REPUBLIC OF KAZAKHSTAN
MINISTRY OF EDUCATION AND SCIENCE

International Information Technology University

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Information and communication technologies

Textbook

1st edition

Almaty 2017

UDC
BBC

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Information and Communication Technologies. Textbook. 1st edition. -Almaty, 2017. – p.480.

ISBN

This textbook is written in accordance with the educational program standard for the general education discipline “Information and Communication Technologies” and is recommended for students of all forms of tuition for all specialties.

The textbook complies with the Standard Academic Program for the discipline "Information and Communication Technologies" and is recommended for students of all specialties.

Recommended by the Ministry of Education and Science of the Republic of Kazakhstan

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ISBN

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Foreword

It is obvious that today the modern world is becoming increasingly dependent on information technology and the future will inevitably demand a huge amount of versatile knowledge from the teachers including the knowledge of information technology. Information-communication technologies also open up great prospects for any student.

Transition from an industrial society to an information stage of development leads to a qualitative change in the content of secondary and higher education which in the fullest sense has become a "fulcrum" transforming the modern world of information.

The research results showed that information and communication technologies are a strategically important field affecting all aspects of life of any modern community.

The rapid development of the information society and wide spread of multimedia mobile technologies, electronic information resources, networking technology require a comprehensive review of the content of the Computer Science subject in Kazakhstan’s universities. It is also necessary to consider the use of information technology (IT) as a means of teaching, communication, education, integration into the global community. The merger of traditional and modern information technologies creates preconditions for the introduction of the new discipline - Information and Communication Technologies (hereinafter ICT).

The textbook on Information and Communication Technologies is the introduction to the main areas of information and communication technologies for student-centered development in today's information world. This is possible only in case of complex sequential interaction of the school and higher education curricula i in the field of information and communication technologies.

The main difference of the textbook on Information and Communication Technologies is introduction of such concepts as the SMART-technology, cloud computing, e-commerce, big data, mobile applications, rapid development of Web sites based on CMS, and others. Nowadays it is not enough to be a programmer and program from scratch. The market requires extensive knowledge in information and communication technology and its rapid development on the basis of ready-made solutions.

This textbook is written in accordance with the educational program standard for the general education discipline “Information and Communication Technologies” and is recommended for students of all forms of tuition for all specialties.

Practical recommendations for laboratory works on discipline "Information and communication technologies" will be presented in another textbook.

Content

CHAPTER 1. ICT DEVELOPMENT: MAIN DIRECTIONS. STANDARDIZATION IN ICT

1.1 Definition of ICT

What do the information and communication technologies (ICT) represent? What is the modern understanding of their opportunities? In development literature ICTs are defined in so many ways that the concept has become quite confusing. Most often the term "ICT" is used to describe the use of computers and the Internet. Sometimes the term "ICT" is associated with the most difficult and expensive computer technologies, and in other cases – with traditional technologies, such as radio, television and telephony which will be considered below. Determination of ICT widely varies depending on the context and conditions of application.

There two main approaches to interpreting the role of ICT:

- ICT as a production sector. This approach concerns the policy of strengthening and/or development of the ICT products;
- ICT as a Development tool (ICT4D), where it is regarded as a catalyst of social and economic development. This approach assumes adoption of the general strategy affecting a large number of social and economic sectors for the purpose of their full informatization.

Many countries have created special organizations for promotion of ICT as there are concerns that if the technologically underdeveloped regions don't have a chance to make up for lost time, further technological progress in developed countries will only aggravate the already existing digital divide between such countries.

In the Industrial Qualifications Framework approved by the order of the RK Minister of Transport and Communications of September 30, 2013, the information and communication technologies (ICT) are defined as a set of the entities and organizations performing the types of economic activity connected with designing, production and trade in software, computer facilities, communication equipment, consumer electronics and their components, as well as with system integration, telecommunication and information and technological services.

According to the European commission, ICT are important not only in the technological sense, but mainly because of their capability to broaden access to information and communications among the population which isn't receiving the service in due amount or quality. At the international scale the United Nations is actively advancing ICT as a means of bridging the digital gap. Besides, for clarity it would be useful to adopt the definitions offered in the UN Development Program (UNDP) in 2003.

