Department of computer science

Microprocessor Assembly Language Programming

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INTRODUCTION TO MICROPROCESSORS

- Computer's Central Processing Unit (CPU) built on a single Integrated Circuit (IC) is called a **microprocessor.**

- A digital computer with one microprocessor which acts as a CPU is called microcomputer.

- It is a *programmable, multipurpose, clock -driven, register-based electronic device* that reads binary instructions from a storage device called memory, accepts binary data as input and *processes data according to those instructions and provides results as output.*

Cont..

- The microprocessor contains millions of tiny components like transistors, registers, and diodes that work together.

- A Microprocessor is an *important part of a computer architecture without which you will not be able to perform anything on your computer.*

- It is a programmable device that takes in input performs some arithmetic and logical operations over it and produces the desired output.

- In simple words, a Microprocessor is a digital device on a chip that can fetch instructions from memory, decode and execute them and give results.
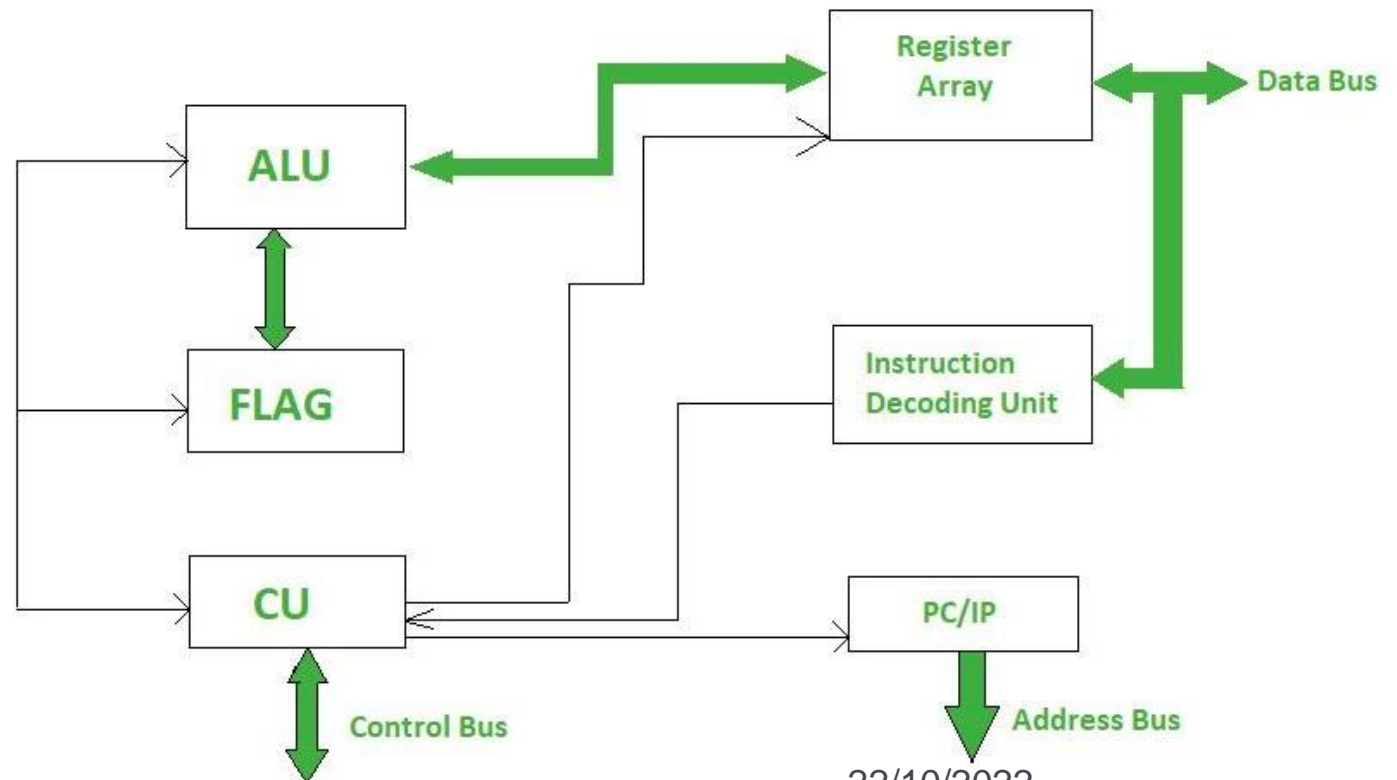
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Basics of Microprocessor

