The key problems of civilization are related to the shortage of energy resources, environmental problems and safety.

ENERGY

"Green Energy" produces electricity from renewable sources sources (wind, tidal, solar).

A typical example is the company "Siemens", which changed a few years ago the general direction of its development, switching to "smart" and "green" technologies, including IT (smart homes and urban infrastructure, solar and wind energy generators, electric cars).

IT implements monitoring, information processing and management and affect the technical level of energy systems, both traditional and green energy.

Every year, information technology in this context acquires independent role, as IT systems are becoming an increasingly active consumer energy Their share accounts for 3% of the total amount of energy consumed.

There is a separate class of systems that can be called energy critical. In such systems, the time of useful operation (lifetime) depends on built-in means of energy supply - autonomous robots, space devices, unmanned systems. Modes can be introduced in such systems forced reduced energy consumption to increase the time of active work in exchange for a reduction in the number of performed functions or their degradation characteristics.

In such systems, IT tools must, on the one hand, manage energy regimes of all equipment, on the other - to minimize own energy consumption, balancing in the space of characteristics "functionality - reliability (safety) - energy".

Ecology

Aspects related to the processes of development, application and disposal of IT systems (production of modern microchips, computer equipment: monitors, printers, memory devices) is environmentally critical and requires capital investments to comply with the provisions of standards and laws and to compensate for risks. Indirect contribution of IT to CO_2 emissions and related greenhouse effect is 2-2.5%: it doubled in 2020 to 4%.

According to existing estimates, every request on the Internet has its own negative CO_2 metric, which is tenths of a gram - a very small level, however, when multiplied the number of users and appeals turns out to be colossal figures.

Annually, the volume of electronic waste - computer waste - increases by 5% techniques that have worked. In the process of functioning of some of them. example, printers, ozone is released, which has a negative effect on humans.

Security

There are issues of functional and information security of it systems an important factor in the sustainable and safe development of civilization. They represent on the one hand, it is a tool that manages various functions technical or organizational (socio)-technical complexes, transfer, storage and information processing, as well as a means of achieving high reliability and security of these complexes, on the other - it systems are the object of providing the specified properties.

Examples of critical systems are computer reactor control systems npp installations. On-board control systems of manned space aircraft devices, information processing systems and management of medical equipment, banking information and analytical systems.

Reactor emergency protection systems. Failure of the emergency protection system of the reactor may lead to non-stopping in case of an unacceptable excess temperature, pressure in the reactor space, seismic fluctuations, etc. What threatens with catastrophic consequences, or to its erroneous jamming and becoming the cause of serious material losses due to the high cost of restoration works.

Aviation systems. In aviation systems, such failures are caused cancellation of flights, forced emergency landings, destruction and disasters with human sacrifices.

Space rocket systems. Failures of the launch vehicle control system or spacecraft for a manned project are similar in their consequences failures of aviation IT systems. For unmanned complexes, they lead to material losses, disruption of the mission within the framework of important scientific programs.

Medical systems. For failure management systems of medical equipment hardware or software lead to a distorted image information, as a result of which the diagnosis may be incorrectly made and/or an operational decision was made, as well as the implementation of procedures dangerous for health or life of the patient, which are generally performed under the control of the computer systems.

Banking systems. As a result of failures of banking information and analytics systems, stock exchange IT systems, there are material losses, which are calculated in millions dollars, loss of reputation by banks or exchange players.

For such systems, in addition to traditional failures caused by hardware failures means (servers, computers of data processing centers (bata sepiegn), which support cloud technologies), or software defects, most situations related to violation or blocking of functions caused by unauthorized and. as a rule, targeted actions (attacks) on the resources of these systems.

In the energy sector, IT has become a powerful consumer of electricity, in the environmental - an additional cause and source of increased CO2 emissions electronic waste, in the field of functional safety - a factor of emergency dangerous failures. You can point to a common reason: the growing dependence of everyone IT systems.

From a security point of view - most components are software tools and/or means that hardware implement software-developed functions. Such systems can be the object of influences (physical or informational nature), which also may lead to either reliability failures or function blocking or system resources, which is equivalent to the consequences of failure.

