals with the low level design issues.
(4) It indicates the hardware.	It indicates performance.

(5) It is decided first. It will be decided second.

(6)

Computer Structure and function.

structure : The way in which the components are interrelated.

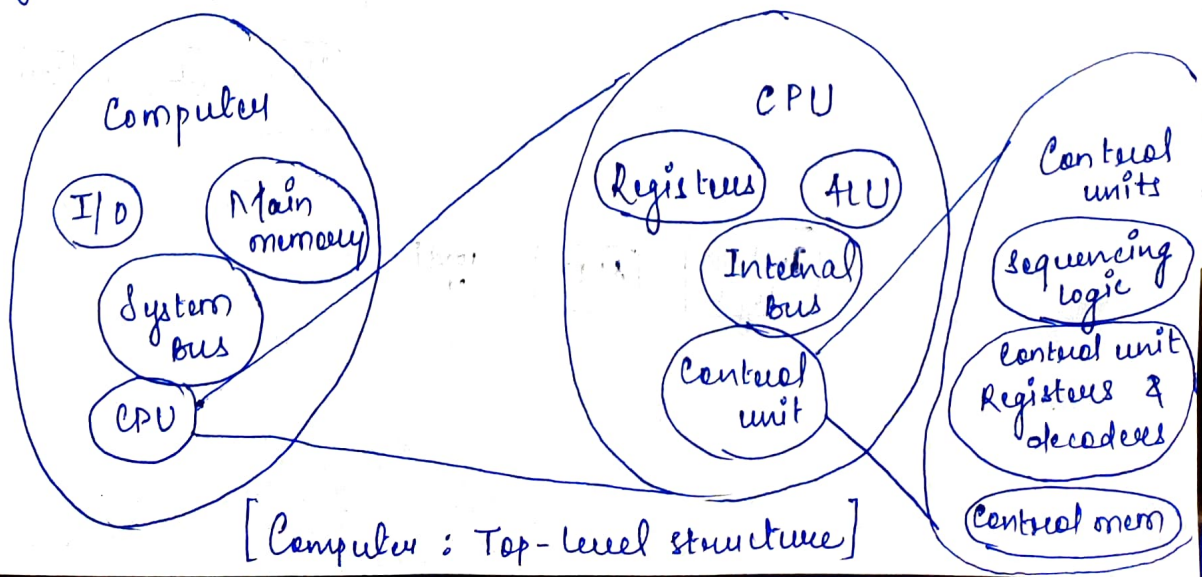
function : The operation of each individual component as part of the structure.

There are 4 functions that a computer can perform :

1. Data processing
2. Data storage
3. Data Movement
4. Control.

There are 4 main structural components :