- A Microprocessor takes a *bunch of instructions in machine language and executes them, telling the processor what it has to do. Microprocessor performs three basic things while executing the instruction:*

- It performs some *basic operations like addition, subtraction, multiplication, division,* and some logical operations **using its Arithmetic and Logical Unit (ALU)**.

  - New Microprocessors also perform operations on floating-point numbers also.

- Data in microprocessors can move from one location to another.

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- Program Counter (PC)
  - Is a register that stores the address of the next instruction based on the value of the PC, Microprocessor jumps from one location to another and takes decisions

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Basic Terms used in Microprocessor

- **Instruction Set** –
  - The group of commands that the microprocessor can understand is called Instruction set.
  - It is an *interface between hardware and software.*

- **Bus** –
  - Set of conductors intended to transmit data, address or control information to different elements in a microprocessor.
  - A microprocessor will have **three types of buses, i.e., data bus, address bus, and control bus.**

- **IPC (Instructions Per Cycle)** –
  - It is a measure of how many instructions a *CPU is capable of executing in a single clock.*

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- **Clock Speed** –
  - It is the number of operations per second the processor can perform.
  - It can be expressed in megahertz (MHz) or gigahertz (GHz).
  - What Is the Difference between GHz AND MHz?
    - **One GHz equals one billion cycles per second whereas one MHz equals one million cycles per second**
  - It is also called the Clock Rate.
- **Bandwidth** –
  - The number of bits processed in a single instruction is called Bandwidth.

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Cont..

- **Word Length** -
- The number of bits the processor can process at a time is called the word length of the processor.
- 8-bit Microprocessor may process 8 -bit data at a time.
- The range of word length is from 4 bits to 64 bits *depending upon the type of the microcomputer.*
- **Data Types** - The microprocessor supports multiple data type formats like binary, A SCII, signed and unsigned numbers.

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Features of Microprocessor

- **Low Cost**
  - Due to integrated circuit technology microprocessors are available at very low cost.
  - It will reduce the cost of a computer system.
- **High Speed**
  - Due to the technology involved in it, the microprocessor can work at very high speed.
  - It can execute millions of instructions per second.
- **Small Size**
- A microprocessor is fabricated in a very less footprint due to very large scale and ultra large scale integration technology.
- Because of this, the size of the computer system is reduced.

Cont..

➤ **Versatile** –

  ○ The same chip can be used for several applications, therefore, microprocessors are versatile.

➤ **Low Power Consumption** –

  ○ Microprocessors are using metal oxide semiconductor technology, which consumes less power.