Problems of the development of green it.

Hardware. There are solutions for microcircuits that allow to reduce power consumption. They are based on the application of: - special electronic circuits, technologies and computing paradigms:

- modes of reduced energy consumption ("sleeping", "semi-sleeping") for everything

Crystal or its parts;

- schematic design solutions that minimize the number of crystal elements,

That are simultaneously switched, and thus reduce current surges:

- adaptation schemes in reserved structures, the channels of which work at the limit

Reduced voltage (in this case, failures caused by unstable operation,

Are eliminated due to structural or other redundancy);

- special settings for programmable crystals.

Software tools:

- each operator, language structure, program module can have its own energy metric (characterized by the energy consumed by the platform, on which the program is implemented);

- software solutions differ in the amount of resources used (not only energy) and can be optimized (according to the energy criterion);

- since energy efficiency becomes an attribute of software quality, for its evaluation and ensuring that it is expedient to use a process approach;

- to evaluate the energy metrics of the software options, it is necessary to use special ones devices, programs and solutions that will ensure the accuracy of energy measurements, sho is consumed during the execution of various applications.

Systems, networks and infrastructures

Systems and networks. Energy for embedded systems and mobile devices restrictions are often critical, which is why the terms "energy critical systems", "energy modulated computing", "resource constrained devices" as well as multitudes tasks where the criterion of energy efficiency is decisive.

Computer networks are characterized by component-level tasks, tasks optimization of energy resources during traditional network data exchange tasks (traffic optimization).

IT infrastructure.

For cluster systems and cloud infrastructures the key task is to reduce energy consumption by data centers, divert and smart use of heat generated in the calculation process. This task is solved at the component and architectural levels:

- the use of new technologies (Silicon-on-Siir). that allow to increase energy efficiency due to the introduction of the next generation of chips, designed for cloud computing;

- optimization of modes and algorithms of cloud computing platforms;

- development of hybrid (cloud and mobile) architectures that provide more high energy efficiency.

Models

- development of mathematical apparatus and methods of green logic for programmable crystals (programmable logic device - PLD): it's about searching electronic and logical basis for natural green crystals - by analogy with bases for naturally reliable digital systems and their possible integration;

- improvement of mathematical methods of optimization of multi-level systems

working capacity;

- development of models and methods of so-called low-resource cryptography for energy-critical systems.

Green technologies and green business.

Green technologies are innovations based on principles of sustainable development and reuse of resources. Green technologies cover three main areas related to:

- environmental management (waste, reduction of water pollution, air and land resources and their restoration) and mitigation of consequences climate change;

- energy production from renewable sources (green energy);

- increasing the efficiency of the use of all types of fuel, electricity on production, houses and lighting devices.

Components of green it

- green cars that run on electricity and are controlled on-board computers that can interact with transport IT infrastructure;

- power plants operating on green energy, controlled by built-in computer means that ensure their efficiency and safety:

- adaptive power grids in which computer control is carried out monitoring of parameters, correction of functions and operational reconfiguration of systems;

- smart and green buildings, offices, universities, cities, etc which all life support systems and business process management are implemented with the help of deep penetration of IT, including cloud computing, Internet of things.

- increase in energy consumption by IT systems: annually increases by 5%. and her the cost exceeds the initial cost of the PC;
- for small and medium-sized enterprises, electricity consumption is 10-50% budget of IT departments;

"Contribution" to the greenhouse effect: IT accounts for 900 million tons of CO2 emissions. Every PC generates up to 1 t/year of CO2.
Increasing volumes of e-waste: for the production of PCs is wasted 240 kg of fuel. 24 kg of chemicals and 1.5 tons of water. The volume of e-waste is increasing (computer equipment), decommissioned (15% of household and radio electronic equipment).

Metric terms and concepts.

Green metrics are based on the GAMES approach (Green Active Management of Energy in IT Service Centers), indicate:

- the share of processes invested in reducing the used resources, in particular,
reducing energy consumption and improving energy efficiency;

- assessment of the relative impact of each of these processes and project actions on resources, energy consumption and energy efficiency;

- degree of improvement of resource indicators of goods obtained at different stages.