1. CPU
2. Main memory
3. IO systems
4. System bus or system interconnections.

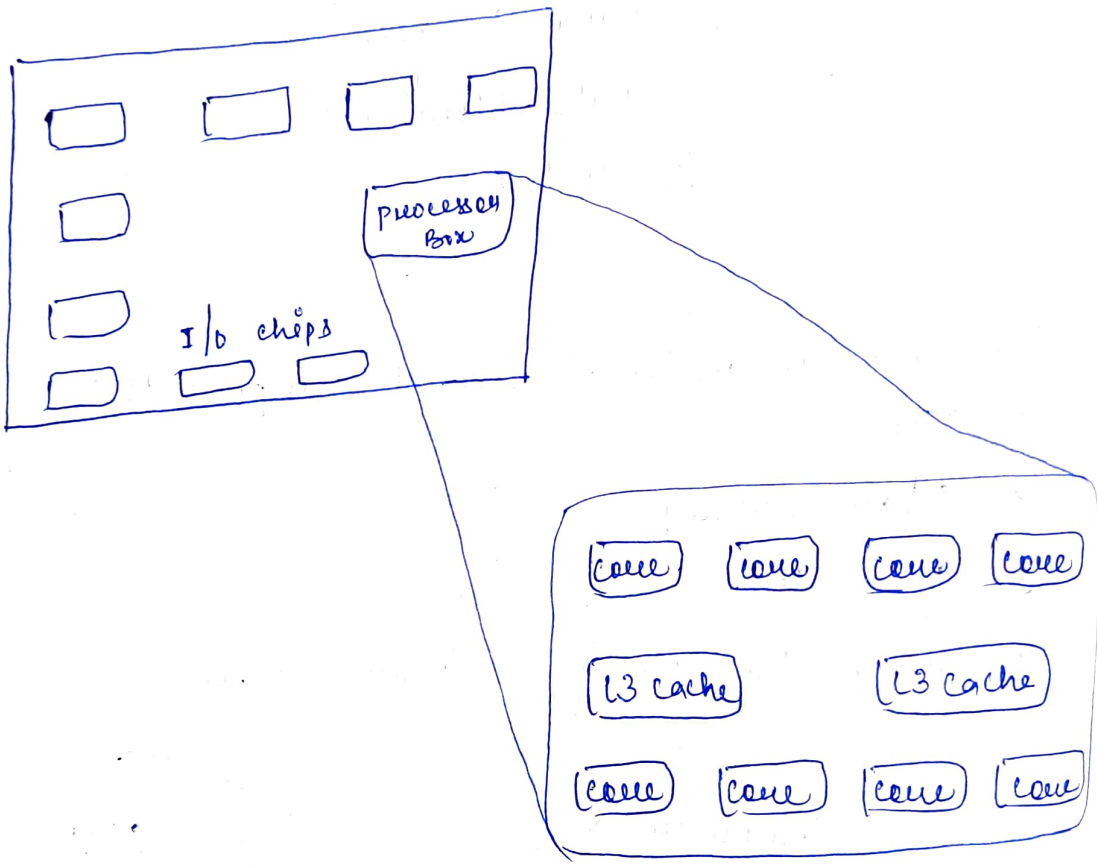


[Computer : Top-level structure]

Multicore Computer Structure

- The computers with multiple processor present on a single chip is called a multicore computer and each processing unit consisting of a control unit, ALU, registers and cache is called a core.

- An important feature of this is the use of multiple layers of memory called cache memory between the processor and the main memory.



Instruc logic | ALU | load/ st

History of Computers

→ Each new generations is Characterized by greater processing performance, larger memory capacity smaller size and lower Cost than the previous one

* Famous first generation Computer is known as IAS Computer is the first Basic prototype for all general-purpose Computers.
* Basic design approach is the Stored-program Concept.
* The idea of the first Computer was proposed By Von Neumann
* It Consists of (i) main memory (which stores Both data and instructions)
  (ii) an arithmetic and logic unit (ALU)
  (iii) a control unit (which interprets the instructions)
  (iv) input-Output (I/O).