➤ **Less Heat Generation** –

  ○ Microprocessors uses semiconductor technology which will not emit much heat as compared to vacuum tube devices.
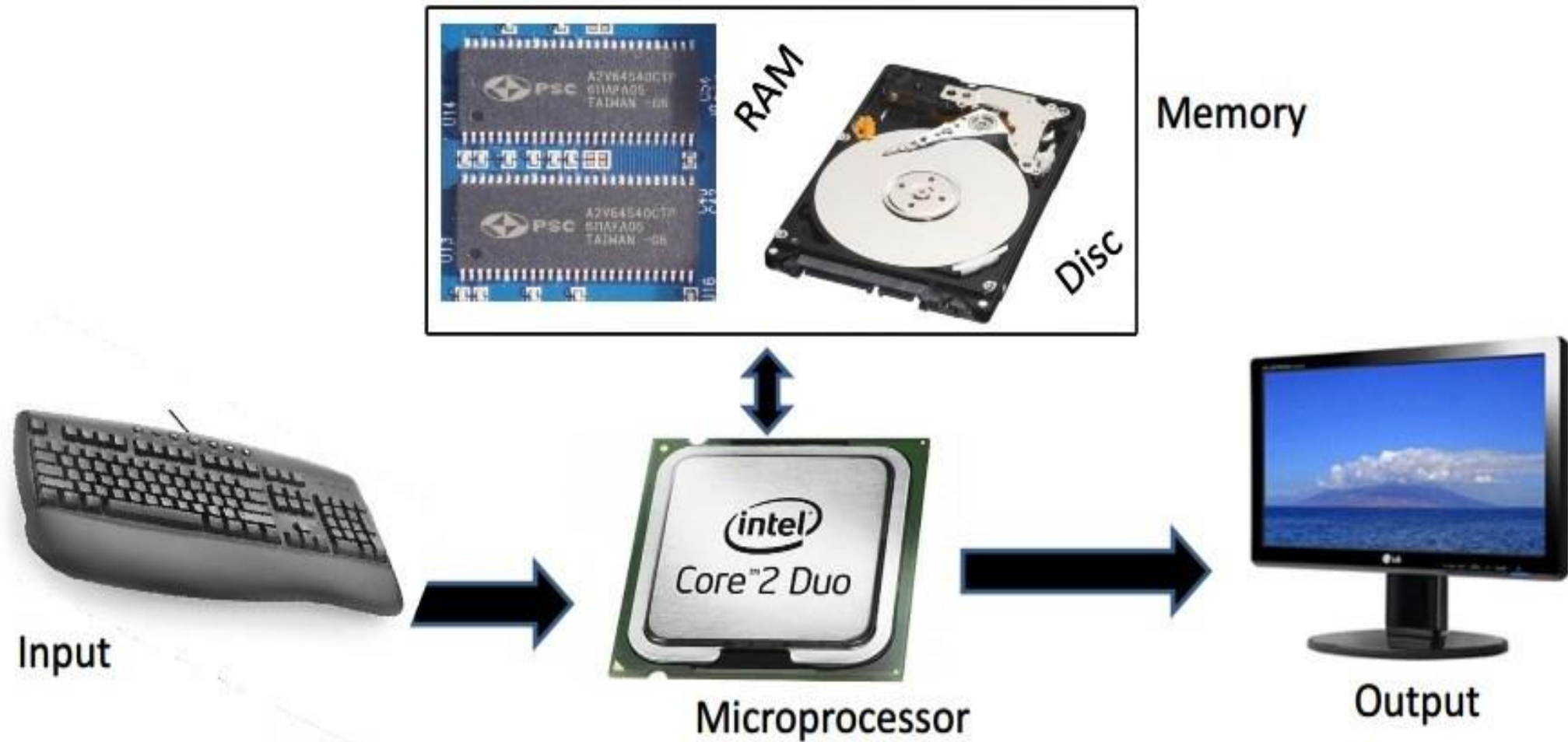
➤ **Reliable** –