ICTs are basically information handling tools – various goods, applications, and services that are used to produce, store, process, distribute and exchange

information. They include the “old” ICTs of radio, television and telephone, and the “new” ICTs of computers, satellites, wireless technology and the Internet. These different tools are now able to work together and jointly form our “networked world”, a massive infrastructure of interconnected telephone services, standardized computer hardware, the Internet, radio and television, which reach into every corner of the globe.

Information and communication technologies (ICT) in this course are regarded as modern technological methods and means used for communication, search, collection, storage, processing and dissemination of information in professional and other activities.

1.2 "ICT" Discipline and Its Purpose

"ICT" discipline is used to form a particular ideology in the field of information and modern information culture, i.e., the ability to specifically interact with information, and use it for receiving, processing, transmission and storage.

The purpose of delivering this course lies in the mastery of information and communication competencies. This will enable the use of modern information technologies in various areas of professional activity, practical and scientific work. In addition to the practical purpose, the course aims at accomplishing educational goals, contributing to the expansion of students’ horizons and raising their general culture, education levels and fostering responsibility.

The purpose of the discipline is to train highly qualified professionals who have acquired the skills of using modern information and communication technologies in their professional field and everyday life.

The subject does not focus on a particular aspect of ICT use but contributes to a better understanding of ICT implementation for socio-economic development. One of the tasks of the discipline is to help the students of different specialties, from technical to social sciences, understand the need for the use of ICT to achieve the objectives and meet the national development needs.

As a result of studying the discipline the student will:

know:

- the conceptual framework for understanding the process of socio-economic development;
- the role of ICT in the community development processes;
- the ways of presenting data in computer systems;
- the basics of operating systems: DOS, Windows, Unix, Linux, Mac OS;
- the concept of spreadsheets and techniques of data visualization with the help of diagrams;
- the database management system;
- the basics of database architecture, the SQL language, and current trends in the database development;
- the basics of local area and wide area networks;

- the basics of social networks, their architecture and performance;
- the specifics of data protection and security of information in the ICT framework, the concept of identification, authentication, access control, logging and auditing, encryption, and integrity monitoring;
- the basics of web technologies, and web page design;
- instruments and forms of graphical presentation of information, information processing, and the concept of business process;
- the concept of human interaction with the computer, and the user interface;
- the basics of multimedia technology, as well as audio and video tools;
- the basics of SMART-technology and cloud computing;
- the basic concepts of e-business, e-commerce, e-government and digital signature;
- the basics of distance learning and ICT development prospects.

be able to:

- use information resources for finding and storing information;
- work on any operating system;
- handle text information;
- work with spreadsheets, consolidate data, and build charts;
- work with macroses;
- work with databases;
- apply the methods and means of information protection;
- create websites based on the CMS;
- process the vector and bitmap images;
- create multimedia presentations;
- use different forms of e-learning to expand professional knowledge;
- work with cloud services of e-technologies.

have skills to:

- use modern information and communication technologies in professional activity;
- apply ICTD in the country-specific context.

1.3 Main directions of development of ICT

Nowadays, any person with a small mobile phone in hand, a tablet or a personal computer (PC) has the ability to access the world of information. This is done through a seamless network of technologies, applications, services and content, interlinked through a grid of telecommunications technologies. It does not matter for the emd- user how the system works, as long as it delivers what is wanted; it broadly introduces a student or the provider of development services to the diverse technologies; unpacking or unbundling of the various terms is critical for understanding the conditions and contexts of their applications and effectiveness.

Essentially, ICT consists of hardware and application software that run the hardware and also enable the development of content. Together they provide services to the user through connectivity media. Underpinning the entire process is a set of supporting environments, physical, political, legal and regulatory, as well as financial frameworks.

Traditionally, it was possible to distinguish ICTs in terms of their particular features (text-print; audio-radio; audio-visual-TV). But since the 1990s, such distinctions have become blurred as convergence or blending of what were discrete media onto a single platform has become a reality.

ICTs can be broadly classified into digital and analog, synchronous and asynchronous. Analog data is received in a continuous stream while digital information reads analog data using only ones and zeros. The older broadcast television and radio, as well as videocassette recorders, were analog devices. But these media are fast becoming digital and so can easily be used with other digital devices such as DVD players. Computers can only handle digital data, which is why most information today is stored digitally. The synchronous ICT assumes interaction of participants of communications in real time, for example, in online chats. In case of asynchronous communication, interaction of users takes place for each participant at any convenient time.