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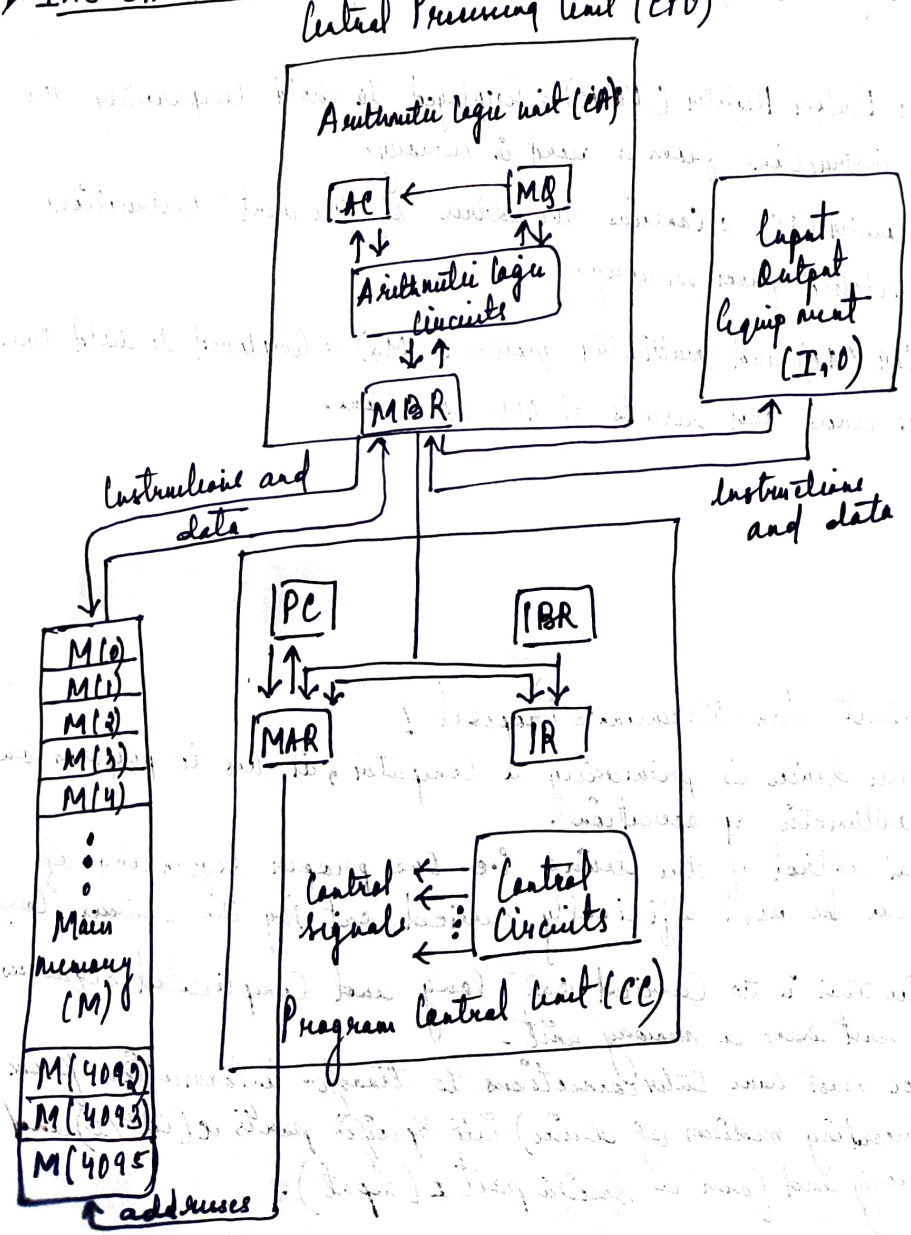
→ IAS Structure.



AC : accumulator register
MQ : Multiply-quotient register
MBR : memory Buffer register
IBR : Instruction Buffer Register
PC : program Counter
MAR : Memory address register
IR : Instruction Register.

Description of Registers :-

→ Memory Buffer Register (MBR) = Contains a word to be stored in memory or sent to the I/O unit, is used to receive a word from memory.

→ Memory address Register (MAR) = Specifies the address in memory of the word to be written from or read into the MBR.

→ Instruction Register (IR) = Contains the 8-bit opcode instructions being executed.

→ Instruction Buffer Register (IBR) = Employed to hold temporarily the right hand instructions from a word in memory.

→ Program Counter (PC) = Contains the address of the next instructions pair to be fetched from memory.

→ Accumulator (AC) and multiplier quotient (MQ) = Employed to hold temporarily operands and results of ALU operations.

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Q- Describe about Von-Neumann's Proposal ?

ans → (i) as the device is primarily a Computer, it has to perform one elementary arithmetic op operations.

(ii) the logical control of the device i.e the proper sequencing of operations can be most efficiently carried out by the central control unit.

(iii) Any device that is to carried out long and complicated sequences of operations must have a memory unit.

(iv) The device must have Inter connections to transfer information from R (central recording medium of device) into Specific parts of (AC+CC) and M (main memory) and from a Specific part to (input).