  ○ Since microprocessors use semiconductor technology, therefore, the failure rate is very less. Hence it is very reliable.
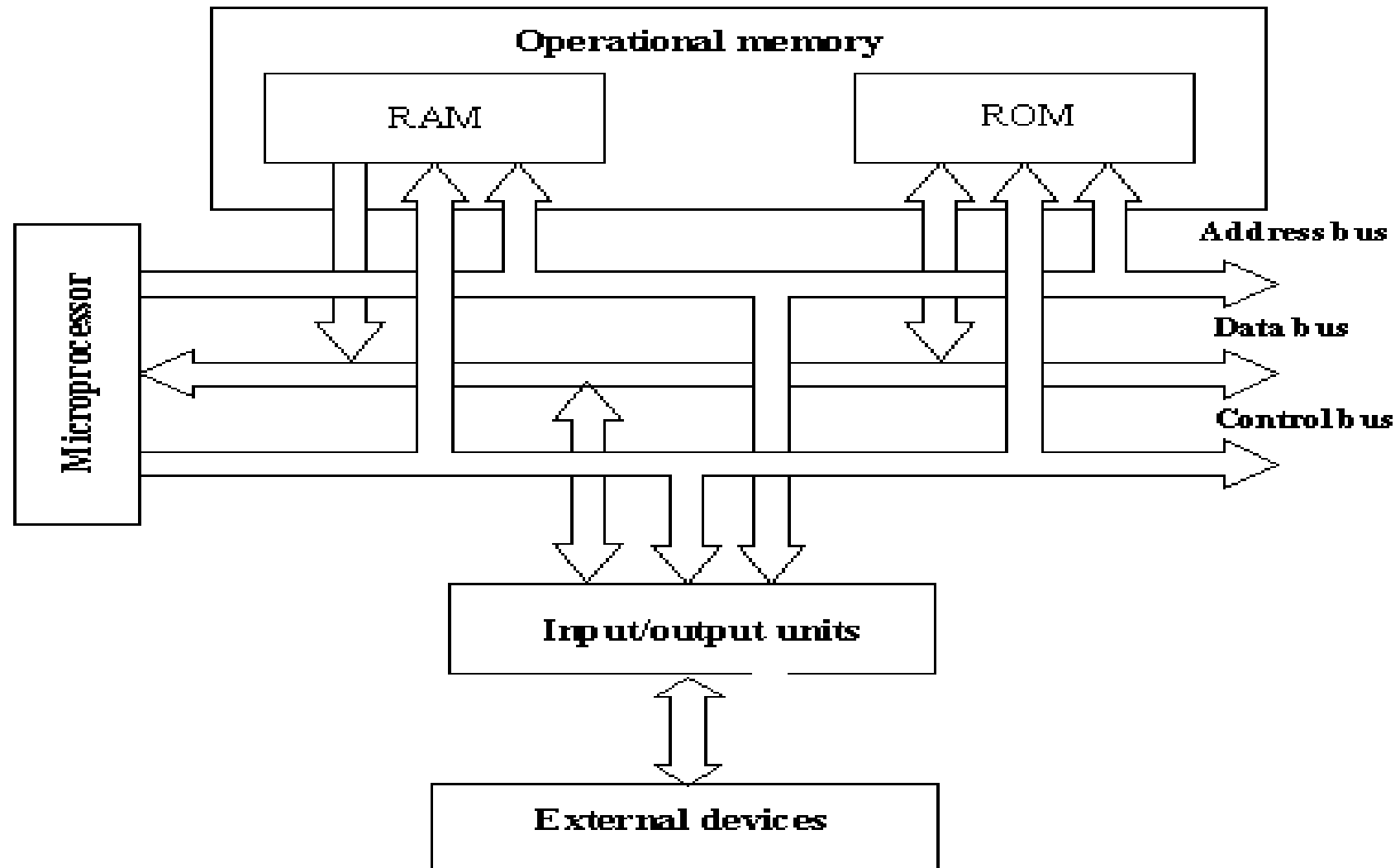
• **Portable** –

  • Due to the small size and low power consumption microprocessors are portable.

A μcomputer system?

Input

Microprocessor

Output

RAM

Memory

Disc

Cont...

- Fairchild Semiconductors (founded in 1957) invented the first IC in 1959.

- In 1968, **Robert Noyce, Gordan Moore, Andrew Grove** resigned from Fairchild Semiconductors.

- They founded their own company **Intel** (Integrated Electronics).

- Intel grown from 3 man start-up in 1968 to industrial giant by 1981.

