An Introduction :-

Embedded Systems Designers use the microprocessor development stages to completely design and manufacture new microprocessors . Microprocessors are integrated circuits (ICs) that include the basic functions of a computer's central processing unit (CPU) . It is a multi - purpose , programmable silicon chip that accepts binary data as input and provides output after processing it according to instructions stored in memory . A computer central processing unit (CPU) built on a single integrated circuit (IC) is called a "microprocessor . " A digital computer is called a single microprocessor that acts as the CPU of a microcomputer . It is a programmable , multi – purpose , clock – based , electronic device The register reads binary instructions from a storage device called memory , accepts binary data as input , processes the data according to those instructions , and provides the results as output . A microprocessor contains millions of tiny components such as transistors , registers , and diodes that work together . When comparing the desktop computer that spread many years ago with the laptop computer and smartphone in terms of size , weight , speed and price , you will notice the rapid development taking place in the field of computerized electronic devices every day , which has entered all the applications of our daily lives . history of its development . We will also learn about its most important specifications and various applications in our lives , in addition to an introduction to the world of programming and smartphone applications . This active progress in the manufacture of computerized electronic devices is due to the emergence and development of microprocessors . As it became possible to increase the density of components on the same electronic chip to be able to develop more complex calculations at tremendous speeds , which led to the small size of computers and the decrease in their price and increase their capabilities such as entering touch screens on smart phones and tablets . The processor industry , like any industry , is witnessing several developments with the development of time in technology . This industry is witnessing great leaps , and some of us are ignorant of how that development happened . The microprocessor has become an essential part of many tools . The development of microprocessors has been divided into five generations such as the first , second , third , fourth and fifth generation and the characteristics of these generations are discussed below . A microprocessor is nothing but the central processing unit and is an essential component of a computer. It is a silicon chip that contains millions of transistors and other electronic components that process millions of instructions per second . A microprocessor is a versatile chip , which is combined with memory and special - purpose chips pre - programmed by software . It accepts numeric data as i/p and processes it according to the instructions stored in memory . A microprocessor has many functions such as those for storing data , interacting with various other devices , and other functions related to time . But the main function is to send and receive data to make the computer function well . This article discusses the types and evolution of microprocessors . Please follow this link for microprocessor history and microprocessor generation.

Why do we need microprocessors?

A microprocessor is like a human brain and can be trained to do anything, it can be programmed to do anything we want . With its own set of instructions and capabilities , sometimes the solutions are too complex for humans to find a solution to .Therefore , the need to use precise manipulations to solve complex issues and problems in our lives is really important . Imagine that you want to build a large building using bricks will make the construction process simple and cost effective and will also give you the freedom to make the building the shape and size you want. Also the instructions placed in the microprocessor are the building blocks that you can use to solve your problem with these instructions you can easily solve a complex program .

Who and when invented the first microprocessor in the world?

Every Intel employee knows who invented the microprocessor. In 1969, Japanese developers, previously engaged in the design of calculators, came to work in this little-known company. Engineers used twelve integrated circuits to create a common desktop computer. The main role in this project was played by Masatoshi Shima. At the time, Ted Hofsor ran one of the Intel divisions. As the creator of the future microprocessor, he realized that instead of a calculator with the ability to program, it would be better to make a computer that would program the work of the calculator.The creation of the world's first processor began with the development of its architecture. In 1969, an Intel employee suggested calling the first series of microprocessors of the 4000 family. Each model in the family had sixteen output chips. This helps to understand what the first microprocessor is. Model 4001 has 2KB of memory. The 4003 has a 10-bit extender with keyboard connectivity and various indicators. The 4004 version was actually a quad-bit processor. Many believe that he was the first microprocessor. In the 4004 model, two thousand three hundred transistors worked. The device operates at a frequency of 108 kHz. Today you can find different opinions about when the first microprocessor was created, however, most of them believe that November 15, 1971 is the date and year of creation of the first microprocessor in the world. Initially, this development was purchased by the Japanese company Busicom for sixty thousand dollars, but Intel later returned the money to remain the only copyright holders of the invention.The first processor was used in traffic control systems, in particular at traffic lights. In addition, the device was used in blood analyzers. A little later, 4004 found a place on the Pioneer 10 space probe, which was launched in 1972.The first domestic microprocessor was created in the early 1970s at the Special Computing Center under the leadership of D.I. Yudetsky.Thus, in the seventies, microprocessors gradually began to penetrate into various areas of human activity.

All processors were later divided into microprocessors and direct microcontrollers. The former are used in personal computers, and microcontrollers have found application controlling various systems... They have a weaker computing core, but there are many additional nodes. Microcontrollers are sometimes called microcomputers, since all nodes and modules are located directly on the chip. Intel 4004 - 4-bit microprocessor designed by Intel Corp. It was released on November 15, 1971. This microcircuit is the world's first commercially available single-chip microprocessor. However, in 1970, more than a year before the release of the i4004 chip, the F14 CADC (en) military microprocessor was manufactured, which is rated up to 1998.1969 Small Japanese company Nippon Calculate Machine, Ltd. (later Busicom Corp.), calculator manufacturer, orders 12 chips from Intel (system logic design developed by Busicom employee Masatoshi Shima (嶋)) for use in a desktop calculator New. These microcircuits have always had highly specialized functions and were intended to perform precisely defined work, so for each new application the entire chipset had to be redesigned. Intel employees found this method unprofitable. Marcian Edward (Ted) Hoff, 32, is suggesting that executives at Intel and Busicom reduce the number of chips by using a CPU that must do arithmetic and logic functions, one rather than several microcircuits. The management of both companies accepted the idea "with great fanfare". During the fall of 1969, Ted Huff, with the help of Stanley Mazur, proposed a new chip architecture, the number of which was reduced to 4, including a central processing unit: a 4-bit central processing unit (CPU), ROM for storing programs and RAM for storing user data. The development of the microprocessor began only in April 1970 when Federico Fagen, a physicist from Italy, joined Intel as the lead designer of the MCS-4 family. With his deep knowledge of the MOS silicon gate technology he developed at Fairchild in 1968, and the extensive experience he gained in 1961 at the Italian company Olivetti in the field of computer logic design, he was able to reduce the CPU microprocessor to a single chip. In 1968, when working for Fairchild, he also implemented the world's first commercial chip to use silicon gate technology: the Fairchild 3708. At Intel, Fagin developed a new chip that, until then, designed the current logic microcircuit design and contributed to many process design innovations. and microcircuits, which is very important to implement a microprocessor in a single chip. Masatoshi Shima, who worked as a software engineer at Busicom and had no experience designing MOS hardware, helped Fagin develop the MCS-4 and later worked with him at Zilog, founded in late 1974 by Fagin and Ralph Ungermann and entirely dedicated to microprocessors. Fagin and Shima jointly developed the Zilog Z80 microprocessor, which is still in production today.The second number indicates the type of product: 0 - processors, 1 - RAM chips, 2 - controllers, 3 - ROM chips, 4 - shift registers, 5 - EPLD chips, 6 - PROM chips, 7 - EPROM chips, 8 - Monitor synchronization chips and circuits in pulse generators, 9-chips for communications.The third and fourth digits correspond to the serial number of the product, and since the first processor required three more specialized microcircuits (ROM, RAM and an I/O extender), which were released before the 4004, the microprocessor was called the 4004.On November 15, 1971, the 4004 microprocessor was

