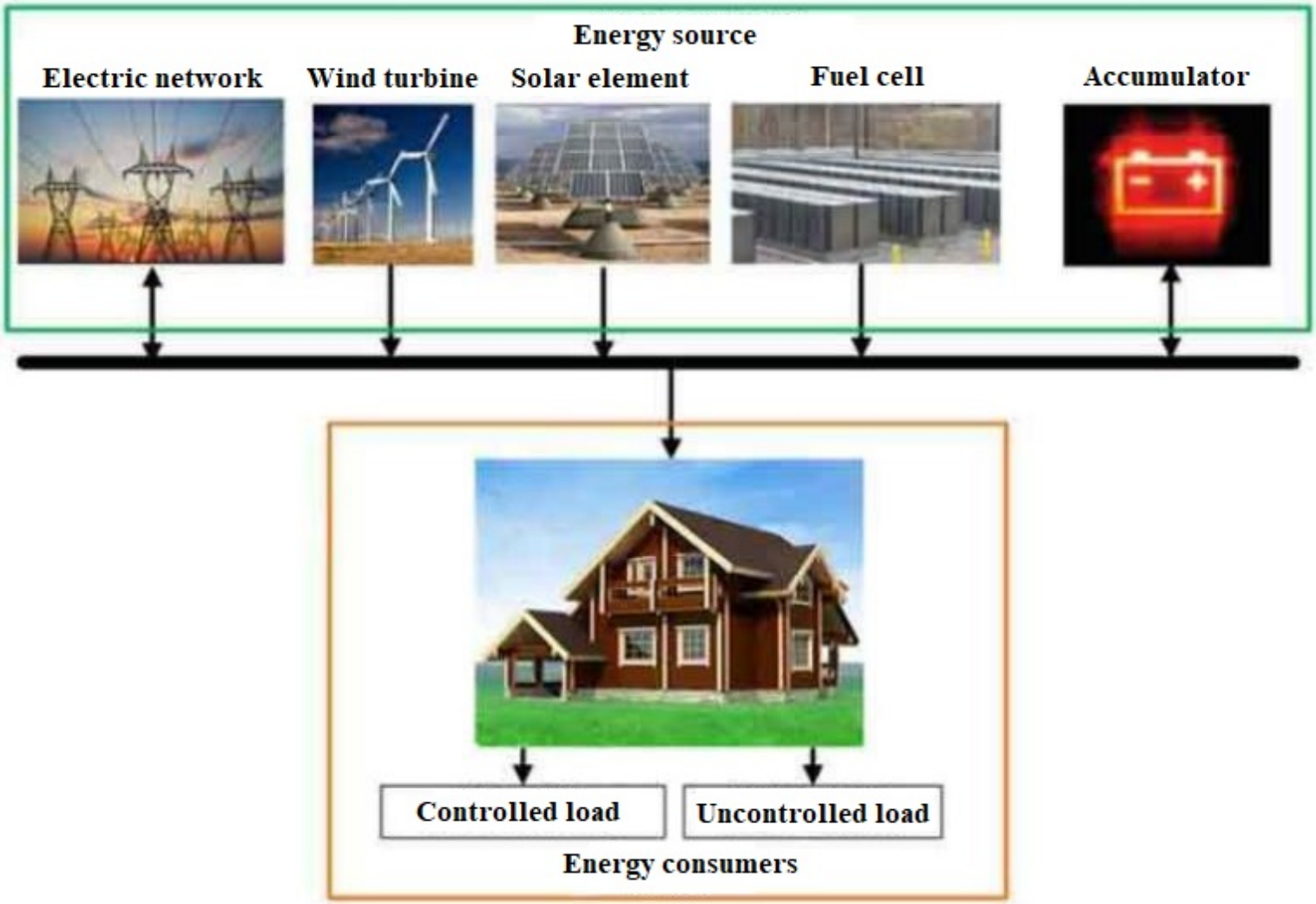
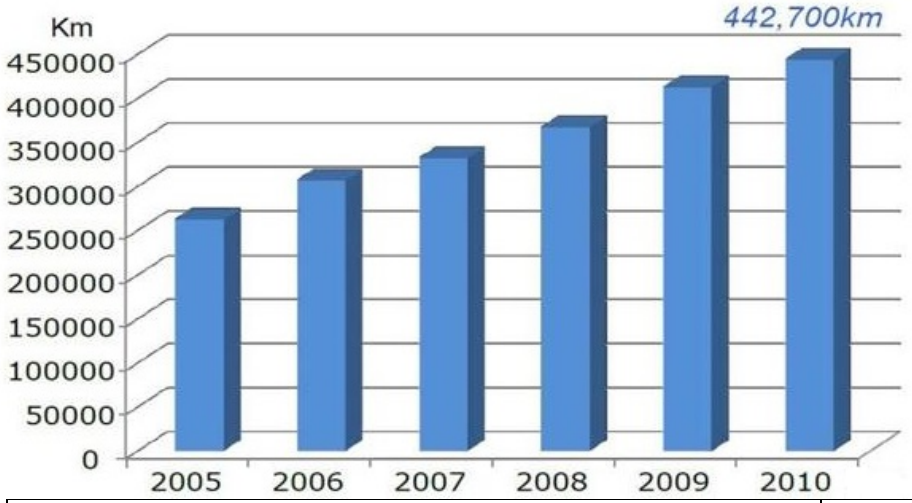
Microgrids.