- I had 20,000 employees and $188 million tevenue.

4Bit Microprocessor :Intel 4004
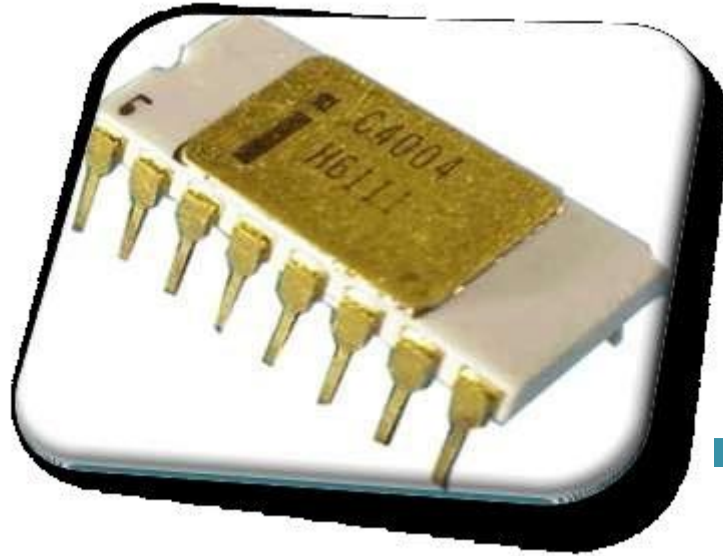
- Introduced in 1971.

- It was the first microprocessor by Intel.

- It was a 4-bit µP.

- Its clock speed was 740KHz.

- It had 2,300 transistors.
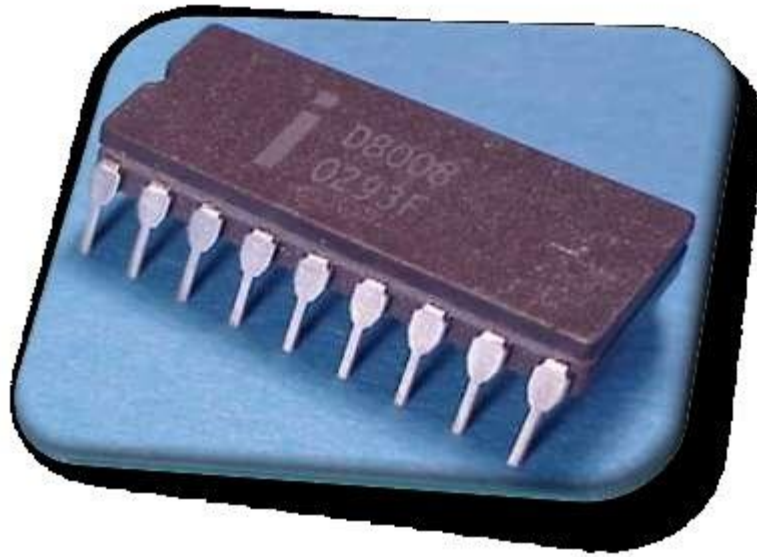
- It could execute around 60,000 instructions per second.

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Intel 4040

- Introduced in 1974.

- It was also 4-bit µP.

- ? KB of program memory

- ? 40 bytes of addressable memory

- ?.000 The number of transistor

- Clock speed is between 500 kHz and 740 kHz. 4 uses a crystal to 5185 MHz

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8 bit Microprocessors: Intel 8008

Introduced in 1972.

It was first 8-bit µP.

Its clock speed was 500 KHz.

Could execute 50,000 instructions per second.

Intel 8080

- troduced in 1974.

- was also 8-bit μP.

- Its clock speed was 2 MHz.

- 't had 6,000 transistors.

- Was 10 times faster than 8008 Could execute

- 5,00,000 instructions per second.