launched - the first microprocessor, at a cost of $ 200, that implemented all the functions of a mainframe processor on a single chip. The world's first microprocessor was announced in November 1971 in Electronic News. The 4004 microprocessor was housed in a 16-tooth DIP package with a die size of 12 mm2 (3 x 4 mm). A processor can execute 60,000 (on average, a maximum of 93,000) instructions per second. (For comparison, one of the first fully electronic computers - the US ENIAC - executed only 5,000 (maximum) instructions per second, occupied an area of 278.7 square meters and weighed 30 tons.) Intel anticipated the critical importance of microprocessors in miniaturizing computers, and therefore bought the copyright for the 4004 microprocessor and its enhanced versions from Busicom for $60,000.However, in 1971, the processor did not achieve much success in sales. Intel's strategy was to commercialize the 4004 to expand the market for the more popular 1101/1103 memory chips. Only the 8080 microprocessor, the "great grandson" 4004, began to enjoy well-deserved popularity.

Common terms used in microprocessors :-

• Transportation System (BUS) :- A transport system is a set of conductors whose purpose is to transmit data , address , or control information to various elements in a microprocessor . Usually a microprocessor has 3 types of transmission system : data bus , control bus , and address bus.

• INSTRUCTION SET :- An instruction set is the set of commands that a microprocessor can understand , so an instruction set is an interface between hardware and software .

• WORD LENGTH :- Word length is the number of bits in the processor's internal data bus , or in other words , the number of bits that the processor can process at one time .

For example :- an 8-bit processor will have an 8-bit data bus and 8-bit register registers and will run an 8-bit processing at a time .

• CACHE MEMORY :- The cache is the random access memory built into the processor . So the processor can access the data in the cache more quickly than normal RAM . Also known as CPU memory , a cache is used to store data .

• CLOCK SPEED :- Microprocessors use the pulse signal to control the rate at which instructions are executed, synchronize other internal components , and control the transfer of data between

them . So the pulse speed refers to the speed at which the microprocessor executes instructions , usually measured in Hertz . It is expressed in megahertz (MHz) , gigahertz (GHz) , etc .

Generations of development of microprocessing:-

first generation :-

This was the period from 1971 to 1973 in the history of microprocessors . In 1971 , INTEL created the first 4004 microprocessor , operating at a clock speed of 740 kHz . During this period , other microprocessors were used on the market including Rockwell international PPS-4 , INTEL-8008 and National Semiconductors IMP-16. But all of these were not TTL compliant processors . The precious time spent in designing this chip gradually turned into the famous 4004 processor , which is the first processor on a chip in history , and the 4004 chip is the godfather of all subsequent processors , and this chip or processor was only (4-bit) and had a separate ROM . The instructions were stored on it , and this chip was used in a calculator at a speed of 670 kHz , i.e. less than 1 MHz . The chip contained 2,300 transistors with a manufacturing accuracy of 10 micrometers . Then the Intel 4040 chip appeared , and it was a breakthrough at that time from the Intel 4004 chip . The first generation of microprocessors was introduced in the year 1971-1972 . The instructions of these microprocessors were processed sequentially , they fetch , decode and then execute the instructions . When the microprocessor's instructions are finished , the microprocessor updates the instruction pointer and fetches the next instruction , performing this sequential operation for each instruction individually . Microprocessors (4) bits , the first generation of microprocessors was introduced in the year (1971-1972) by (Intel Corporation) , it was named (Intel 4004) because it was a (4) bit processor , it was a processor on a single chip , It could perform simple arithmetic and logical operations such as addition , subtraction , (Boolean OR) and (Boolean AND) , and it had a controller capable of performing control functions such as fetching instructions from storage , decoding them , and then generating control pulses to execute .

second generation:-

This was the period from 1973 to 1978 in which highly efficient 8-bit microprocessors such as the Motorola 6800 , 6801 , INTEL-8085 , and Zilog's-Z80 were implemented , which were among the most popular . Due to its super fast speed , it was very expensive because it was based on NMOS fabrication technology . It is the (8-bit) stage . A year after the launch of the ancient Intel 4004 , the (4-bit) was not enough to work on it during advanced calculations , so Intel resorted to the new generation and it contained three new processors :- Intel 8008 (1972) and Intel 8080 (1974) and Intel 8085 (1976) and speeds ranged between 500 kHz and 3 MHz . In 1970 , only a few transistors were available on the integrated circuit in the second generation of microprocessors . Examples of second-generation microprocessors are 7-pipe 16-bit arithmetic instruction processing , and the Motorola MC68000 microprocessor . These processors were introduced in 1979 , and the Intel 8080 is another example of a microprocessor . The second generation of microprocessors is defined by nested fetching , decoding , and executing steps . When the first generation is processed in the execution unit , the second instruction is decoded and the third instruction is fetched . (8) Bit Microprocessors The second generation of microprocessors was introduced in (1973) again by (Intel) , it was the first (8) bit microprocessor that could perform arithmetic and logical operations on 8 bits long words , it was (Intel 8008) , and another improved version for (Intel 8088) .

The difference between first-generation microprocessors and second-generation microprocessors was the use of new semiconductor technologies to manufacture chips. The result of this technology resulted in a fivefold increase in instructions, speed, execution and a higher density of chips.

third generation :-

Microprocessors (16) bits ", the third generation of microprocessors , which was introduced in 1978 , was represented by the (8086) , (Zilog Z800) and (80286) processors from (Intel) , which were (16) bits perform similar to a small computer . The third generation of microprocessors was introduced in 1978 , as evidenced by Intel's 8086 and Zilog Z8000 . These were 16-bit processors as performing as small computers . These types of microprocessors were different from previous generations of microprocessors as all the manufacturers at major workstations started developing their own ISC-based microprocessor architectures . 16-bit processors , namely Intel 8086 (1978) , Intel 8088 (1979) , Intel 80186 (1982) , Intel 80188 (1982) and Intel 80286 (1982) . During this period, 16-bit processors were created and designed using HMOS technology . From 1979 to 1980 , INTEL 8086/80186/80286 , Motorola 68000 and 68010 were developed . The speeds of these processors were four times better than those of the second generation .