Energy efficiency Ee is a complex indicator that can be calculated as the ratio of productivity, accuracy or their increase P when using IT-system per unit of consumed power Pe or its change ΔPe

Ee = P/Pe or Ee = P ΔPe

In order to estimate the share of Pe energy consumed by such equipment system, to the total energy Ps of any object into which they are embedded software and hardware, the PIM indicator is used (rower IT-sistem metric)

PIM = Pe/Ps

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When it comes to systems designed for data processing (data centers), the PUE indicator (Power Using Effectiveness) is used, which determines the share overhead energy costs when processing information by IT systems. An ideal data center is one when the PUE is equal to one.

PUE = Ps/Pe

The coefficient of green energy of the GES (Green Energu Coefficient) - determines that part of the energy Per which is obtained from renewable sources

GES = Per/Pe

Values and principles of implementation of green it engineering.

The value model of green IT is based on the principle of "chain of values", which implies the need to analyze each step in any business process in terms of its value.

The value chain includes four components:

- awareness;

- transformation, transformation;

- understanding, conscious perception;

- values of green IT.

Principles of implementation of green IT systems.

- balance by life cycle stages of green IT systems - calculation of the effect of application of green IT, taking into account all stages of the life cycle: from development technologies (systems). its implementation, application and utilization.

- the balance of green characteristics and other technical characteristics of IT systems, such as power consumption.

- balance of applied methods and measures aimed at development and implementation of green IT. which should be created using the principles green computer. Software and hardware of IT systems, which are introduced for their landscaping should consume less energy than is saved during implementation.

Conclusions

Green IT is technologies that perform:

a) internal tasks: own "greening" aimed at reducing energy and resource consumption of IT systems and components, as well as exclusion or reduction to a reasonably acceptable level of negative impact on the environment the environment, other systems and people;

b) external tasks:

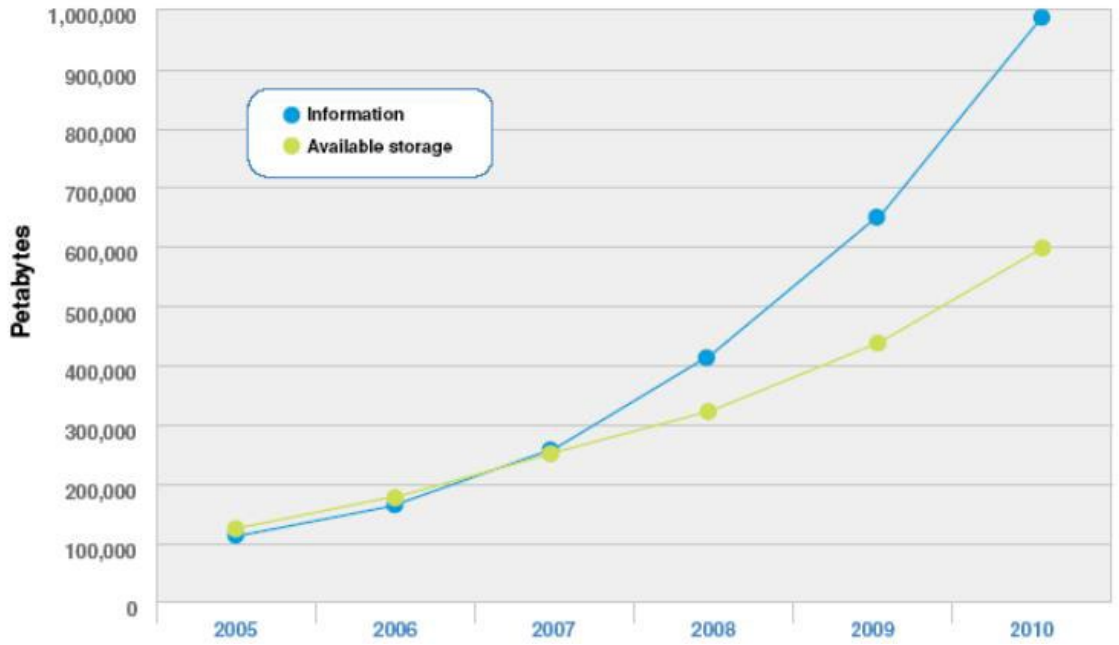
- support for the sustainable development of society, preservation, restoration and improvement environment;