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Intel 8085

- Introduced in 1976.
- It was also 8-bit μP.
- Its clock speed was 3 MHz.
- Its data bus is 8-bit and address bus is 16-bit.
- It had 6,500 transistors.
- Could execute 7,69,230 instructions per second.
- It could access 64 KB of memory.
- It had 246 instructions.
- Over 100 million copies were

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Intel 8086
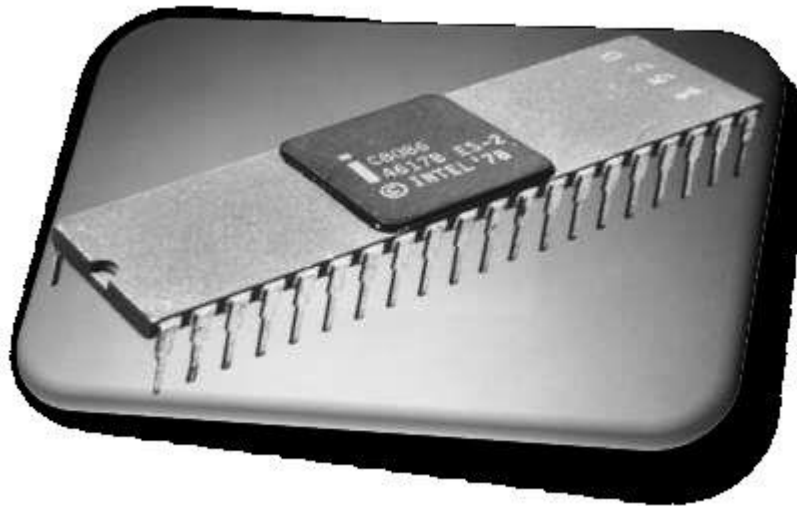
- Introduced in 1978.

- It was first 16-bit µP.

- Its clock speed is 4.77 MHz, 8 MHz and 10 MHz, depending on the version.

- Its data bus is 16-bit and address bus is 20-bit.

- It had 29,000 transistors.

- Could execute 2.5 million instructions per second.

- It could access 1 MB of memory.

- It had 22,000 instructions.

- It had *Multiply* and *Divide* instructions.

Intel 8088

↗ Introduced in 1979.

↗ It was also 16-bit μP.

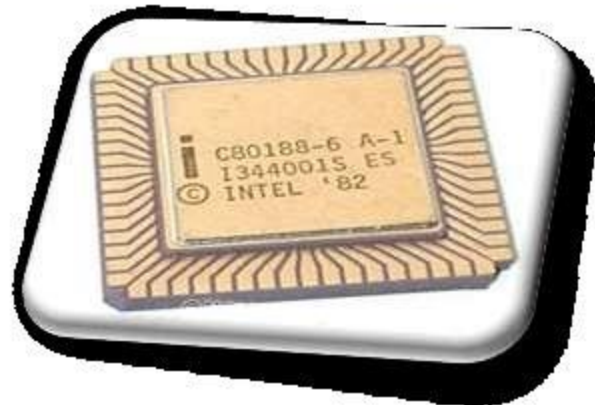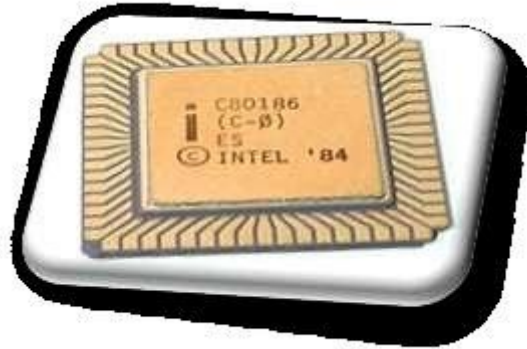↗ It was created as a cheaper version of Intel's 8086.

↗ It was a 16-bit processor with an 8-bit external bus.

↗ Could execute 2.5 million instructions per second.

↗ This chip became the most popular in the computer industry when IBM used it for its first PC.