The fourth generation :-

32-bit microprocessors :- Many different companies have offered 32-bit microprocessors , but the most popular is the Intel 80386 . As many industries shifted from commercial microprocessors to interior designs , fourth generation processors were introduced with a premium design with one million transistors . Leading microprocessors such as Motorola's 88100 and Intel's 80960CA can issue or pull more than one instruction per clock cycle . Processors (32-bit) Intel 80386DX (1985) Intel 80386SX (1988) Intel 80376 (1989) Intel 80386SL (1990) Intel 80386EX (1994) Intel 80486DX (1989) Intel 80486SX (1991) Intel 80486DX2 (1992) Intel 80486SL (1992)¡Intel Pentium (1993) ¡Intel 80486DX4 (1994) ¡Intel Pentium Pro (1995) ¡Pentium MMX (1997) ¡Intel Pentium 2 (1997) ¡Intel Celeron (1998) ¡Intel Pentium 2 Xeon (1998) ¡Intel Pentium 3 (1999) ¡Intel Pentium 4 (2000) ¡Intel Pentium 4 Extreme (2004) .The speed of these processors (Pentium 1 - Pentium 4) ranges from 700 MHz to 3600 MHz . From 1981 to 1995 this generation developed 32-bit microprocessors using HCMOS manufacturing . The most popular were the Motorola INTEL-80386 and 68020/68030 processors .

The Fifth generation:-

Microprocessors (64) bits , from (1995) to now we are in the fifth generation , after the microprocessor (80856) , " Intel " came out with a new processor , the Pentium processor , followed by the (Pentium Pro CPU) , which allows many units of Central processing in a single system to achieve multiple processing , other (64) optimized processors are (Celeron) , (Dual) , (Quad) and (Octa Core) . Fifth-generation microprocessors used ultradiscrete processors , and their design quickly surpassed 10 million transistors . In the fifth generation , computers are a low-profit-margin business , the large volume of which is conquered by a single microprocessor . On December 23, 1947, the transistor was invented at Bell Lab , while an integrated circuit was invented in 1958 by J . Kilby at Texas Instruments . Therefore , Intel or INTegrated ELectronics invented the first microprocessor . Processors (64-bit) such as the Intel processor · Itanium IA-64 ¡ Itanium 2 (2005) ¡ Pentium D (2005) ¡ Intel Dual Core (2006) ¡ Intel Core 2 Duo (2007). ¡ Intel Core 2 Quad (2008) . ¡Intel Core i7 (2009) . The speed of these processors (Intel Core - Intel Core 2 Quad) ranges from 1700 MHz to 2600 * 8 MHz. Since 1995 until now ,

this generation has been offering high-performance and high-speed processors using 64-bit processors . These processors include Pentium , Celeron , Dual , and Quad-core processors . Thus , the microprocessor has evolved through all these generations , and the fifth generation microprocessors represent an advancement in specifications . Therefore, some of the 5th generation processors with their specifications are briefly explained below .

Intel Celeron :-

Intel Celeron was introduced in April 1998. It refers to a family of Intel X86 CPUs by value PC x. It is based on a Pentium 2 and can run on all IA-32 computer programs. Intel also announced the release of a new batch of Intel Xeon processors at the end of this year.

Types of microprocessors :-

- ❖ Intel 4004 :- The first single-chip microprocessor was the Intel 4004 4-bit microprocessor, released on November 15, 1971. Intel was just beginning to build it and its creators Robert Noyce, Gordon Moore and Andrew Grove spent a lot of energy on the development process. Thanks to the contribution of the Italian physicist Federico Fagina, the company's engineers were able to put the main components on a single chip and create the 4004 microprocessor. The Intel 4004 was produced using a 10-micron process technology, calculating 2,250 transistors and working at a frequency of 108 kHz (performed 92,600 operations per second). The clock frequency was 740 kHz. The memory capacity is 4 KB, the bus capacity is 4 bits. The crystal area was 12 mm .
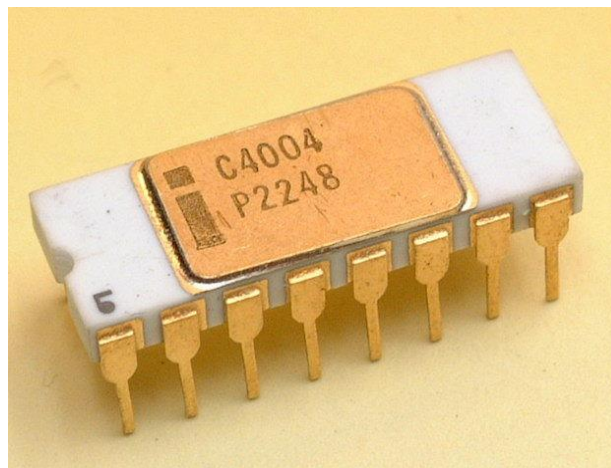

- ❖ Intel 8008:- In the early 1970s , the company released the first 8-bit CPU , Intel 8008 . It was developed simultaneously with the 4004 at the request of Terminal Corporation (later Datapoint). But the company refused the CPU (as well as cooperation with Intel) due to the fact that the process of creating the microcircuit exceeded the specified deadlines , and its characteristics did not meet expectations . According to the technical characteristics , the 8008 microprocessor was