At this juncture, it is important to admit that ICTs are now a part of everyday life going beyond their above-mentioned typical uses. The evolution and use of ICTs have refined and redefined many traditional industry sectors and have made a considerable impact on how industries and sectors operate and/or are managed.

This changes the traditional sectors such as agriculture, where ICTs make crop management easier by helping to analyze and predict optimum planting and harvesting conditions. Technologies are also available to help run and monitor industrial processes such as factory and building management systems, which can control internal and external access to rooms and offices, and manage heating/cooling and lighting systems to save and conserve energy. ICTs are used in modern motor vehicles to control the efficient running of the vehicles' engine and fuel systems, and help guide drivers (e.g. through the use of parking sensors and global position systems [GPS]). All these systems use ICTs in various forms to function, to increase efficiency, as well as to relay information for other systems and the user to take appropriate decisions and actions.

ICTs can be further unpacked into technologies, applications, services and content (Fig. 1.1). Development of newer and faster computers and mobile phones running multiple applications, building more wireless towers, laying more fiber optic cables, and embedding smart sensors and related technology in various everyday items from cars to fridges form a part of the ICT infrastructure and must be seen as a component of technologies.

Computer software both in English and in local languages, whether proprietary or created from Open Source, consists of creating software applications. The tools provided through the technologies or the content of the

applications, whether for business or for e-government, are the services that can be provided through technologies or applications. What forms the substance of the services is the content that is available or made available through the ICTs as carriers. For a user or a citizen to benefit, there has to be a link between each of the elements of the taxonomy and the citizen.