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Intel 80186 & 80188

↗ Introduced in 1982.

↗ They were 16-bit µPs.

↗ Clock speed was 6 MHz.

↗ 80188 was a cheaper version of 80186 with an 8-bit external data bus.

↗ They had additional components like:

↗ Interrupt Controller

↗ Clock Generator

↗ Local Bus Controller

↗ Counters

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Intel 80486

↗ Introduced in 1989.

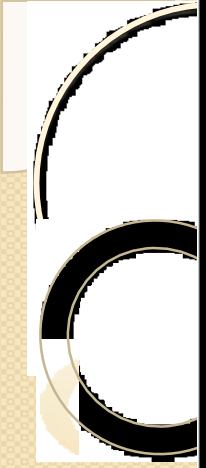↗ It was also 32-bit µP. It had It

↗ ad 1.2 million transistors.
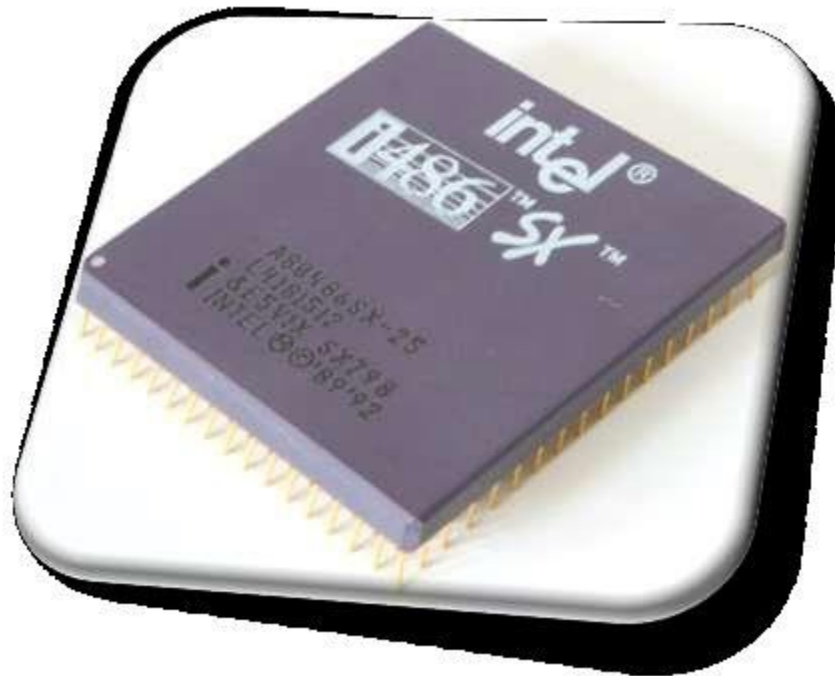
↗ Its clock speed varied from 6 MHz to 100 MHz depending upon the various versions.

↗ It had five different versions:

> ➢ 80486 DX
> ➢ 80486 SX
> ➢ 80486 DX2
> ➢ 80486 SL
> ➢ 80486 DX4

↗ ^ KB of cache memory
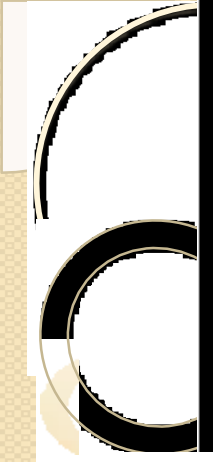
↗ introd uced.

32-bit Microprocessors

Intel 80386

- ‘ntroduced in 1986.

- ‘t was first 32-bit μP.

- ‘ts data bus is 32-bit and address bus is 32-bit.

- ‘t could address 4 GB of memory.

  ➢ It had 2,75,000 transistors.

  ➢ Its clock speed varied from 16 MHz to 33 MHz depending upon the various versions.

  Different versions:

- 80386 DX

- 80386 SX

- 80386 SL

  ➢ Intel 80386 became the best selling microprocessor in history.