largely consistent with the previous version . It was produced using the same 10 micron process technology and contained 3,500 transistors. The internal stack supported 8 levels, and the memory capacity was 16KB. The clock frequency was less than 4004, it was 500 kHz. In terms of speed, the 8-bit Intel processor lags behind the 4-bit processor. Bus width was 8 bits. The processor can access 8 input ports and 24 output ports. Project Sac State 8008 (1972) was one of the first microprocessor-based computer systems. It was an all-in-one minicomputer with a disk operating system, color display, 8KB of RAM, 3+2MB disk, keyboard, modem and printer. Its purpose was to process and store medical records.
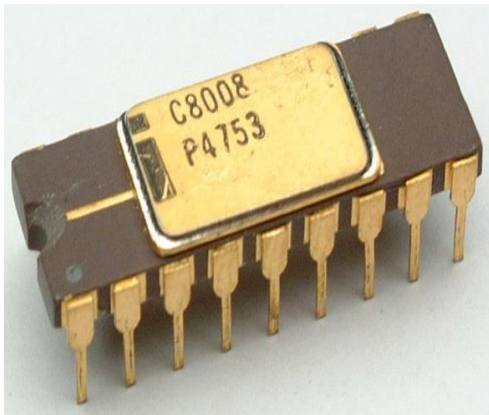
❖ Intel 8080:- In the spring of 1974, Intel released an improved version, the 8-bit Intel 8080 processor. It was produced using the new 6-micron processing technology using NMOS technology, which allows placing 4758 transistors on the chip. The clock frequency was 2MHz (with timers of 2.5MHz, 3.1MHz and 4MHz), the memory capacity was 64K. The width of the data bus was 8 bits, and the address bus was 16 bits. The 8080 has a highly developed command system: 16 commands to transmit data, 31 commands to process it, 28 commands to move (with direct addressing), and 5 control commands. Due to the high performance of the processor, it was successful. Based on the Intel 8080, MITS released the Altair-8800 microcomputer. Despite the modest characteristics (256 bytes of RAM, the absence of a screen and keyboard), it gained unprecedented popularity and sold very quickly. There have been quite a few Intel 8080 clones from other companies, such as National Semiconductor, NEC, Siemens, and AMD. There was also a Soviet analogue of the Kiev Scientific Research Institute of Microprocessors - the KR580VM80A microprocessor (1977).
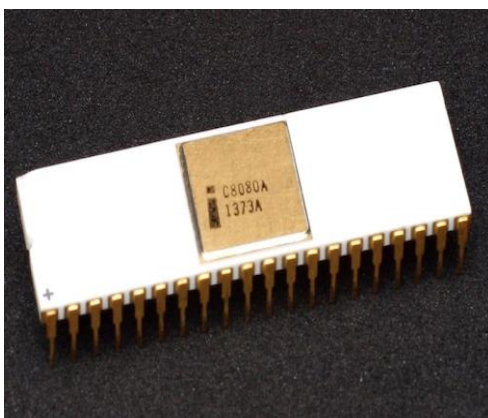
❖ <u>**Motorola 6800 :-**</u> In 1974, Motorola released its processor - 6800. The crystal was produced using 6-micron processing technology, with a clock frequency of 2 MHz and memory of 64 KB. N-MOS technology was used. The processor had a 16-bit address bus and a 78-process command system. There was an existing index record. The Motorola 6800 was very popular, and it was used in many computers. Motorola 6801 and 6803 microcontrollers are built on the basis of their architecture.
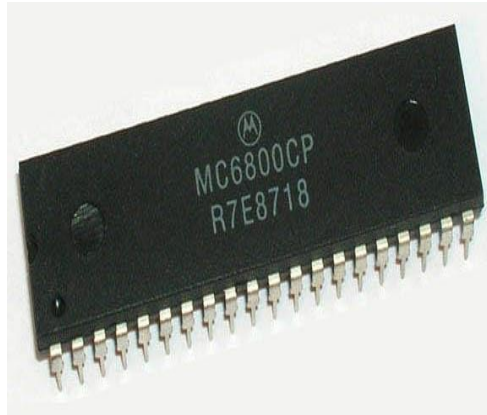

❖ <u>**MOS Technology 6502:-**</u> In 1975, MOS Technology introduced the 8-bit microprocessor 6502. In fact, this processor was an updated version of the 6501, which failed due to pin compatibility with the Motorola 6800. The CPU was inferior to the 8080 and 6800 competitors of terms of performance. It had a 16-bit address bus, 64 KB of RAM. The clock frequency was only 1MHz. The processor was a CISC architecture.The advantage of this model was the price - only $ 25 (several times cheaper than Intel and Motorola). This contributed to the rapid growth in sales of processors. The 6502 was used in computers such as the Apple I, Apple II, Commodore PET, and others. Also, processors of this series found application in video games, starting with the Atari 2600, using the 6507 model with fewer pins and the ability to process only 8 KB of memory.MOS Technology was granted licenses by Rockwell, Synertek companies to produce processors and use the 6502. There was Soviet analogue 4K602BM1.

❖ <u>Zilog z80 :-</u> In the second half of the seventies, one of the creators of the processor, the Italian Federico Fagin, left Intel. Together with engineer Ralph Wengermann and Japanese engineer Masatoshi Shima, they founded Zilog. And already in the early summer of 1976, the Zilog Z80 processor entered the market, which in its architecture is similar to the improved 8080. The microprocessor had an expanded set of instructions, new registers, interrupt patterns, and two separate register blocks. The Z80 was manufactured using a 3-micron CMOS process technology and contained 8,500 transistors. The clock frequency ranged between 2.5MHz and 8MHz for the main version and 1MHz to 20MHz for the CMOS version. Memory reached 64K, with a 16-bit address bus. The crystal size was 4.6 mm x 4.9 mm, with an area of 22.54 mm 2. In addition to the technical advantages, the Z80 was also cheaper than the Intel processor. The CPU came in different versions: Z80 (2.5 MHz), Z80A (4 MHz), Z80B (6MHz) and Z80H (8MHz). It was used in computers by Sharp, NEC, and others.

❖ <u>Intel 8086 and 8088:-</u> In 1978, Intel released the first 8086 16-bit microprocessor, which has been in development for more than two years. The processor was manufactured using 3-micron process technology and contained 29,000 transistors. The memory capacity is 1MB. The clock frequency was 4MHz - 10MHz, the width of the recordings and data bus was 16 bits, and the width of the address bus was 20 bits. The speed of the Intel 8086 varied. The 8086 processor has fourteen 16-bit registers: 4 general-purpose (AX, BX, CX, DX), 2 index registers (SI, DI), 2 index (BP, SP), 4 segment registers (CS , SS, DS, ES), program counter or instruction pointer (IP) and flag register (FLAGS, includes 9 flags). In order to increase sales of the 8086, Intel released the 8088 processor, which is largely consistent with its predecessor. The bus width only decreased from 16 bits to 8 bits. This change allowed the processor to work with 8-bit support chips. The geometry has also changed slightly. The Intel 8088 processor used a 4-byte prefetch queue instead of 6 bytes. The processor was used in the first prototype of the IBM PC 5150 (1981) line. Many large companies, such as AMD, Siemens, NEC, etc., clone 8088.
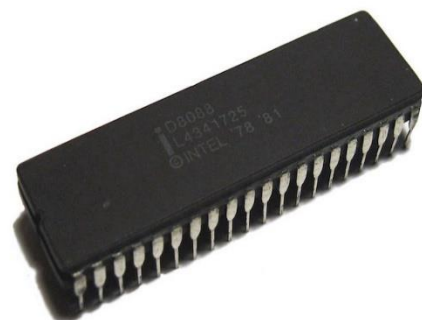
❖ **Zilog Z8000 :-** In 1979, Zilog launched its Z8000 16-bit processor. It was produced using 6-micron-3-micron processing technology with 17,500 transistors. The clock frequency ranged from 4MHz to 10MHz for the main version and from 4MHz to 20MHz for CMOS. The memory capacity has reached 8MB for Z8001 and 64KB for Z8002. The width of the data bus was 16 bits, and the address bus was 23 bits (in the Z8002 version - 16 bits). Initially, two versions of the processor were released: Z8001 and Z8002. Their differences consist only in the fact that the first served up to 8 MB of memory, and the second only up to 64 KB. A little later, the Z8003 and Z8004 models appeared, which were able to work with virtual memory.Z8000 processors were used in Unix desktop computers, allowing you to create real multi-user systems.

❖ **Motorola 68000 :-** The Motorola 68000 series of CISC (68k) microprocessors was introduced in 1979. The crystal had a 32-bit core, but it worked through a 16-bit data bus and a 24-bit address bus. Its frequency was 8MHz - 20MHz, and the total number of transistors was 68000 pieces. The CPU is manufactured in a DIP form factor with 64 pins. But there were also models with LCC and PGA connectors.The processor gained popularity among many companies and was used in various computers. But of course, the most famous of them are Apple computers: Lisa and Macintosh.