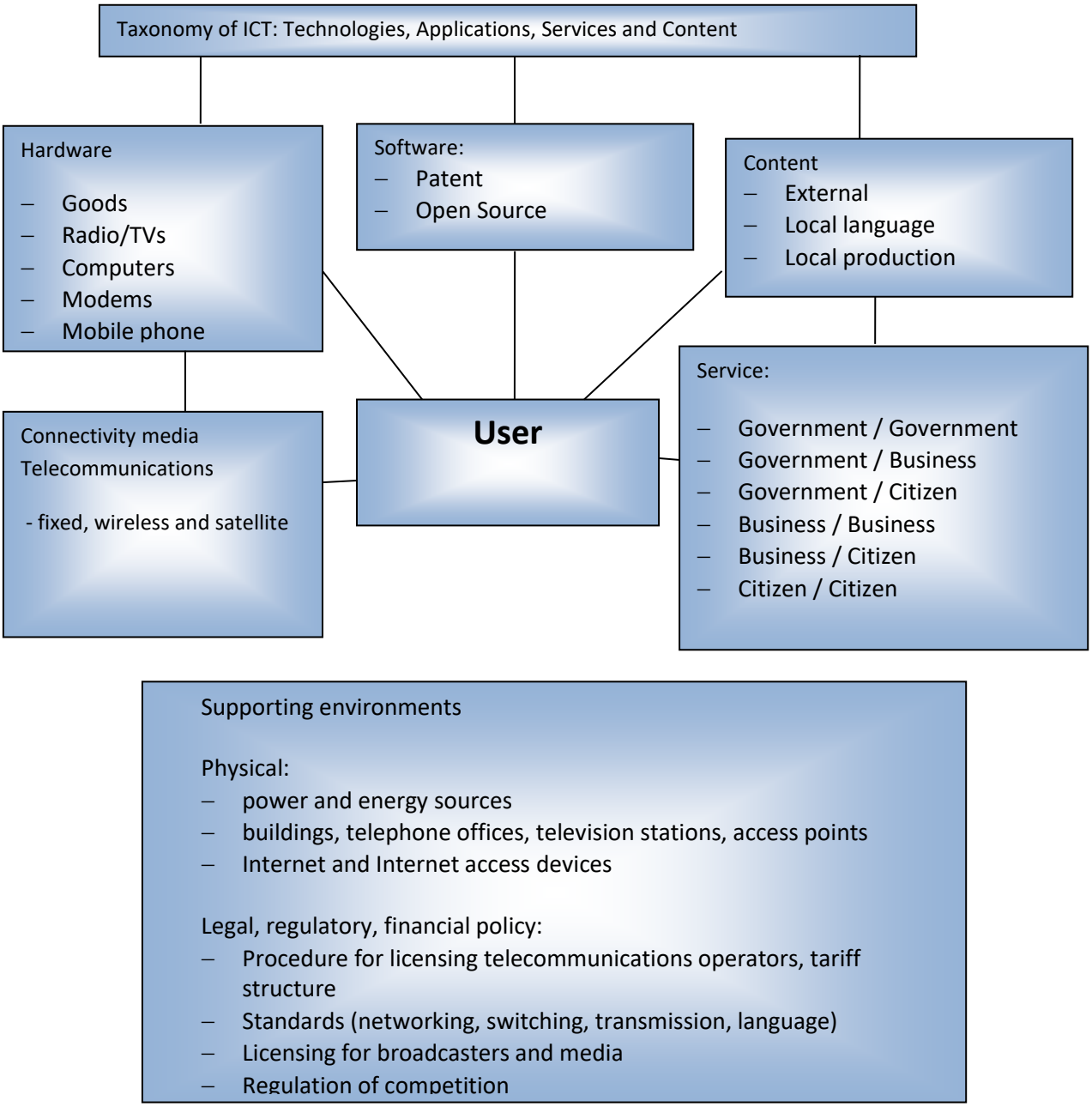

Figure 1.1 – Taxonomy of ICTs
(adapted UN-APCICT/ESCAP, 2011)

To function successfully, ICTs require supporting physical, political, legal, regulatory and financial environments. ICT systems require stable electricity, cables and wires, wireless solutions to run on, and buildings to house them. Appropriate technical resources to build, deploy, operate and maintain such

systems are also required. Other enabling environments include laws and implementation norms, whether these are in licensing, competition norms and processes, revenue sharing mechanisms, or intellectual property rights (IPR). Development of ICT is on a global scale caused by mainly "cloudy", mobile and social technologies, and also technologies of processing large volumes of data. Practically all applications will be created and work in "cloud".

In Kazakhstan the importance of the ICT sector development is emphasized by the State Informatization Program "Kazakhstan - 2020", adopted in 2010. The program has determined the four key directions of ICT development in Kazakhstan:

- ensuring the efficiency of the public administration system;
- ensuring availability of information and communication infrastructure;
- formation of the information environment for social and economic and cultural development of society;
- development of the national information space.

Tasks of improving the government administration, creating an "open" and "mobile Government", and developing the information infrastructure will be solved within these areas through the widespread introduction of ICTs. Considering that the development of information society must be accompanied by the development of human resources, the Program includes provisions for the creation of opportunities for citizens to learn and gain skills in information technology through e-learning and to avail themselves of electronic healthcare services. In addition, the program envisages maximum implementation of smart systems in the basic sectors of the economy in order to build a more open, accessible and competitive national economy.

Let us outline the most urgent directions in ICT development.

System of communications. The force and possibilities of ICT consist in connecting different parts within an integral and integrating network by communications. The telecommunication network which includes fixed telephone lines, transmitters to lines of direct visibility, wireless networks, satellite and optical fiber cables, is a part of extensive system. The same list includes:

- intelligent sensor telecommunication networks;
- the Internet of things, the built-in technologies for interaction;
- "smart" dust – networks of neurochips;
- high speed multimedia;
- next generations of information systems.

Cognitive technologies and robotization. The word "Cogito" from Latin means "to know". That is, cognitive technologies "working" with our knowledge of: evaluating our attention that tracks our state following the work of the brain and trying to "understand" human. In other words they are the methods and algorithms of goal achievement based on the information about processes of learning, training, communication, information processing by people and animals, on neuroscience, the theory of self-organization, computer information technologies, mathematical

modeling of elements of consciousness, some other scientific data until recently referred to the sphere of fundamental science. Research in this area is conducted by cognitive science, science developing at the intersection of neuroscience, linguistics, physiology, mathematics, theory of knowledge, psychology, and the theory of artificial intelligence.

Robotization is automation of production by using industrial robots. It includes the following directions:

- Coexistence of people and robots.
- Robotization in terms of population aging.
- Manipulative techniques.
- Robots in the system of entertainment.
- Home robots.
- Kiborgs, exoskeletons, built-in medical sensors.
- Cars without drivers.