Energy source
Electric network
Wind turbine
Solar element
Fuel cell
Accumulator
Controlled load
Uncontrolled load
Energy consumers



AC power line length (220 kV and above)

Technology	g CO_2e/kWh
Hydropower	7
Ocean power	8
Wind	10
Nuclear power	13
Concentrating solar power	20
Biopower	35
Solar photovoltaics	40
Geothermal	50
Natural gas combined cycle (NGCC)	450
Natural gas-fired combustion turbines (NGCT)	670
Coal	1000

Generation technologies and emission volumes, calculated to one CO_2 indicator per generated kilowatt-hour.

Approximations are based on either Published or Harmonized data. g - gram; CO_2e - carbon dioxide equivalent; kWh - kilowatt hour.

This is how the microgrid concept appeared - a solution for energy in cities that most fully satisfies the needs of various components of the digital economy. There are many definitions of a microgrid - "a local system that consists of three key components: generation, storage and consumption. It also includes an electrical network connecting them and a control system. A microgrid can be autonomous or connected to the general energy network".

In fact, thanks to the many possibilities, it is possible to set various requirements for energy performance within the system. A microgrid is primarily an energy system. but may also include a heat supply or water supply component. For example, if gas generation is used inside the microgrid, and as a result of burning gas (natural or biogas), in addition to electricity, heat is also produced, then this will be managed by one system. The possibility of using both direct current (DC) and alternating current (AC) or their combinations also gives huge advantages.