❖ **Intel 80186:-** The next Intel processor was the 80186, which was based on the 8086 architecture. It was produced using 3-micron process technology and contained 134,000 transistors. The memory capacity was 1MB, the data bus was 16 bits, and the address bus was 20 bits. The clock frequency reached 6MHz - 25MHz. New commands added to 80186:-

- two direct memory controllers with interrupt circuits (DMA);

- decoders ; Three-channel programmable timer.

- synchronization generator; Programmable interrupt controller.

Processors have been used little in computers, only in some computer models, such as Compis (Sweden), RM Nimbus (Great Britain), Unisys ICON (Canada), HP 200lx (USA), and Tandy 2000 (USA) .

- ❖ Intel 80286:- The company's next model was released in February 1982. It was a 16-bit x86-compatible microprocessor of the second generation 80286. There was support for real mode. In protected mode, the capacity of the address space can reach 1 GB by changing the memory processing mechanism. The processor surpassed the previous model in technical specifications. Produced using 1.5 micron process technology with 134,000 transistors. The RAM was 16 MB, and in protected mode it was possible to use up to 1 GB of virtual memory. The width of the recordings and the data bus were 16 bits. Depending on the model, the clock frequency can be 6MHz, 8MHz, 10MHz or 12.5MHz (at 12.5MHz the processor performed at least 2.66 million operations per second).
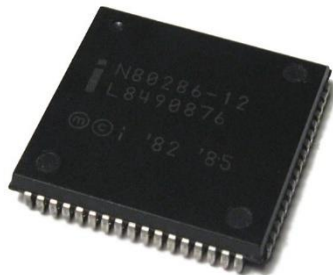
- ❖ WDC W65C816S:- In 1984, the Western Design Center (WDC) launched the 16-bit W65C816S microprocessor. The model has a 24-bit memory address and supports up to 16 MB of RAM, as well as an extended set of instructions. The processor was used in the Apple IIGS computer, as well as the Acorn Communicator and C-One systems.

❖ <u>Intel i386:-</u> In 1985, a 32-bit processor was released with the third generation x86 architecture of the Intel 80386 (or i386). The processor retained backward compatibility with the 8086 and 80286, and was produced using 1.5 micron 1.0 micron process technology. By turning the page, the processor can handle up to 4 GB of physical memory and 64 GB of virtual memory. The clock frequency was 12MHz - 40MHz. The Intel i386 processor was presented in various modifications, differing among themselves in performance, power consumption, connectors, cases and other characteristics. Models: 386DX (DX - eXternal double word), 386SX, 386SL and 386 EX (modification of the 386SX processor). The first computer to use the processor was the Compaq Deskpro 386. The model was also the first 32-bit processor for IBM desktop and laptop computers. The i386 contains Few clones made by AMD, Cyrix and IBM. The top AMD model was the Am386DX, which was not inferior in performance, and cheaper, and had a clock frequency of 40MHz. Cyrix 86SLC and 486DLC clones were also well received by users. The most famous IBM clones were the 386SLC and 386DLC processors, which were used on the IBM PS/2 and PS/ValuePoint desktop computers.

❖ <u>Intel i486:-</u> The company's next 32-bit processor, the i486 (1989), was more productive due to the update. The CPU contained approximately 1.2 million transistors (about half was allocated to the cache). The chips were produced using 1 micron processing technology, later by 0.8 micron and 0.6 micron manufacturing processes. Memory size was 4 GB. The clock frequency was 25MHz - 50MHz. The wizard was completed by:-

- cache (8 KB);

A computer pipeline that splits the processing of computer instructions into a series of independent stages, with the results being saved at the end of each. The carrier included the selection, decoding and decoding of transaction addresses, command execution, and recording of the result of executing instructions;

- built-in internal processor (unit operations with floating point) that helps to perform arithmetic operations on real numbers;

Multiplication factor (the multiplier). Various companies have also copied the Intel i486, as well as previous models. Copy production was carried out by AMD, Cyrix, IBM, Texas Instruments and others.

- ❖ <u>Motorola 68020, 68030, 68040:-</u> From 1984 to 1990, Motorola launched its 32-bit processor family: 68020, 68030, 68040. The Pioneer i386 (68020) was manufactured using 2-micron processing technology and totaled 190,000 transistors. The clock frequency was 12MHz - 33MHz. The 68020 became the first processor in the Motorola 68k line with an integrated Layer 1 cache (256 bytes). The processor was used in Apple computers: Macintosh II and Macintosh LC. The 68030 appeared on sale in 1987. The processor had a dynamic data bus, working in 8-bit, 16-bit and 32-bit modes. An additional 256 bytes of cache appeared at the first level. The clock frequency ranged from 16MHz to 50MHz. The Motorola 68030 was also used on the Apple Macintosh II and Commodore Amiga computers, on the Next Cube, Sun 3/80, Atari TT, and Atari Falcon systems. In 1990, the 68040 processor entered the market, and an integrated coprocessor appeared in it. Instructions cache and data cache increased to 4KB. The principle of the processor was based on computer pipelines, which consist of six stages. The clock frequency was 40MHz. The 68040 processor became the backbone of the Macintosh Quadra High-End System. The Macintosh Centris and Performa also used the 68040 family of processors.

- ❖ <u>December Fax:-</u> Between the 80s and the 90s, DEC released an entire series of 32-bit processors based on its VAX architecture (the 32-bit computer architecture was developed by Digital Equipment Corporation as part of the Star Project). The first in the series is the MicroVAX 78032. It was manufactured using 3-micron processing technology and contains 125,000 transistors operating at a frequency of 5MHz. In 1987, the CVAX chipset was introduced, the clock frequency was 11.11 MHz or 12.5 MHz. The processor was produced using first-generation CMOS technology, the total instruction and data cache was 1 KB and 64 KB of external cache was supported.

❖ <u>NEC V60, V70, V80 :-</u> Special mention deserves the processors of the domestic market in Japan. The first 32-bit V60 processor was released by NEC in 1986. This CPU was manufactured using 1.5 micron process technology and totaled 375,000 transistors. It used six-phase computing pipelines, and also had a built-in coprocessor and memory management unit. The clock frequency was 16 MHz. In 1987, the V70 came out, which eventually began to be produced using a 1.2-micron process technology. The clock frequency was 20MHz. At this speed, the chip performed 6.6 million instructions per second.And in 1989, the company released the V80 processor. This model already has an instruction cache and a data cache (1 KB each). A crystal was produced using a 0.8 micron process technology and contains 980,000 transistors. The V80 worked at 25/33MHz.