- ensuring the safety of technical and organizational-technical systems and reducing risks of dangerous failures and accidents through the development of IT systems for monitoring, decision-making support and security management systems;

- spreading the values of green culture and raising awareness of IT-industry in the advantages of green business.

Widespread use of cheap computers.

In 2007, cheap computers (netbooks) appeared with high operational characteristics. These PCs will lower the barrier to purchasing a computer and will contribute to the expansion of the number of users.



Growth of information volume by year.

Thin clients: reduction of energy consumption by 30%.

Another approach to reducing energy consumption is to use thin client technologies. Instead of "panel PC" type devices, a thin client will consume about a fifth of the power of a regular PC.

Advantages of a thin client in the conditions of "smart" production:

— requires about 1/3 of the space compared to a regular workstation;

— requires about 30% of the power consumed by an ordinary PC;

— the speed of operation is comparable to the speed of ordinary desktop PCs:

— reducing workstation costs by up to 40%;

— fast loading time;

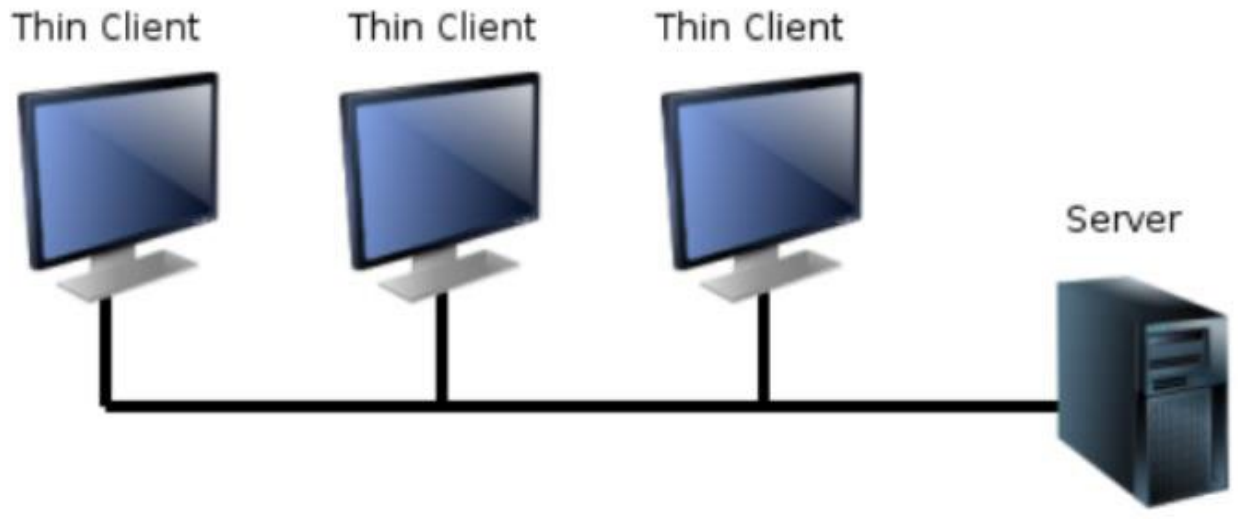
— reducing the participation of antivirus protection;

— the possibility of configuration with a minimum of registration (no need to use mass storage devices);

— no differences for a user who is used to working on any based on the Windows platform;

— possibility for extracted calculations (the server takes over all processing).