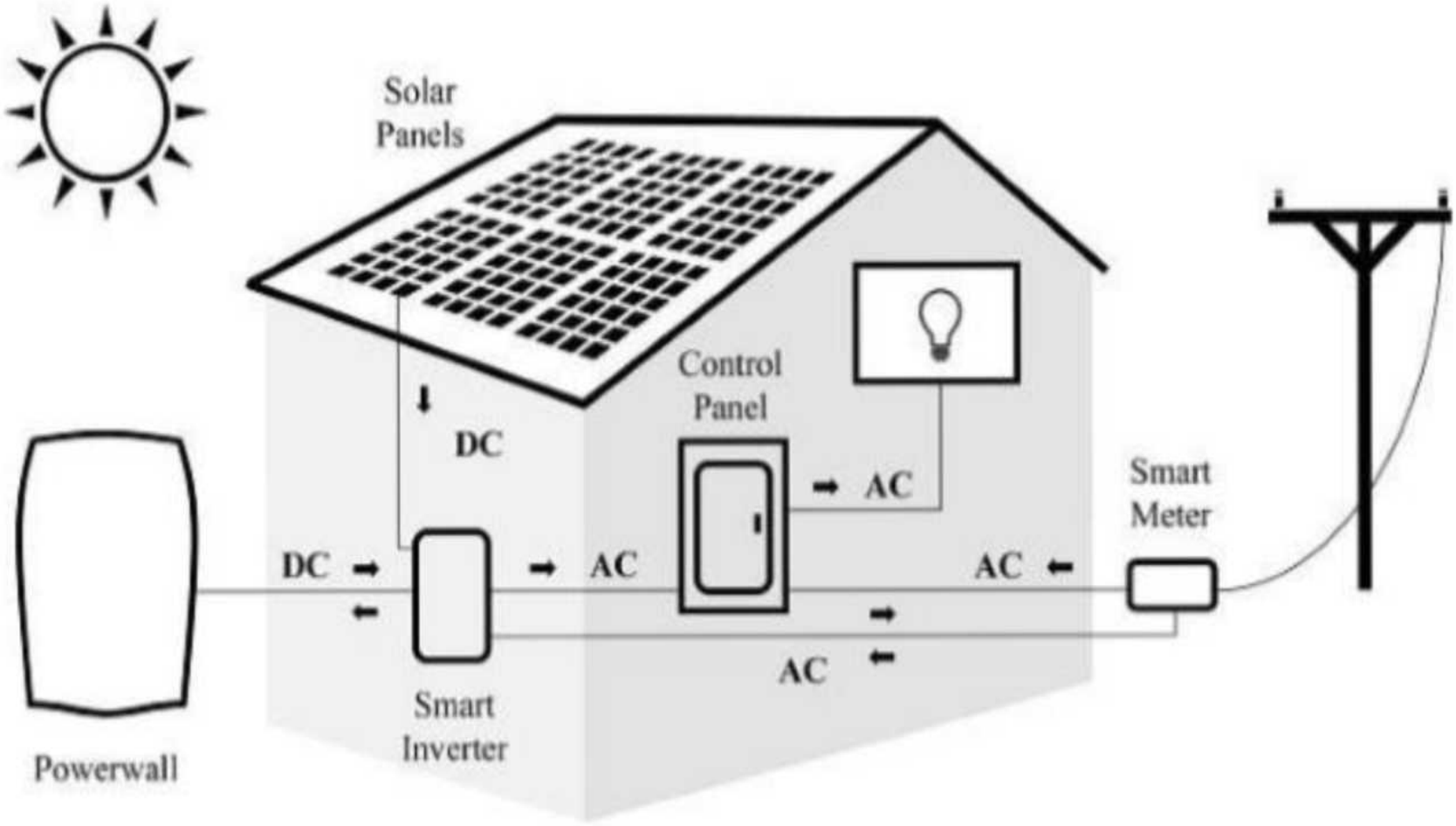
The microgrid is a tool of the digital economy that allows you to make specific systems in it maximally oriented to the needs of specific parts of it from the point of view of their requirements for energy and its quality characteristics.

Formally, a huge number of microgrids are already functioning today, but they are mostly of small unit energy capacity. In these systems, the use of renewable energy sources, mostly solar and wind, is growing sharply. In a large number of countries, the installation of solar panels for homeowners is carried out free of charge, and electricity from them is purchased by electricity grid companies at preferential rates, and, for example, in Spain, the installation of solar panels is mandatory for new construction of houses.

China has become the largest producer of solar cells in the world. More than 40% of the world's microgrid installations operate in SILA, where they collectively amount to 940 MW.

Today, approximately 83% of U.S. homes already have solar panels, and homeowners are eager to transition to zero pollution and energy savings.