Intel 4-bit 4004 transistors, amplifiers, and electronic switches, which are now at the heart of everything from portable radio to supercomputers, were invented in 1947. Early prototypes were called bipolar transistors, and they are still in motion. By the 1960s, engineers figured out how to combine several bipolar transistors into a single integrated circuit. But because of their complex structure, only a few of them can be on the diagram. Therefore, although a microcomputer based on bipolar integrated circuits was much smaller than the first computers, it required several boards containing hundreds of chips. In 1960, a new type of transistor was demonstrated: the semiconductor transistor Metallic, MOS transistor. At first, the technology didn't look promising. They were slower, less reliable and more expensive than the poles. But by 1964, integrated circuits based on MOS transistors could already boast a higher density and lower production cost than bipolar ones. The complexity of integrated circuits has grown according to Moore's Law, but MOS technology has advanced. By the end of the 1960s, on one MOS chip there could already be about 100 logic elements, each of which contained several transistors, and all this seemed promising for creating computers. These multicomponent chips were called IVIs, Large Scale Integration (LSI). Engineers realized that the increased density of MOS transistors would allow a computer processor to be placed on a single chip. But due to the fact that MOS transistors were slower than bipolar ones, a computer based on MOS chips only made sense when a small speed was required or a light and compact device - data

terminals, calculators, space electronic equipment. So the microprocessor revolution started from these applications. Most engineers today believe that the revolution began in 1971, with the 4-bit Intel 4004 chip, followed immediately by the 8-bit 8008 chip. But the story of the birth of the microprocessor is much richer and more fascinating. In particular, some newly discovered documents show how the forgotten Texas Instruments TMX 1795 chip bypassed the Intel 8008 and became the first 8-bit microprocessor, but then sank into oblivion. The first processors paved the way for the use of MOS chips in the computer field. The first MOS-IVU-based computer was the D200, created in 1967 by Autonetics, a division of North American Aviation in Anaheim, California.


Three proud fathers: Federico Fuggin and Marcian Hoff Jr. and Stanley Maysor in the Inventors Hall of Fame, demonstrating the Intel 4004 processor. The 24-bit universal microcomputer is designed for aviation and navigation. Its processor was built from 24 MOS chips and used four-phase logic using four different clock signals. Each signal with its own on/off circuit, or phase, controlled changes in the state of the transistors, simplifying the circuit. Weighing just a few kilograms, the computer was used to navigate a Poseidon-class ballistic missile launched from submarines and to control the fuel on the B-1 launcher. They even thought about putting it on a space shuttle. The D200 was soon followed by another flight computer with three processors and a total of 28 chipsets: the Air Central Data Computer, authored by Garrett AiResearch (now part of Honeywell). The computer was used to control the flight of the F-14 fighter, and the MP944 MOS-LSI chipset, developed by the company from 1968 to 1970, was used. A 20-bit computer processed information from sensors and provided data for a set of equipment and aircraft control. The computer architecture of the F-14 was unusual. It had three functional units running in parallel: one for multiplication, one for division, and one for special logical functions (for example, keeping the value between upper and lower constraints). Each module consists of several different MOS chips, such as a ROM containing the data that determines the operation of the module; data management chip; Various arithmetic chips. The computer was rated F-14, so only a few people knew about the MP944 chipset. But Autonetics covered the D200 extensively, which inspired the creation of a smaller MOS computer: the System IV. It was the brainchild of Lee Boycele, who left Fairchild Semiconductor in 1968 to found Four-Phase Systems, a company he called Four-Phase Logic. The 24-bit system processor was made of only 9 MOS chips: three Arithmetic Logic Units (ALU), whose design was called AL1 (carry out arithmetic operations such as addition and multiplication, as well as logical operations, and, or or not), three ROM chip and three chips With random logic generation.
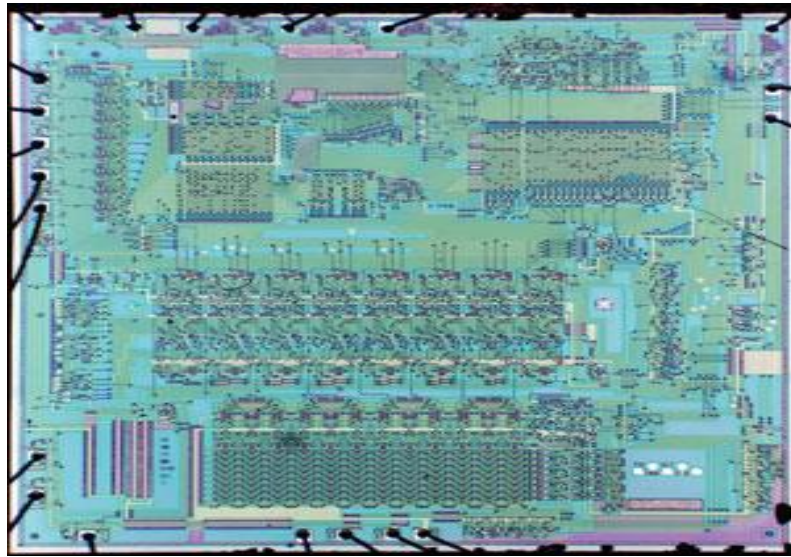
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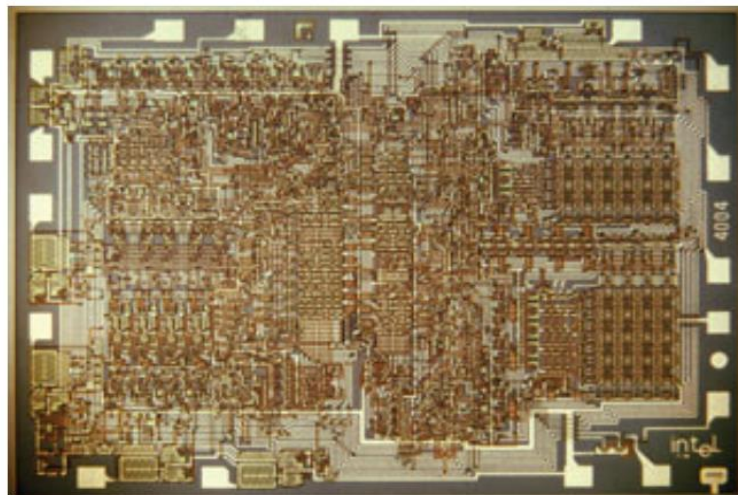
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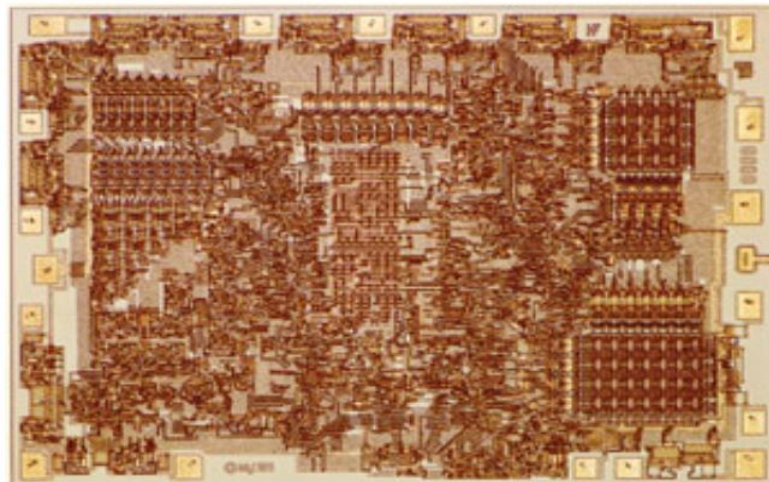
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Around the same time, a Massachusetts startup Viatron Computer Systems got into the game. Only a year after its launch in November 1967, the company announced System 21, a 16-bit mini computer with various accessories, built on the basis of homemade MOS chips. It was they who coined the word "microprocessor". For the first time, the company used it in an advertisement in October 1968, when it announced a project called 2101. But it was not a chip - in Viatron's terminology, this word meant part of a small station, with a keyboard and a drive, connected to a separate small computer. This "microprocessor" controls the terminal and consists of 18 special MOS chips on three boards. During this demonstration, in the late 1960s, the Japanese calculator maker Business Corp. (commonly known as Busicom), Intel ordered the manufacture of chips for a multi-chip calculator. The final product consisted of a single-chip processor, now known as the Intel 4004, with associated memory and I/O chips. The 4-bit 4004 (4-bit data processing) processor is often considered the first microprocessor. The calculator with the 4004 first appeared in early 1971. He had many competitors. Mostek Semiconductor Corporation released its first "calculator on a chip", the MK6010. Pico Electronics and General Instrument have their own G250 calculator. Six months later Texas Instruments TMS 1802 was released, this was the first chip in the very successful 0100 series, these circuits worked fine as a calculator, but they didn't know much, but the 4004 followed the instructions stored in the ROM. It could be a general-purpose computer. It was a time of rapid change for electronic calculators, and after financial difficulties, Busicom sold its exclusive rights to the 4004. In November 1971, Intel began producing them and auxiliary chips as the final product of general computing. After a few months, the 4004 was overshadowed by more powerful microprocessors, so its commercial success was small. He worked on various pinball machines, a word processor, and a counting machine.