New technologies of the computer and human interface. With the development of technologies there appear more and more opportunities for improving human-computer interaction, however one should not forget that human opportunities are not limitless, which holds true with respect to the above processes. According to the model of human-computer interaction developed by Bill Verplank, interaction of the user with any system is affected by three human factors:

- efficiency of perception of information: whether we perceive the system signals correctly;
- principle of information processing: whether we understand and process these signals correctly;
- efficiency of information transfer: whether we re-enter the results into system correctly.

There appear new concepts of interaction based on noncontact sign and natural language interfaces and also on:

- technologies of reading emotions;
- new generation of displays;
- machine translation in all languages;
- technologies of monitoring of poses and movements;
- development of mood recognition technology;
- technology of the next generation of computers with the Android-based interface.

Virtual world. There are several definitions of the virtual world concept. According to the English-Russian dictionary by professor V. K. Müller the word ‘virtual’ means – actual (not nominal), valid, effective, possible. There is a set of various opinions concerning the virtual world development trends, such as:

- experimental training systems based on virtual reality;
- virtual avatars;
- virtual systems of life;

- automated systems of personality identification;
- network economy and life in a network.

Smart city, smart production, smart transport. Smart city is a system of interacting systems, thus ensuring modern quality of life due to the use of innovative technologies which provide economic and eco-friendly use of urban systems . In other words, it is smart management, smart accommodation, smart people, smart environment, smart transport, smart economy, smart business, smart mobility. Smart production is connected with the technological evolution from built-in systems to cyberphysical systems (CPS). Smart transport is the system managing capacities due to close integration of land use planning and transportation. These systems include the following technologies:

- reasonable computer facilities;
- supercomputers, including quantum;
- digital factories;
- global automated distributed products production system with the use of a 3D seal;
- transition to cloud computing of a new generation;
- "Cloud" mobile entities.

Cloud technologies. Cloud technology is a model of universal and convenient network access to a common pool of configurable computing resources (e.g. servers, applications, networks, storage systems and services) that can be provided quickly and released with minimal effort by management and the need for interaction with the provider. A feature of cloud computing is not attached to the hardware platform and geographical area, and the possibility of scalability. This type of technology includes:

- Mobile technology and mobile applications;
- Processing of large data volumes;
- The development of social networks and the use of ICT in social life;
- Information Security.

1.4 Standardization in ICT

The main role in the development of the information society belongs to international standards. A standard is a document that sets out requirements, specifications, guidelines or characteristics for materials, products, processes and services. Standards can also be used to support an industrial or innovation policy, for example, in acquiring new technologies.

At the international level, there is a strong cooperation of organizations that develop ICT standards, among which is ISO (International Standardization Organization), IEC (International Electrotechnical Commission), ITU (International Telecommunication Union), Internet Society, ECMA (European Computer Manufacturers Association), EWOS (European Workshop for Open Systems), ETSI (European Telecommunications Standards Institute), IEEE

(Institute of Electrical and Electronic Engineers), OSF (Open Software Foundation), OMG (Object Management Group) etc.

International ISO standards ensure that products and services are safe, reliable and of a good quality. For business they are strategic tools aimed at reducing costs by minimizing waste and errors and increasing productivity. They help companies gain access to new markets, provide equal conditions for developing countries and promote free and fair international trade. The ISO has published more than 21,000 international standards, which can be obtained from the ISO and its members.

International ICT standards prevent occurrence of costly market battles for priority technologies. Also, they create equal conditions for companies from emerging markets, which provide access to new markets. These standards are an essential support for developing countries in building their infrastructure and promoting economic development.

They can cause a reduction of costs for everyone, manufacturers, operators and consumers, due to the scale effect.

Study Groups of the ITU Telecommunication Standardization Sector (ITU-T) unite experts around the world to develop international standards known as ITU-T. They define elements in the global infrastructure of information and communication technologies (ICT).

Standards are critical to ICT interoperability. When we exchange voice or video messaging or data, standards make it possible to implement global communications, ensuring that ICT networks and devices from different countries speak the same language.

Since its creation in 1865, the ITU-T applies an approach to the development of standards on the basis of contributions and consensus, in which all countries and companies are given equal rights to influence the development of the ITU-T Recommendations.

Being a standardization body of the international telegraph exchange and playing a constructive role in telecommunications and modern converged ICT system, ITU-T provides the world's best conditions for the global community standards. Also, ITU-T is the only global body aimed at developing truly global standards in ICT.