As a successful project, we can mention the work from active buildings in Finland. The house is completely self-sufficient in energy with the help of the sun, wind and heat from the depths of the earth. And it is possible even in the north of Finland. A zero-energy house (or, as it is called, a more active house) makes as much energy as it consumes. Annual energy consumption is round zero. Surplus energy produced in the summer is sold to power grids, through which the necessary amount of electricity is purchased in the winter.



Installation scheme of PowerWall in a house with solar batteries and connection to the general electrical network.

Distributed computing is a way of solving resource-intensive computing tasks and operations using several computers, most often combined into a parallel computing system.

Grid computing is a form of distributed computing in which a supercomputer consists of single computers and clusters that are geographically distributed in different locations and work together to perform certain operations. At its core, the grid is a technology that is used to solve scientific problems that require significant computing resources.

GRID - system (or DICE - distributed information and computing environment), as a rule, consists of various software and hardware platforms, contains computers of different levels and classes, such as home personal workstations, industrial computers, supercomputers.

GRID is characterized by the following properties:
- the scale of the computing resource (the amount of RAM, the number of CPU cores), which usually exceed the resources of a single computer, computing complex or supercomputer:
- geographical distribution;
- pooling of resources that cannot be managed centrally;
- use of standard, open, publicly available protocols and interfaces;
- ensuring information security.
Tasks for which GRID can be used include:
- complex modeling;
- joint visualization of large sets of scientific data:
- distributed processing for data analysis purposes;
- connecting scientific tools with remote computers and data archives.
The most effective application of GRID is to solve the following tasks:
- distributed high-performance computing,
- "high-flow" calculations that allow you to organize the efficient use of resources for small tasks
- carrying out large one-off calculations:
- calculations involving large volumes of distributed data, for example,
in meteorology, astronomy, high energy physics;
- collective computing: simultaneous work of several interacting tasks of different users.

An analysis of the global experience of building GRID systems shows that they are based on solutions to the following problems:

- **unification of disparate systems;**
- **data sharing;**
- **dynamic allocation of resources;**
- **portability of applications in a heterogeneous environment;**
- **ensuring information security.**

GRID technologies are actively used by both state management and defense organizations, as well as private companies, in particular, financial and energy companies. The field of application of GRID now covers nuclear physics, environmental protection, weather forecasting and climate change modeling, numerical modeling in aircraft construction, biological modeling, pharmaceuticals.

The grid system must have a set of services that ensure the controlled execution of programs of authorized users. The grid network is dynamic - both the number of computing nodes and their configuration may change over time.

For normal functioning, the grid system must provide:

- identification of the executable program:

- user authorization;

- resource search:

- description of resources;

- reservation of resources;