Datapoint 2200 Terminal

So the first 4-bit microprocessor was created by the calculator. And the 8-bit microprocessors that quickly succeeded him have a completely different origin. Their story began in 1969 with the development of the Datapoint 2200 "programmable terminal" at Computer Terminal Corp. (CTC) of San Antonio, Texas. The Datapoint 2200 was a general purpose computer, not just a terminal. Initially, an 8-bit microprocessor was built on 100 bipolar chips. Developers are looking for ways to reduce energy consumption and heat production. In the early 1970s, CTC agreed with Intel to create a single MOS chip to replace the processor board, although it is unclear which of them decided to use the processor on a single chip.

By June 1970, Intel developed a working chip specification for the Datapoint 2200 architecture, and then froze the project for 6 months. This design will soon be translated to the Intel 8008. So whether it's the 4004, inspired by the calculator, or the 8008, inspired by the terminal, the creation of a general-purpose microprocessor should be credited to Intel, right? Not really. The fact is that in 1970, when Intel began developing the 8008, it was a start-up of 100 people. Having learned about the development, the giant Texas Instruments, consisting of 45,000 people, offered its services to STS to develop a processor for the Datapoint 2200 terminal. STS released the TI specifications and gave the go-ahead. When they came back with a three-chip design, STS politely asked if they could design on a single chip, as Intel did. T.I. took on the single-chip design in April 1970. Work was completed the following year, the chip was called TMX 1795 (X from "beta"), the name later switched to TMC 1795 when it ceased to be a prototype. In June 1971, it launched TI An advertisement for the TMC 1795 telling us how to use the "single-chip CPU" in the Datapoint 2200, "a powerful computer with features the previous version didn't." But this did not happen - after checking the TMC 1795, the CTC refused, and decided to make the processor on board and with bipolar chips. The Intel chip won't be ready until the end of that year. Many tech historians believe that the TMC 1795 died around the same time. But the newly found documents, which are owned by the leading developer of the chips Gary Boone, show that after the rejection of the STS, TI tried to sell the chip (slightly modified, therefore called the TMC 1795A) to various companies. Ford Motor Company in 1971, they became interested in the possibility of using the chip as an engine control unit, which is why Boone wrote "I think we found a huge market for our processor on a chip." Unfortunately, these attempts were unsuccessful, and T.I. stopped advertising the TMC 1795, concentrating on more profitable calculators. However, if you want to properly honor the creation of the first 8-bit microprocessor, you need to give it to TI, even though he lost his capabilities.

MEMORANDUM

October 4, 1971

TO: Dan Baudouin
                Don Crocker
                Fran Krch

COPY: Glenn Hartsell
                Widge Henrion

FROM: Gary Boone

SUBJECT: Inquiry Report

   I think we may have walked into the mass market our "CPU-on-a-chip" concept desperately needs. Bob Fortier of Ford's Engine Control Division called to discuss their current development of an engine control system utilizing an MOS computer plus RAMs and ROMs. They are currently at an engagement stage with an unnamed Japanese vendor for an MOS feasibility study. However, my inputs on the 1795/4019 and future TI systems were apparently interesting enough to put that plan on hold until we can get to Detroit. Bob has requested that we meet as soon as I get back from Europe, tentatively on Thursday, October 21, 1971.

   In the interim, Glenn will have made some progress in terms of specification and application data, the breadboard demonstration unit, and possibly prototype samples.

   I have asked Don Crocker to send some data (Kent Andres PLA Application Report, TMS 1802 Specification, and 1795/4019 preliminary data) to Bob. Also, I think marketing should pick up the ball with respect to any additional information, planning, and scheduling meetings, etc.

   Gary Boone

GB:ls

Boone's message about Ford

By the time Intel acquired the 8008, by the end of 1971, STS had already lost interest in single-chip processors and had given up exclusive design rights. But Intel went further and released the 8008 on a commercial basis, making an announcement in April 1972, and as a result, produced hundreds of thousands of these chips. Two years later, out of the 8008, the 8080 processor was born, which greatly influenced the creation of the 8086, which, in turn, made the line of x86 chips possible today. And if your computer is equipped with an x86 processor, you're using a computer based on a design rooted in the 1969 Datapoint 2200 programmable workstation. Many things depend on contingencies and the outcomes of different business decisions that can easily become different. Remember how the 8-bit processor architecture developed by STS for the Datapoint 2200 was implemented in four different ways. Twice, STS has implemented it through plates filled with bipolar chips, first through serial data transmission, and then through faster parallelization. Then TI and Intel satisfied STS requests for individual chips with approximately the same set of instructions, but their packages, control signals, instruction synchronization and internal circuits were completely different. Intel technology was more advanced than TI, in particular, self-aligning polycrystalline silicon gates were used, which led To speed up transistors and increase output. This approach made it possible to arrange more dense transistors. As a result, the 4004 and 8008 were even smaller than the TMC 1795 combined. Intel engineers thought that the TI chip was too large and therefore impractical, but in fact it was not: a very successful chip for the TMS 0100 calculators, which appeared a little later, there was more than the TMC 1795. Given all this, who should have Do we give a hand in creating a microprocessor? We can say that the microprocessor is not an invention, but something that everyone has been

