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New Descendant's Electronics The Development Trend Of Microprocessors Is From "Bigger" To "Small"

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ABSTRACT

The article discusses the issues of minimizing the size of microprocessors, their use in various spheres of human life, as well as in modern technologies such as micro drones, SIM-cards.

KEYWORDS

Microprocessor, transistor, SIM card, nanometer, Virtual SIM, GSM, Super SIM, micro drones, nanosystem technology, miniaturization.

INTRODUCTION

All electrical devices are provided with microprocessors. Modern microprocessors are the fastest and smartest microcircuits in the world. They can perform up to several billion operations per second and are produced using many different technologies. Since the early 90s of the XX century, when processors went into mass use, they have gone through several stages of development.

A microprocessor is an integrated circuit formed on a small silicon chip and executes machine instructions. Silicon can be made both an insulator that prevents the movement

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of electric charges, and a conductor - then electric charges will freely pass through it.

The microprocessor contains millions of transistors, interconnected by the thinnest conductors of aluminum or copper, and used for data processing. This is how the internal tires are formed. As a result, the microprocessor performs many functions - from mathematical and logical operations to controlling the operation of other microcircuits and the entire computer.

One of the main parameters of a processor is the crystal frequency, which determines the number of operations per unit of time, the system bus frequency, and the amount of internal SRAM cache. The frequency of operation of the crystal is determined by the rate at which the transistors switch from the closed state to the open state. The ability of a transistor to switch faster is determined by the technology used to manufacture the silicon wafers from which the chips are made. The technological process determines the size of the transistor (its thickness and gate length). For example, when using the 90 nm process technology, which was introduced in early 2004, the size of the transistor is 90 nm, and the gate length is 50 nm [10].

THE MAIN FINDINGS AND RESULTS

All modern processors use field effect transistors. The transition to a new technological process allows you to create transistors with a higher switching frequency, lower leakage currents, and smaller sizes. Downsizing allows for a simultaneous reduction in die area and hence heat dissipation, while a thinner gate allows less switching voltage, which also reduces power consumption and heat dissipation.

The SIM card (Subscriber Identity Module) is an essential part of GSM mobile phones. Its main task is to securely identify the phone on the network.

Despite its tiny size, the architecture of the SIM card is a complete microcomputer. It is built around an 8-bit instruction set compatible Intel 8051, Motorola 6805 or Hitachi H8. The SIM card processor supports a set of 18 SIM Tool Kit (STK) commands.

In addition to the processor, the microcomputer contains three types of memory: permanent memory (ROM, Read Only Memory), reprogrammable non-volatile memory (EEPROM or NVM, Non-Volatile Memory) and random access memory (RAM, Random Access Memory).

The ROM memory with a volume of 10 to 90 KB stores the operating system of the SIM card. Like any other OS, it is entrusted with input / output tasks, and the main feature is mandatory authentication using a PIN code and PUK code and encrypting all data.

In 2020, brand new SIM cards called Super SIM went on sale in China. A distinctive feature of the novelty from the usual SIM-cards is the support of fifth-generation mobile networks and the presence of many times increased internal memory. So, if the more familiar “SIM” has an internal memory of around 512 KB, then the Chinese novelty can be equipped with 32, 64 and even 128 GB of flash memory. The information recorded on it is encrypted without fail, and only the owner of the SIM card itself gets access to it.

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At the moment, the novelty is available only in one Chinese city of Guangzhou, and only two specially released smart phones received its support. If users appreciate the new type of SIM, the technology is promised to be made more widespread among the masses. By the way, the 32 GB Super SIM was priced at $20 and the maximum 128 GB version will cost $ 78.

Virtual SIM is the general name for a variety of non-standard technical solutions that allow you to remove a SIM card from a mobile phone. The SIM card is inserted into a special device connected to the Internet (for example, a modem, another cell phone, a special SIM card server) or connected to the user's cell phone via a wireless channel (for example, Bluetooth). In the user's mobile phone, software is installed that allows, when requested by the cellular operator, to redirect this request to the SIM card via the Internet or another communication channel.

The first transistor made by Bell Labs scientists in 1947 was the size of a human palm. And already 45 nm transistor from Intel by 2006-2007 was 400 times smaller than a human red blood cell [6].

In manufacturing, a decrease in the process technology leads to the fact that the thickness of the transistor component that is responsible for the passage of electrons (that is, the thickness of the gate dielectric) decreases. And the processor, which is manufactured using the 65 nm process technology, is only 1.2 nm [10].

For many years, the material of the gate dielectric was silicon dioxide, the molecule of which consists of 1 silicon atom and 2 oxygen atoms [1]. Another round has taken place in the development. Intel has taken the path of replacing silicon dioxide with a higher-quality material required to produce the gate dielectric. It is a high-k, hafnium based insulator with a high dielectric constant.

In 2018, a group of researchers from the Massachusetts Institute of Technology demonstrated a microprocessor for unmanned aerial vehicles based on programmable logic arrays FPGA. The hardware implementation of the vehicle control algorithms has significantly reduced the weight and energy consumption - the new processor took only 2 watts to solve the problem of orientation in space, for which the processors of conventional drones require from 10 to 30 watts.

However, this is still too much for a miniature, palm-sized drones. Therefore, in the new processor model, called Navion, a data compression scheme was applied to reduce the amount of memory for storing images. Instead of 2 megabytes, only 0.8 MB is left on the processor. The processor size is 20 mm2, and it consumes only 24 mille watts. At the same time, the processor is capable of processing data from inertial sensors and images from cameras in real time with a frequency of up to 171 frames per second.

Micro drones - small, sometimes miniature flying devices - have tremendous capabilities. They are used for aerial photography of the area, tracking traffic jams, observing order in the streets. The micro drone easily fits in the palm of the hand, and in flight it is capable not only of hovering in the air, but also very easy to change the direction of flight and even turn over on its own axis on the fly.

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There are several different terms for small UAV, but in general they belong to the family of tactical unmanned vehicles that can be quickly deployed for short-term surveillance.

CONCLUSION

As a conclusion, we can say that the main driving forces of technological changes in the 21st century are the intellectualization and miniaturization of technical systems. The development of information, executive and sensory components and their integration on the basis of nano and micro system technology formed the basis of these processes. As a result, small-sized technical objects with advanced capabilities of interaction with the external environment were created. They are indispensable for deploying the digital revolution in industry and for creating applications such as unmanned driving systems, the Internet of Things, and intelligent infrastructures. For example, already today about 10% of GDP in European countries is directly related to micro- and nano engineering.

In recent years, nanosystem technology (NST), which originates in integrated microelectronic technologies, has become a segment with a rich variety of design and technological areas. The basis for the future of nanosystems should be the unification of their components at the functional, constructive and informational levels.

The traditional approach to the development of NST, associated with a consistent reduction in size by various types of processing: lithography, etching, etc. (the so-called top-down approach) has its own technological limitations... The alternative is the use of new materials and nanotechnologies in the creation of nanosystems (bottom-up approach) and the introduction of self-organization technologies.

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