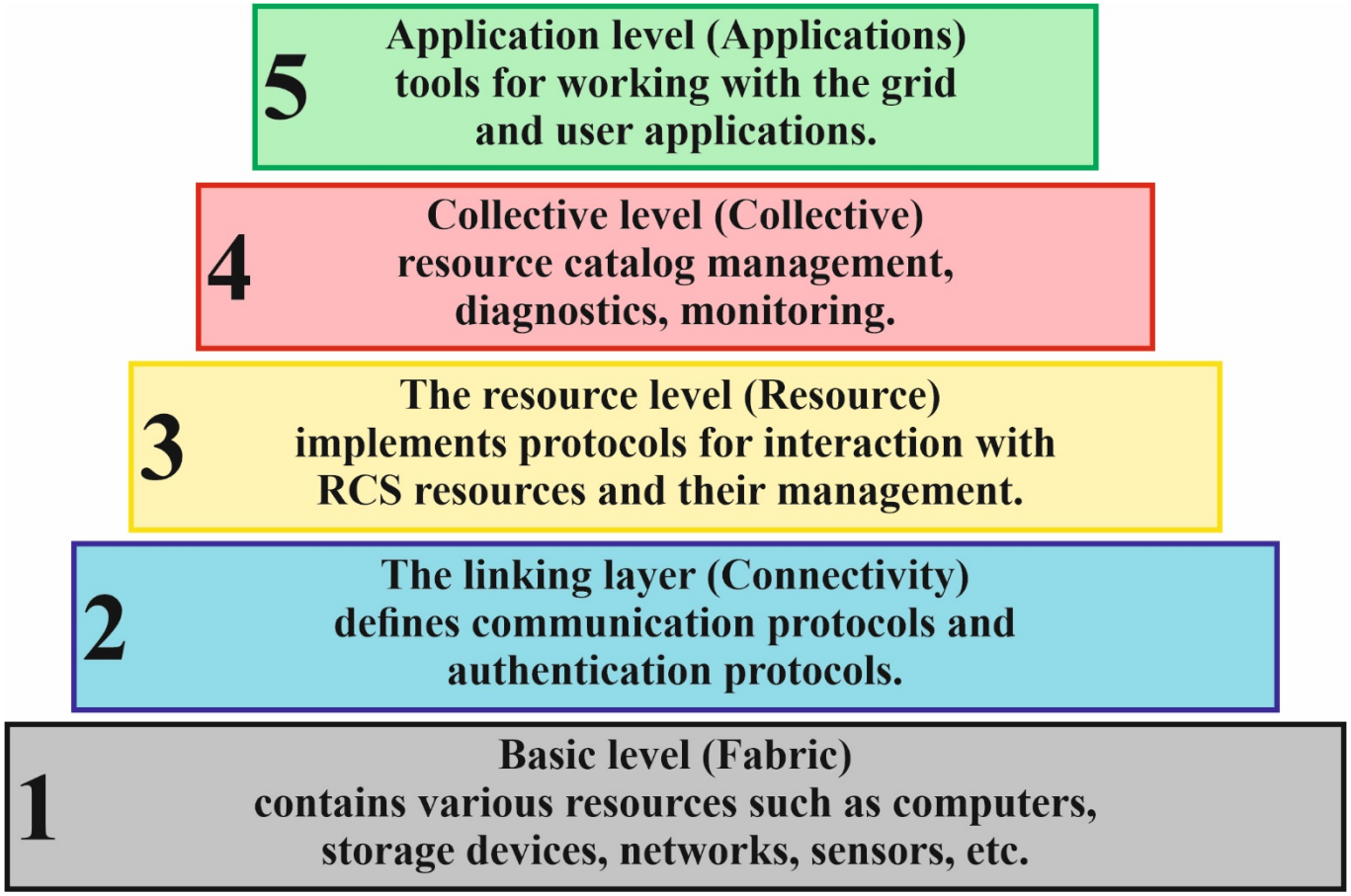
- access to remote data;

- distribution of resources;

- troubleshooting.

Number and nature of services. that ensure the operation of the grid system. may vary depending on the purpose of this computing environment.

The GRID architecture can be represented as a hierarchical structure consisting of several levels. At each of the presented levels, there are certain services that interact using standard protocols.



Security issues in GRID.

Kerberos is a IETF standard that supports system security by establishing the authenticity, integrity, and confidentiality of a message created when using the shared secret cryptography method. This protocol can provide one-time authorization and flexible protection of messages. However, Kerberos has various implementations that tend to replace local security solutions.

TLS\SSL - IETF standard for establishing the authenticity, integrity and confidentiality of a message created using public key cryptography technology. The use of this protocol is difficult when implementing one-time authorization and delegation.

PKIX - a set of IETF standards that describe the protocols and syntax of X.509 certificate management in infrastructures of security systems that use public key technology. X.509 standards are used in combination with other secure communication standards, for example. TLS.

CMS - the IETF standard defines a syntax that allows digitally signing, authenticating, or encrypting arbitrary messages.

GSS-API is an IETF standard that defines an application program interface that ensures authenticity, integrity, and confidentiality of a message. He foresees. that two parties exchanging messages. have a connection based on a protocol that ensures the reliability of the delivery of information packets.