waiting for. It was just a matter of waiting for the right technology and market demands. I like this approach more than others.Another opinion may be that the microprocessor is an advertising term necessary for the promotion of their products by Intel, TI and others. Boone, although he was developing the TMC 1795, later praised Intel for its determination to turn the processor into a valuable product. In an undated letter relating to a dispute over who should be considered the creator of the first microprocessor, he wrote: "The main thing in the development of the microprocessor was Intel's policy in 1972-1975 ... Their innovations in design, software and advertising created the industry, or, at least accelerated its appearance" .
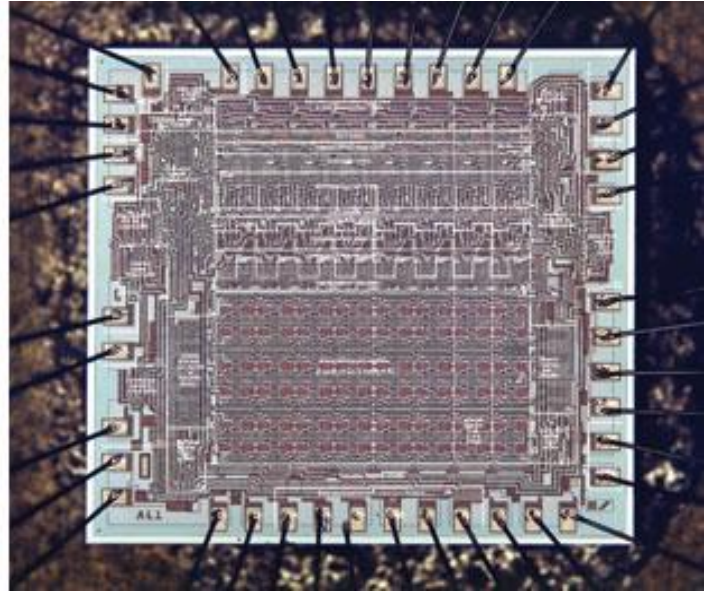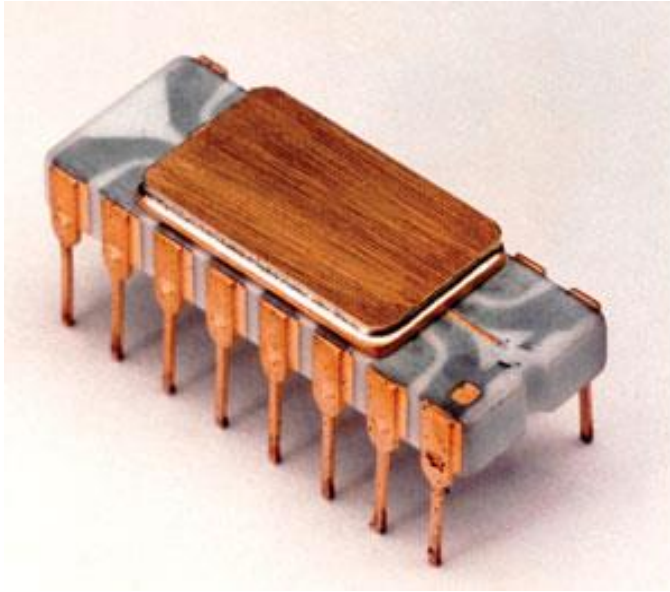
AL-1

The honor of creating the first microprocessor also depends on the understanding of this term. Some consider the microprocessor to be a central processor on a single chip. Others say that the arithmetic logic on the chip is sufficient. Others believe that it is enough to put these functions on separate chips, and together they can form a microprocessor. I think that the main features of the microprocessor are the central processor on a single chip (including ALU, control functions, registers) and its programmability. But the microprocessor is not the whole computer. Usually, more memory chips, I/O, and other auxiliary functions. Using this definition, most people would think that the first processor was the Intel 4004, since all of the CPU components were on the same chip. Boone and Federico Faggin of the Intel 4004 agree that the 4004 beat the first TMX 1795 in two months. Then the latter introduced the first 8-bit microprocessor, and then the Intel 8008 became the first successful commercial 8-bit microprocessor. But if you accept a less strict definition of a microprocessor, other systems may be the first. If we consider the ALU microprocessor on a chip, the first would be Boisel, who created the first chip at Fairchild in 1968, shortly before his departure and founding Four-Phase Systems. Four-Phase Systems' AL1 could also be a candidate, combining registers and ALUs on the same chip, with external control loops. If we assume that the microprocessor can consist of several IVU chips, then Autonetics D200 will be the first.

From a patent standpoint, the story looks a little different. TI quickly realized the profitability of the patent system. They obtained several patents for the TMX 1795 and TMS 0100 and often used them in litigation and licensing. On this basis, TI can be considered the inventor of both a microprocessor and a microcontroller, a single-chip layout for the CPU, memory and various auxiliary functions. or not. Because Hilbert Hyatt patented a single-chip processor in 1990, based on a 16-bit serial computer, which he built in 1969 from bipolar-chip boards. This led to claims of Hyatt's supremacy in the invention of the microprocessor, but T.I. won the patent for it in 1996 after a tough court battle. Boysel may be another contender for the inventor's place. In 1995, during a lawsuit that Gordon Bell later called "TI against all," Boisel fought T.I.'s patents with a single AL1 ALU chip from 1969, demonstrating a working computer in court. This move torpedoed T.I.'s case, although I personally do not find her demonstration very convincing, because she used many technical tricks. Regardless of which invention she considers the first microprocessor, you can agree that there was no shortage of contenders for this title. It is a pity that most people want to find one winner, while now other applicants are almost forgotten. But for those who are interested in the early days of microprocessors, their rich history will live on.

Sources used in the report :-

- ✓ https://ar.jf-parede.pt/evolution-microprocessor-types-microprocessors
- ✓ https://ar.jf-parede.pt/microprocessor-history
- ✓ http://althawrah.ye/archives/23265
- ✓ https://coreiten.com/article/%D8%AA%D8%B7%D9%88%D8%B1-%D8%A7%D9%84%D9%85%D8%B9%D8%A7%D9%84%D8%AC%D8%A7%D8%AA-%D8%A7%D9%84%D8%AF%D9%82%D9%8A%D9%82%D8%A9-evolution-of-microprocessor-54
- ✓ https://www.anaengineer.com/what-is-a-microprocessor/
- ✓ https://mkr-novo2.ru/ar/obrazovanie/istoriya-razvitiya-mikroprocessorov-kratko-istoriya-mikroprocessora.html
- ✓ http://processortech1.blogspot.com/p/blog-page_51.html
- ✓ كتاب عن المعالجة الدقيقة 8086