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QUANTUM COMPUTER

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This article is about quantum computers, shows its advantages over classical computers and prospects for their use.

Over the past few years, almost all people have heard the name «quantum computer»,however, only few people imagine how this works and why it is needed.A quantumcomputerisadevice that uses quantum effects to process and transfer data.Forexample, in classical computer information is encoded using a binary code and bit, as the minimum unit of information, has two basic states: 0 and 1. A quantum computer uses qubits (quantum bits), capable of accepting not only states 0 and 1,but the superposition of both numbers, i.e. 0 and 1 at the same time [1].

Figure 1 shows the representation of a bit and a qubit:

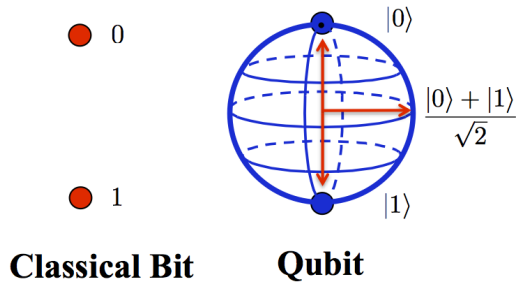

Figure 1. – Bit and Qubit

Objects of the real world capable of realizing qubits may be elementary particles. Due to the superposition of qubits, quantum computers can perform parallel computations, which will lead to a significant increase in computation speed.Therefore, it is believed that a quantum computer consisting of several dozen qubits in computing power will be equal to a supercomputer operating with a performance of tens of teraflops (trillions of operations per second), while the power of modern classic computers does not exceed billions of operations per second.Another important physical phenomenon that can be used to create quantum registers and help in reading information from qubits is quantum entanglement. If you apply external force to two atoms, you can establish a connection between them - "entangle" together in such a way that one atom will start to have the properties of the second one and, when measuring the spin of one atom, the second atom immediately changes its spin to the opposite one. This property of particles will allow you to read information from qubits without measuring them directly [2].

However, a number of problems stand in the way of creating quantum computers, the main one is the phenomenon of decoherence [3], in which quantum uncertainty disappears, without which a quantum computer will be no different from the classical one. Also, the work of quantum computers depends on external interference. One of the methods of dealing with these problems is the isolation of a quantum system.

If you still manage to overcome all these problems, then we can expect a breakthrough in technology and various fields of science, it is already assumed that quantum computers will be able to bring cryptography to a new level, since they will be able to quickly decompose large numbers into simple factors. This rapid decomposition of numbers into simple factors will create a security risk for the RSA encryption system, which is widespread today. Other applications for quantum computers: research in the field of artificial intelligence, molecular modeling, which will help to simulate chemical reactions and theoretically help in the creation of drugs [4].

Despite the fact that science has made a step far in the field of creating quantum computers and the leading companies can boast not only a few units but dozens of entangled qubits, their computing power is not enough to outrun classic computers. Leaders in the field of construction of quantum computers are IBM, D - Wave, Google, Microsoft.

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The IBM quantum computer came out under the name Q System one in January 2019. It is a 20 qubit machine operating at temperatures close to absolute zero. To isolate and counteract external interference, the computer is enclosed in a sealed glass cube. As the manufacturer says, the computer has a modular design, which makes it relatively easy to modify and maintain. However, it is not yet possible to buy this computer, but it will be available for IBM partners. IBM has staked on the development of quantum computers capable of performing a wide range of tasks.

The quantum computer of Google has 72 qubits and has the original architecture. In Google's quantum computer, qubits are not connected in a chain, but form two square arrays, which makes it possible to achieve extremely high accuracy and reliability of computations.

Figure 2 shows an architecture of a Google computer:

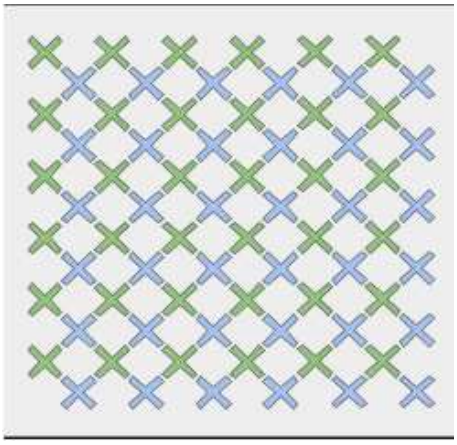

Figure 2. – Google architecture of a quantum computer

Google has relied on high accuracy of calculations, which will allow to scale quantum systems and soon it is possible to get a quantum computer consisting of hundreds of connected qubits. [5]

Company D - Wave was one of the first to create quantum computers incorporating many dozens of qubits. To date, the latest D-Wave computer models contain 2000 qubits and are capable of decomposing a six-digit number into simple factors, but this machine is not a full-fledged quantum computer, as it can perform only a limited range of tasks.

Microsoft has been researching quantum computers since the mid-2000s, but so far it boasts the idea of creating a quantum computer using an elementary particle — Majorana fermion, which, according to Microsoft, is more suitable for solving real-world problems.

Conclusion: quantum computers are promising computing systems that can be used in any field of science and eventually force out classic computers. Quantum computing can change our world forever. However, the leading technology development companies do not have a single view on a quantum computer, each manufacturer sees its own unique way of creating the final product. Therefore, on the way of their creation, there are still certain difficulties that can be solved in the next decades.

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