An analysis of the global experience of developing and using GRID systems shows that the GRID security system should have the following properties:

- implementation of one-time registration of users - such registration assumes that the identification procedure is carried out only at the time of user login to the system;

- delegation of rights - the user's program must have access to the resources on which the user is authorized;

- possibility of integration with local security systems;

- implementation of trust relations - if the user is authorized on resource A, and resource A interacts with resource B, then this user should be considered authorized on resource B as well.

Each resource can use any of the existing ways to solve the problem of system security.

The problem of protecting communication between different resources of the computing environment should be taken into account. Two main points can be distinguished here:

- **Flexible message protection. It is assumed that the application program (application) should be able to dynamically configure the security service protocol to use different levels of message protection: either to determine only the integrity of the message, or integrity and confidentiality.**
- **Support of various communication protocols that guarantee the delivery of information packets. Currently, the TCP protocol is widely used, which ensures the guaranteed delivery of information packets, but GRID should be able to use other protocols with similar properties.**

A supercomputer is a specialized computing machine that significantly surpasses the majority of existing computers in the world in terms of its technical parameters and calculation speed.

Supercomputers are used in all areas where numerical modeling is used to solve a problem; where a huge volume of complex calculations is required, processing a large amount of data in real time, or the solution to a problem can be found by simply sorting through many values of many initial parameters.

Parallel computing systems are physical computer as well as software systems that implement one way or another parallel processing of data on many computing nodes.

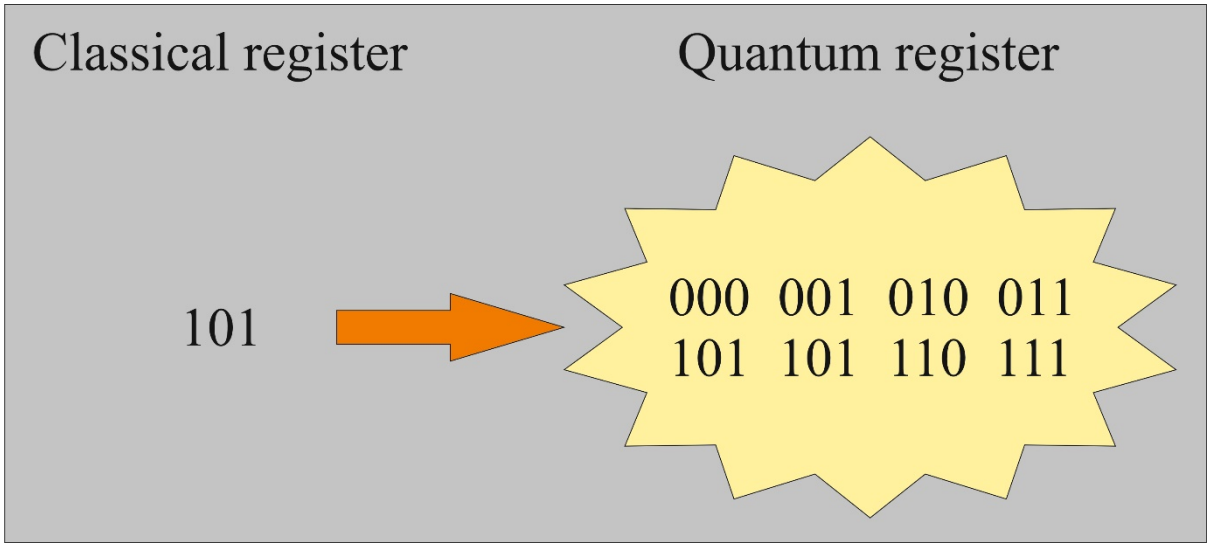
The performance of supercomputers is most often evaluated and expressed in the number of operations on floating-point numbers per second (FLOPS). This is because the numerical modeling tasks that supercomputers are built for most often require calculations involving numbers, often with a high degree of precision, rather than integers. Therefore, the number of millions of operations per second (MIPS) is an unsuitable measure of the speed of ordinary computer systems for supercomputers.