Based at the ITU headquarters in Geneva, the Telecommunication Standardization Bureau (TSB) provides support to the Secretariat of the research commissions of ITU-T, using advanced electronic working methods and equipment in Geneva and applying six official languages of the Union - English, Arabic, Spanish, Chinese, Russian and French. This body, headed by an elected official, the Director, is responsible for ensuring consistency in the development of the ITU-T standards.

Private and public entities can participate in the process of developing technical standards at the national, regional or international level.

Exerting influence on the development of standards, both private and state structures of the country may have an impact on the development of standards, defining exactly what standards are needed and what tasks they need to address.

Standardization Development Ladder has been developed by ITU as a recommendation to increase participation in ITU activities (Figure 1.2).

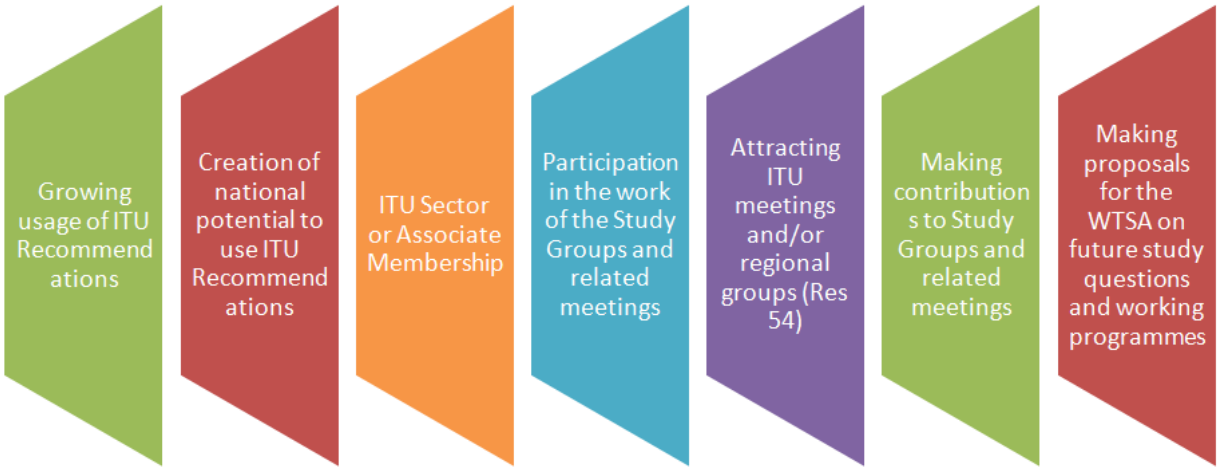

Figure 1.2 - The ladder of the ITU standardization development (adapted from the ITU website)

On the lower level there is an increased use of ITU recommendations and its website. An indication of this is the number of cases of Recommendations download. The use of international standards in the procurement of ICT should help to reduce costs and ensure interoperability.

On the second level of the ladder there is the creation of a national capacity of ICT standards' use. Capacity building contributes to the formation of a national body of qualified engineers able to implement the recommendations. ITU can provide capacity building and training programs.

The third level of the ladder is formed by associate membership in the ITU Sectors. Institutional membership in the international community promotes globalization, compensating its negative sides. Membership also allows to get acquainted with the reports of the meetings, contributions, and temporary and working papers.

On the fourth level of the ladder there is participation in the work of study groups and operational groups. Such participation promotes learning in practice and creates opportunities for establishing contacts. There is also a possibility of remote participation (for example, broadcast of Study Group meetings, as well as groups working by correspondence via the Internet).

Being on the fifth level of the ladder, the countries can host the activities of the ITU or establish the regional groups for active participation. Host of events will create new opportunities for learning by doing, training and awareness.

Currently the number of joint study groups and operational groups of the ITU-T / ITU-D working in different regions is increasing and there are held more joint workshops.

The sixth level of the ladder represents "deposits" (i.e., the input documents) at the meetings of the ITU-T Study Groups and related meetings. Contributing to this process, it is possible to shape future standards.

The process of standardization is generally defined by "contribution", as they are the basis of virtually all the recommendations.

The seventh level of the ladder is nomination of representatives, such as for the positions of chairmen, vice-chairmen and reporters of the study groups.

These individuals are a part of each of the study groups' management and help it at work. Appointment to this position is an expression of recognition of individual contributions, made by them for several years.