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Intel Pentium

- Introduced in 1993.
- It was also 32-bit µP.
- It was originally named 80586.
- Its clock speed was 66 MHz.
- Its data bus is 32-bit and address bus is 32-bit.

➢ It could address 4 GB of memory.

- Could execute 110 million instructions per second.

➢ cache memory:

- 8 KB for instructions.
- 8 KB for data.

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Intel Pentium Pro

↗ Introduced in 1995.

➢ It was also 32-bit µP.

➢ It had L2 cache of 25.6 KB

➢ It had 21 million transistors

➢ It was primarily used in server system

✓ cache memory:

↗ 8 KB for instructions.

↗ 8 KB for data.

↗ It had L2 cache of 256 KB.

Intel Pentium II

- Introduced in 1997.

- It was also 32-bit µP.

- Its clock speed was 233 MHz to 500 MHz.

- Could execute 333 million instructions per second.

- L2 cache & processor were on one circuit.

Intel Pentium II Xeon

- Introduced in 1998.

- It was also 32-bit µP.

- It was designed for servers.

- Its clock speed was 400 MHz to 450 MHz.

- L1 cache of 32 KB & L2 cache of 512 KB, 1MB or 2 MB.

- It could work with 4 Xeons in same system.

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Intel Pentium III

↗ Introduced in 1999.

↗ It was also µP. 32 bit

↗ Its clock speed varied from 500 MHz to 1.4 GHz.

↗ It had 9.5 million transistors.

Intel Pentium IV

↗ Introduced in 2000.

➢ It was also 32-bit µP.
➢ Its clock speed was from 3 GHz to 3.8 GHz.

  1 cache was of 32 KB & 2 cache of 256 KB.

➢ It had 42 million transistors.

  II internal connections were made from aluminium to copper.

Intel Dual Core

↗ Introduced in 2006.

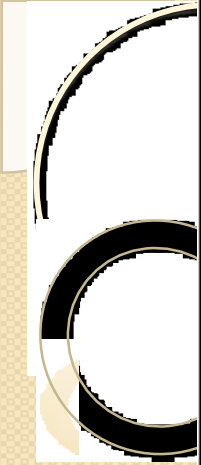↗ It is 32-bit or 64-bit µP.

↗ It has two cores.

both the cores have there wn internal bus and L1 ache, but share the external bus and L2 cache *(Next Slide)*.

➢ It supported SMT Technology.

SMT: Simultaneously Multi- threading

↗ E.g.: Adobe Photoshop

64-bit Microprocessors

Intel Core 2

- Introduced in 2006.

- It is a 64-bit µP.

- Its clock speed is from 1.2 Hz to 3 GHz.

- It has 291 million transistors.

- It has 64 KB of L1 cache per core and 4 MB of L2 cache.

- It is launched in three different versions:
  - Intel Core 2 Duo
  - Intel Core 2 Quad
  - Intel Core 2 Extreme

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Intel Core i7

- ...troduced in 2008.

- ...is a 64-bit µP.

- ...has 4 physical cores.

- ...s clock speed is from 2.66 GHz to 3.33 GHz.

- It has 781 million transistors.

- ...has 64 KB of L1 cache per core, 256 KB of L2 cache and MB of L3

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Intel Core i5

- Introduced in 2009.

- It is a 64-bit µP.

- It has 4 physical cores.

- Its clock speed is from 2.40 GHz to 3.60 GHz.

- It has 781 million transistors.

- It has 64 KB of L1 cache per core, 25KB of L2 cache

Intel Core i3

- troduced in 2010.
- is a 64-bit μP.
- has 2 physical cores.
- s clock speed is from 2.93 GHz to 3.33 GHz.
- has 781 million transistors.
- has 64 KB of L1 cache per core, 51 KB of L2 cache and MB of L3 cache.

THE END?

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