With all its ambiguity and approximation, the evaluation in flops makes it easy to compare supercomputer systems with each other, based on an objective criterion.

A vector processor is a processor in which the operands of some commands can be ordered arrays of data - vectors. It differs from scalar processors, which can only work with one operand per unit of time. The vast majority of processors are scalar or close to them. Vector processors were popular in the field of scientific computing, where they were the basis of most supercomputers from the 1980s to the 1990s. But a sharp increase in productivity and the active development of new processors led to the displacement of vector processors from the sphere of everyday processors.

For the first time, the possibility of creating a quantum computer was expressed by the physicist Richard Feppman. In the early 1980s, the concept of a quantum computer began to take shape.

A quantum computer is a computing device 3 that uses the phenomena of quantum mechanics (quantum superposition, quantum entanglement) for data transmission and processing. A quantum computer (unlike an ordinary one) does not operate with bits (capable of taking the value of either 0 or 1), but with qubits, which have the value of 0 and 1 at the same time. Theoretically, this allows processing all possible states at the same time, achieving a significant advantage over ordinary computers computers in a number of algorithms.



Three bits of an ordinary register versus 3 qubits of a quantum register.

A qubit (q-bit, quantum bit) is a quantum unit or the smallest element for storing information in a quantum computer.

The qubits can be entangled with each other, that is, an unobservable connection can be imposed on them, which is expressed in the fact that with each change on one of several qubits, the others change in agreement with it. In other words, a set of entangled qubits can be interpreted as a filled quantum register.

Like an individual qubit, a quantum register is much more complex than a classical bit register. It can not only be in all kinds of combinations of its component bits, but also implement subtle dependencies between them.

Despite the fact that we ourselves cannot directly observe the state of qubits and quantum registers in their entirety, they can exchange their state with each other and can transform it. Then it is possible to create a computer capable of parallel calculations at the level of its physical device, and the problem remains only to read the final result of the calculations.

A qubit is anything that can occupy any state between two "border" states. For example, if a bit can only be black or only white, then a qubit can become a gray color of any saturation between these two tones. If a bit can only be 0 or 1, then a qubit can take any value between 0 and l. A bit can be thought of as an analogue of a switch: it is either off (0) or on (1).

In this respect, a qubit is more like a volume knob on a radio. The receiver is turned on from the off state (knob position at 0) by turning the volume knob. With further rotation, the volume will increase until it is turned to the limit (position 1). The volume knob can take any position between 0 (off) and 1 (max volume).

A quantum algorithm is an algorithm designed to run on a quantum computer.
The quantum algorithm is a classical algorithm that specifies a sequence of unitary operations with an indication of which qubits they should be performed on. The quantum algorithm is specified either in the form of a verbal description of such commands, or with the help of their graphic record in the form of a system of gates (quantum gate array).
The result of the work of the quantum algorithm is probabilistic in nature. Due to a small increase in the number of operations in the algorithm, the probability of obtaining the correct result can be brought closer to unity as desired.
Quantum superposition - superposition (mixing) of states that cannot be realized simultaneously from a classical point of view; it is a superposition of alternative (mutually exclusive) states.
Quantum entanglement is a quantum mechanical phenomenon in which the quantum states of two or more objects are interdependent. For example, you can get a pair of photons in an entangled state, and then if when measuring the spin of the first particle, the helicity turns out to be positive, then the helicity of the second always turns out to be negative, and vice versa.

It should be borne in mind that the information stored in a modern quantum computer is extremely unstable compared to a classical computer. Quantum computers will bring artificial intelligence closer. But one should not think that a quantum computer will be as universal as a classical one. There will be a wide range of problems where a quantum computer will be better, but no more.

The figure shows a block diagram of a quantum computer. At the physical level, there is a quantum processor, control nodes (microwave), a reading system, as well as a quantum error correction unit. At the top level, modules of a logical quantum processor, a control system and quantum algorithms.