The last level of the ladder is making proposals to WTSA, for example, with respect to issues for study or programs of work for the future. In its activity ITU-T is focused on research issues that determine the content of work of the Study Groups.

1.5 ICT and Program of the UN of Sustainable development of the Millennium

You already understand that ICT plays an important role in the world around, but still do not fully realize the influence of ICT on social and economic development around the world including our country. On a global scale ICT gave the population new opportunities and resources: the electronic government expanded provision of the state services; social media gave social groups, which are the most often subjected to marginalization, an opportunity to express themselves; rural remote districts thanks to electronic health care have an opportunity to consult experienced doctors, and electronic training has provided access to education to those who are beyond the traditional training system.

Importance of ICT use in acceleration of development is one of the important issues for the world community.

However, considerable inequalities in terms of ICT infrastructure, connectivity and know-how still exist and inhibit the potential benefits of ICTs from being adequately leveraged. Access to ICTs is not uniform across regions, countries and communities, with many significant discrepancies existing between neighboring regions and social groups within them. Indeed, the digital divide in Asia and the Pacific is still seen to be one of the widest in the world.

In order to fully bridge the digital divide and realize full potential of ICTs, a requisite level of human resources and institutional capacity must first exist. Towards this end, the Asia and Pacific Training Centre for Information and Communication Technology for Development (APCICT) was established as a regional institute of the United Nations Economic and Social Commission for Asia

and the Pacific (UN/ESCAP) on 16 June 2006 with the mandate to strengthen the efforts of the 62 ESCAP member and associate member countries to use ICT for their socio-economic development through human and institutional capacity development. APCICT's mandate responds to the Declaration of Principles and Plan of Action of the World Summit on the Information Society (WSIS), which states that: "Each person should have an opportunity to acquire necessary skills and knowledge in order to understand, participate actively in, and benefit fully from, the Information Society and the knowledge economy."

Of particular importance for this course is one of the millennium development goals that specifically state that it is necessary to make available the benefits of new technologies, especially information and communication technologies in cooperation with the private sector.

This is where the role of ICTs becomes important, as tools that governments can deploy in their poverty reduction programmes to accelerate growth. Indeed, within the last ten years, the ability to effectively use computers and the Internet has become a key driver of the rapid development of several Asian countries. ICTs can be used to:

- provide improved and equitable delivery of services;
- facilitate complex processes of planning and coordination across sectors;
- enable increased information sharing, outreach and monitoring of key efforts.

Governments have increasingly focused on ICTD worldwide. For these governments, ICTD is not only about developing the ICT industry or sector of the economy, but it encompasses the use of ICTs to engender economic as well as social and political growth.

The variety of use and the number of ICTD initiatives are numerous. They include providing access and infrastructure, development of policy and regulatory frameworks, capacity building. There are also many ICTD initiatives that aim at improving management and delivery of various sectors, including agriculture, climate change abatement, disaster risk management, education, environmental management, gender, government and governance, and health, to cite a few. The use will be explained below.

As one looks back at various inventions that have transformed the society over the past hundred years, the revolution in ICTs, with the Internet riding on it, emerges as the invention that has managed to unleash unparalleled social and economic changes. The world today is very different from what it was even twenty years ago. Today, it best fits the description of a global village, where everyone can be connected irrespective of time, space, culture, language and distance. Riding on this revolution, some very poor countries have suddenly become market leaders and global powerhouses.

The growth path of ICTs and, consequently, ICTD, is on a continuum beginning with the humble radio in the early part of the twentieth century and moving on to today's versatile mobile phone. The success and direction of its growth will depend not so much on the ingenuity of its developers but rather on the

inventive capacity of its ultimate users, whether in a rich metropolis or in a poor mountainside village. The factors that will also determine the direction of ICT growth will largely remain the same as they were earlier, these being:

- adaptability – the extent to which it can be adapted to a range of tasks;
- leverage – the better it makes a difficult task easier, the more capable it is in producing change;
- ease of mastery – how easy it is for broad audiences to understand how to adopt and adapt it;
- accessibility – how easy it is to obtain and access;
- affordability – how much it costs;
- participatory – how much it engages it users and is interactive with them;
- transferability – how easily its use can be transferred to others;
- generative capacity – how easily it enables the user to create and build on its features for his/her own benefit and use.