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VON NEUMANN'S PROPOSAL:

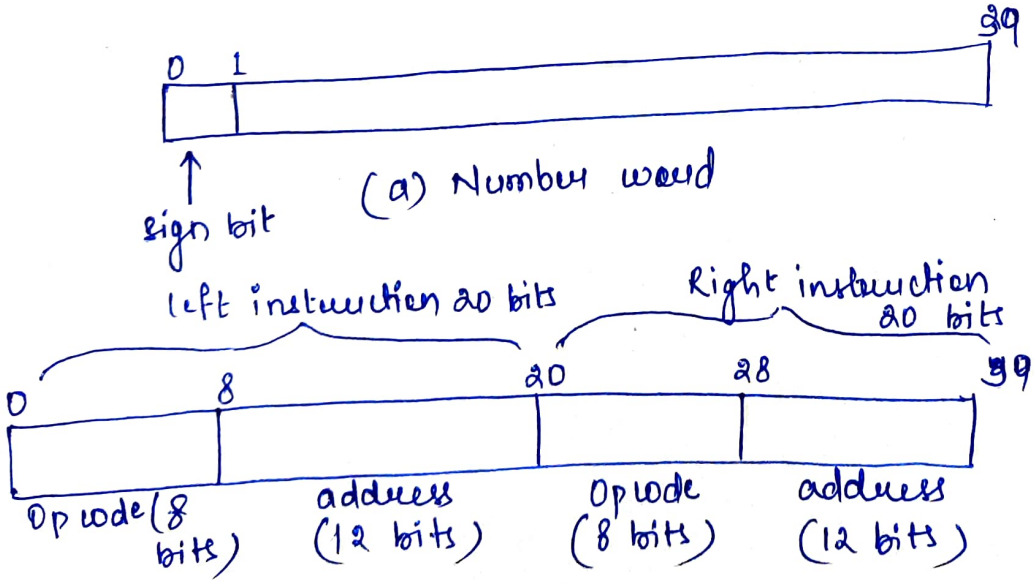
(1) As the device is primarily a computer it has to perform the elementary arithmetic operations.

(2) The logical control of the device, i.e the proper sequencing of operations can be most efficiently carried out by the central control unit.

(3) Any device that is to carry out long and complicated sequences of operations must have a memory unit.

(4) The device must have interconnections to transfer information from R (outside recording medium of the device) into specific parts C (CA + CC) and M (main memory) and from the specific part I (input).

(5) The device must have interconnections to transfer from its specific parts C and M into R and from the specific part O (output).



(b) Instruction word.

Second Generation Computers : Transistors

Third Generation computers : Integrated Circuits

Inductors are not used to create circuit because it is bigger in size.

Registors and Transistors are used to create circuit having current.

Moore's law which states that the number of transistors doubles in every 18 months.

Later Generations

1. Semiconductor Memory
2. Microprocessors.

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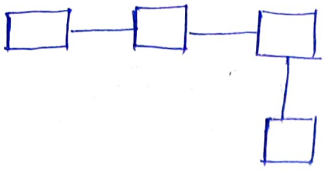
Q. { Short note on embedded system?
4 application of embedded system?
How embedded system works?

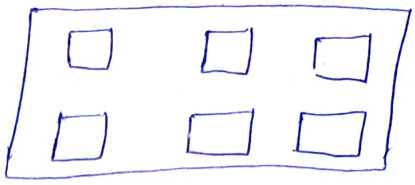
Embedded Systems

PCB (printed circuit board)

Microprocessor



Microcontroller



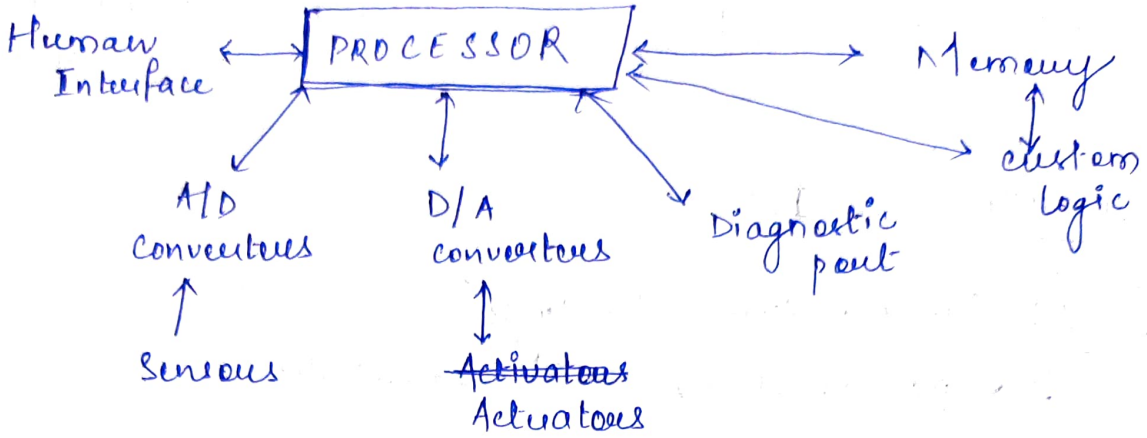
An embedded system is a microprocessor based computer system with software that is designed to perform a dedicated function either as an independent system or as a part of a large system.