A thin client is a device for entering and displaying information (terminal). A physically thin client is a compact and silent computer without hard disk (and without fans), loading the main operating system system which takes place on the server. All custom programs are executed on the terminal server. Since all the computational load lies on the server, then the thin client has a minimal hardware configuration, without harm productivity. Thin clients are used in organizations where the majority users use computers to perform similar tasks: work with databases, information catalogs, work with \UEB browsers (stores, pharmacies, libraries, schools, universities, hospitals, hotels, supermarkets), work as bank terminals, etc.



A thin client in most cases has a minimal hardware configuration, instead of a hard drive to boot a local specialized OS DOM (DiskOnModule) is used (a module with an IDE connector, flash memory and microcircuit that implements the logic of a conventional hard disk - is determined in the BIOS like a regular hard disk, only its size is usually 2-3 times smaller). in some system configurations, the thin client loads the operating system by network from the server.

Advantages of using thin clients instead of regular PCs

- **Reduction of initial acquisition costs due to minimum requirements for configurations;**
- **Significant reduction in energy consumption;**
- **Unification of devices;**
- **Ease of implementation of tasks;**
- **Saving time of the system administrator;**
- **Maspggabovanity;**
- **Safety and fault tolerance;**
- **Protection against information leaks.**

A terminal server is a server that provides clients computing resources (processor time, memory, disk space) of the solution day tasks Technically, a terminal server is a super-powerful computer (or cluster), connected to a network with terminal clients—which typically have low-powered or outdated workstations or special solutions for access to terminal server. Terminal server serves for remote user service with desktop provisioning.

Advantages of Terminal Server:

- **Reduction of time costs for administration;**
- **Increased security;**
- **Reduction of software and hardware costs;**
- **Reduction of electricity consumption.**

Disadvantages

- **Concentration of all functionality within one (several) servers many users;**
- **The negative consequences of software configuration and operation errors are increasing;**
- **Licensing issues.**

Green Ethernet

The IEEE 802.3az standard defines "green" Ethernet as symmetric protocol that allows network ports to switch from normal power mode (data transfer mode) to low power consumption mode (LPI mode) depending on whether a data transfer has taken place (active state) or not (state idling or waiting).

This technology is called LPI (Low Power Idle) which actually determines the state low energy consumption, which can be used in periods when there is no channel usage.

Advantages of energy-efficient Ethernet, according to IEEE 802.3az:

- reduction of the total power consumption for each port, which in in the long run saves a lot of energy for organizations that have a large number of network devices;

- significant savings in electricity in the event that end devices (for example, computers, edge switches, etc.) correspond to EEE because their structure usually consists of long waiting periods and several bursts of traffic with work almost or at full capacity;

- the possibility of working from the lines of the standard Base-T interface over unshielded twisted pair of copper wires and data support at speeds of 10, 100, 1000 Mbit/c and Gigabit Ethernet with a speed of 10 Gbit/s.

Principles of Green Engineering.

Principle 1: Product developers make every effort to ensure that all materials and energy at the input and output of production, were by their nature as can be less dangerous.

Principle 2: Waste prevention is better than treatment and management waste after their appearance.

Principle 3: Separation and purification operations should be designed to to minimize energy and material costs.

Principle 4: Products, processes and systems should be created with maximum efficiency relative to mass, energy, place and time.

Principle 5: Products, processes of its system should be planned in relation to use of energy and materials taking into account, first of all, the situation "at the exit" (production process) than "at the entrance".

Principle 6: Estimated entropy and complexity should be considered as investment when making decisions about recycling, processing or favorable accommodation.

Principle 7: Aim for durable, not timeless products.

Principle 8: Optional improvements (eg “one size for all”) should be considered as a disadvantage.
Principle 9: Number of components in multicomponent materials and products should be minimized in order to ensure the possibility dismantling and preserving the value of the material.
Principle 10: The development of products, processes and systems should include integration and interconnection with available energy and material streams.
Principle 11: Products, processes and systems should be designed with taking into account commercialization after the end of use.
Principle 12: There must be a balance of materials and energy sources used in favor of renewable resources.

These 12 principles of "Green Engineering" cover some of the most important ones industrial processes and technological issues. These principles are not a list of goals, but a set of important methodologies that must change to achieve these goals and contribute sustainable development. The old ways of production must be changed.