> embedded system = electronic component + software

examples of embedded system :

1. domestic appliances like Microwave oven, tv, washing Machine, AC tooth brush, lighting system.
2. Central heating system
3. Digital computers, digital watch, fitness trackers, printers, electronic calculators
4. GPS System.
5. Automobile industry.
6. Home security system.

Q. How the embedded system works ?



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(*) Internet of Things

IoT

The IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or human beings that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human to human or human to computer interaction.

Iot is driven by the embedded devices

Applications

1. Home and building.
2. Health sector.
3. precision agriculture.
4. Smart environment control.
5. Smart Retail
6. Logistics and transportation.

Working.

- From the sensors it is going to the gateway.

Sensors ⟷ Gateway ⟷ cloud ⟷ Mobile apps.

Generations of IoT

(a) IT (information Technology).
↳ pc, servers, routers, fireballs.

(b) OT (operational Technology)
↳ devices with embedded systems.

(c) PT (personal Technology)
↳ smart phones, tablets, ebook readers.

(d) Sensor/actuator Technology
– data acquisition systems.

Differentiate between application processor and dedicated processor.

Application processor	dedicated processor
(1) Application processors are defined by the processors ability to execute complex operating systems like Linux, chrome and android.	Dedicated processors are dedicated to one or a small number of specific tasks required by the host devices.

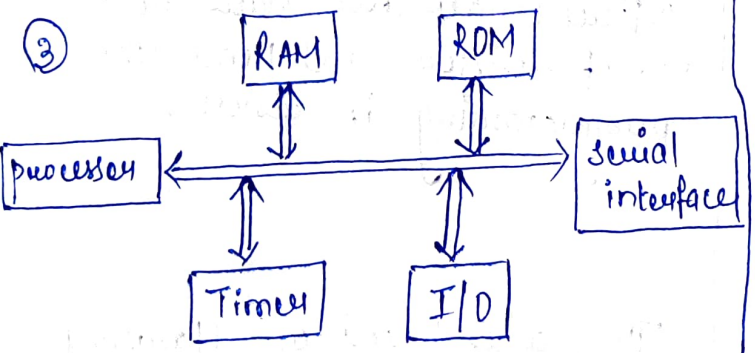
② It is general purpose in nature.

It is dedicated to a specific task and can be modified to reduce the size and cost of the processor.

③ Smart phones are embedded application processors.
→ examples.
It is designed to support numerous apps and wide variety of functions.

Anti lag break, fuel injection system.
→ examples.

Differentiate between Micro processor and Micro controller.

	Microprocessor	Micro controller
①	It is the basic unit of a computer system.	It is the basic unit of an embedded system.
②	It is just a processor, memory and IO components have to be connected externally.	It has an internal processor along with internal memory and IO components.
③		Processor | RAM | ROM Timer | I/O | serial interfaces
④	The circuit becomes large since the memory and the I/O components are connected	The circuit is small since the memory and the I/O components are present

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externally.	Internally.
(5) Cannot be used in compact systems and so the efficiency is less.	Can be used in compact systems and so it is more efficient.
(6) The cost of the entire system increases.	The cost of the entire system is low.
(7) Due to the external components the entire power consumption is more.	Since the external components are very less the total power consumption of the system is very less.
(8) Most of the micro processors do not have power saving features.	Most of the micro controllers have power saving mode. (this helps to reduce power consumption)
(9) Since memory and I/O components are externally connected, each instruction will need external operation Hence it is relatively slower.	Since the components are internally placed most of the operations are internal instructions. Hence speed is faster.
(10) Microprocessor has less no. of registers and most of the operations are memory based.	Micro controllers have more no. of registers and hence the programming is easier.
(11) They are based on Von Neuman's architecture where the program and data are stored in the same memory module.	They are based on Harvard architecture where the program memory and the data memory is separate.

(12) Mainly used in personal computers (desktops, laptops)	Mainly used in embedded system application – AC, oven.

CISC	RISC
(1) Complex instruction set computers.	Reduced instruction set computers.
(2) Example : X86 architecture	Example : Arm architecture (used by embedded system)
(3) More emphasis is given on the hardware design.	More emphasis is given on software.
(4) less no. of resistors.	More no. of resistors.
(5) More addressing modes.	less no. of addressing modes.
(6) pipe lining is difficult.	Pipelining is easier.
(7) Multiple instruction sizes and formats.	Instruction of same set with few formats.
(8) The original microprocessor of the IAS computer architecture.	~~It is~~ Redesigned IAS architec

ARM : Acorn Risk Machine

(9) A full set of computer instructions that intends to provide the necessary	An instruction set architectur that is designed to perform a smaller number of computer

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capabilities in an efficient way.

instructions so that it can operate at a higher speed.

2/5/2

* Arm chips are the processors in Apple's popular ipod and iphone devices.

The Arm design matched the growing commercial need for a high performance, low-power-consumption, small size and low cost processor for embedded applications. ⟶ Advantages of ARM architecture

Q. Short note on instruction set Architecture on thumb instruction set.

ARM Products

There are 3 cortex architectures, conveniently labeled with the initials A, R and M.

1. Cortex-A / Cortex-A50
2. Cortex-R
3. Cortex-M

MMU - Memory Management unit

2/5/22

Cloud Computing :

A model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud Services :

- All cloud services are provided using one of the three models (I) SaaS (II) PaaS (III) IaaS.
  - SaaS → Software as a service
  - PaaS → platform as a service
  - IaaS → Infrastructure as a service

SaaS - Software as a service

In simple this is a service which leverages business to work over the internet. SaaS is also called as "on demand software" and is priced on pay per use basis. SaaS allows business to reduce IT operational costs by outsourcing hardware and software maintainence and support to the cloud provider. SaaS is a rapidly growing market as indicated in recent reports that predict on going double digit growth.

PaaS - Platform as a service

PaaS provides a computing platform and solution stack as a service. In this model user or consumers creates software using tools or libraries from the providers. consumers also controls software deployment and configuration settings. Main aim of providers is to provid

network services, storage and other services.

IaaS - Infrastructure as a Service

It provides delivery of computing as a shared service reducing the investment cost operational and maintenance of hardware.

Infrastructure as a service (IaaS) is a way of delivering cloud companies computing infrastructure services storage network and operating system as an on demand service.

4/5/22

Chapter 2 : Performance Issues

pipelining / parallel processing

T1 ⟶ 1 (PF + D)

T2 ⟶ 1(E) + 2(PF + D)

T3 ⟶ 2(E) + 3(PF + D)

Microprocessor Speed

Can be increased by the following techniques :

(1) Pipelining - enables the processor to work simultaneously on multiple instructions at the same time by performing a different task (prephase decode execute) for each of the multiple instructions.

(2) Branch prediction — The processor looks ahead in the instruction code fetched from the memory and predicts which branches or groups of instructions are likely to be processed next.

(3) Super scalar execution — This is the ability to process more than one instruction in one clock cycle.

(4) Data flow analysis — The processor analysises which instructions are dependent on each others results or data to create an optimized schedule of the instructions.

(5) Speculative execution – By using branch prediction and data flow analysis some processors theoritecally execute instructions ahead of their actual appearance in the program.

Performance Balance

(1) Interface between the processor and the main memory.

(2) Managing the I/O devices.

(3) Balance the throughput and the processing demands of the processor components and the system interconnect.

Improvements in chip organisation and architecture

(1) Increase the hardware speed of the processor.

(2) Increase the size and speed of the cache memory.

(3) Make changes to the processors organisation and architecture that will help to increase the effective speed of the instruction execution (by using parallel processing)

5/5/22

Traditionally the dominant factor in performance gain is the increase in clock speed and the chip density. But there are certain disadvantages as follows :-

(1) Power
(2) RC delay
(3) Memory latency (delay)

MIC (Many Integrated core)

GPGPU (General purpose graphic processing unit)
GPU is a specialized electronic circuit designed to rapidly manipulate and alter memory to accelarate the formation of image in a frame in a display device

TWO LAWS

provide insights / information into the performance of parallel systems and multicore system.

Amdahl's Law

Speculative execution

Improvements in Chip Organisation and Architecture :-

→ Increase the hardware speed of the processor.
→ Increase the size and speed of the cache memory.
→ Make changes to the Processors Organisation and Architecture that help to increase the effective speed of the Instruction Execution. (By using Parallel Processing)

05/05

→ Traditionally the dominant factor in performance gain is the increase in the clock speed and the chip density.
→ But there are certain disadvantages as follows :-

- Power
- RC delay
- Memory latency. (delay)

MICs → Many Integrated Core.

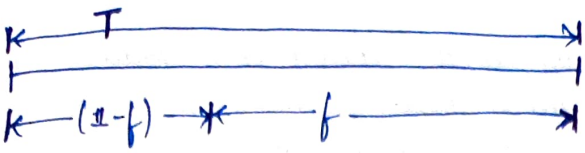
* MICs.

* GPGPU → general purpose graphic processing unit.
GPU is a specialized electronic circuit designed to rapidly manipulate and alter memory to accelerate the formation of images in a frame in a display device.

Two Laws :- (Provides information into the performance of parallel systems and multicore systems)

1. Amdahl's law.
2. Little's law.

Amdahl's Law → it deals with the potential speed up of a program using multiple processors compared to a single processor.
→ Consider a program running on a single processor such that a fraction $(1-f)$ of the execution time involves code i.e inherently sequential and a fraction f that involves code i.e infinitely parallel with no scheduling overhead.



→ Let T be the total execution time of the program By using a Single processor. Then the Speed up By using a parallel processor with N processorsone that fully exploits the parallel portion of the program is as follows:-

$$\text{Speed up} = \frac{\text{time to execute program on a Single processor}}{\text{time to execute program on N parallel processors.}}$$

$$= \frac{T(1-f) + Tf}{T(1-f) + Tf/N}$$

$$= \frac{1}{(1-f) + f/N}.$$

Conclusions Based on this Eq' :-

- When f is Small the use of parallel processors have no or very less or little.
- As N approaches Infinity so Speed up is given By $1/(1-f)$, there are very less effect of using more no. of processors.

The Speed up Can also Be Computed as

$$\text{Speed up} = \frac{\text{Performance after Enhancement}}{\text{Performance Before Enhancement}}.$$

$$= \frac{\text{Execution time Before Enhancement}}{\text{Execution time After Enhancement}}.$$

$$= \frac{1}{(1-f) + \frac{f}{S.Uf}}.$$

f = fraction of time Before Enhancement

S.Uf = Speed up after Enhancement.

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$$\text{Speed up} = \frac{1}{(1-f) + \frac{f}{Suf}}$$

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eg. 2.1 Suppose a task makes extensive use of floating point operations with 40% of the time consumed by the floating point operations. With a new hardware design the floating point module speeds up by a factor k. Calculate the overall speed up.

Soln

$$\text{Speed up} = \frac{1}{(1+f) + \frac{f}{Suf}}$$

$$f = 40\% = \frac{40}{100} = 0.4$$

$$Suf = k$$

let $k = 200$

$$\text{Speed up} = \frac{1}{(1-0.4) + \frac{0.4}{200}}$$

$$= \frac{1}{\frac{200 \times 0.6 + 0.4}{200}}$$