All of these factors are also important in ICTD programmes and activities. Keeping the features of ICTs in mind, it is now important to study the link between ICTs and development goals.

Review questions

1. How do you understand the possibilities of ICT?
2. What types of ICT do you know?
3. What does the interrelation between the purposes of development and ICT consist in?
4. What are the main stages of information development of the society?
5. What is the best method for reducing a digital gap?
6. What is the difference between "the economy of knowledge" and "the society on the basis of knowledge"?
7. What aspect of ICT will you refer the portal of the electronic government to?
8. What are the purposes and tasks of intellectual economy?

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CHAPTER 2. COMPUTER SYSTEMS

2.1 Overview of Computer Systems

Computer Systems are formed by several subsystems, namely, hardware, software and network. Knowledge of how these subsystems work together allows understanding the whole process of work of a computer system. This chapter provides a general view of the computer system components and the primary role of each subsystem. In the following subchapters more information about each subsystem is presented. In order to study in depth the computer, it is important to know how computers were designed and evolved.

Unless you know how computers can be used, their importance may not be apparent. Some interesting examples of using computers are presented for better understanding of versatile usage of computer systems. This will help you to choose suitable development field related to computers

This chapter provides a general view on the different components in a computer system and basic understanding of the process of work of a computer system using its sub-components.

Components of a Computer System are**:**

- Hardware System.
- Software System - Operating System and Application Software.
- Network System.

A computer is an electronic machine that performs input, processing, storing, and output operations according to programmed instructions to carry out specific tasks. Formerly, computers were used primarily to do arithmetic computations. Let's consider the primitive form of a computer – a calculator. For example, if you need a calculator to perform such an operation as "3+5=", you input numbers and perform the arithmetic operation. Then the calculator processes arithmetic expression by adding 3 and 5, stores the result - 8, and outputs the result onto the display.

Computer architecture is a specification detailing how a set of software and hardware technology standards interact to form a computer system or platform. In short, computer architecture refers to how a computer system is designed and what technologies it is compatible with.

The example of a very good explanation of computer architecture is Von Neumann architecture, which is still used by the most types of computers nowadays. It describes the design of an electronic computer with its CPU which includes the arithmetic logic unit, control unit, registers, memory for data and instructions, an input/output interface and external storage functions (Fig. 2.1).

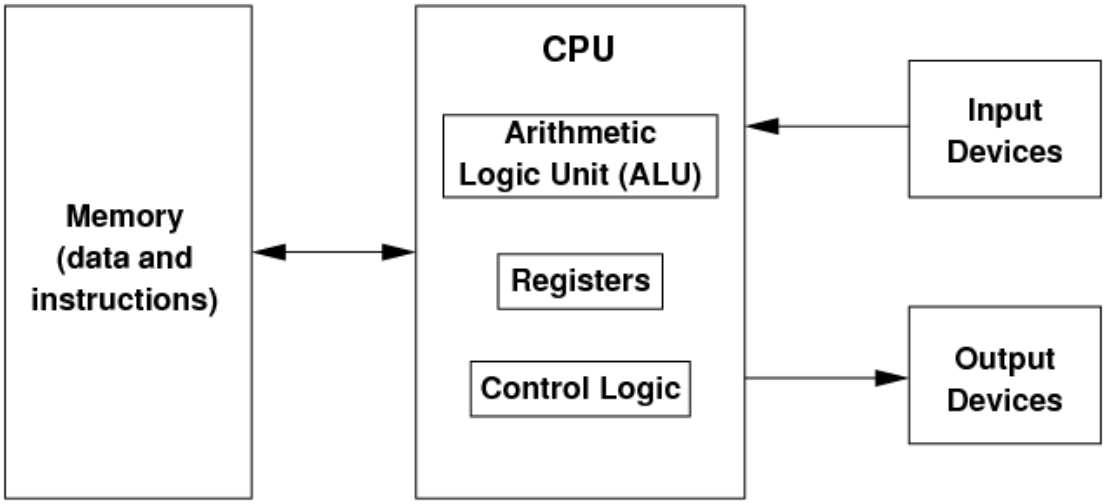

Figure 2.1 - Von Neumann architecture.

There are three categories of computer architecture:

- System Design: It includes all hardware components in the system including data processors aside from the CPU such as the graphics processing unit and direct memory access. It also includes memory controllers, data paths and different things like multiprocessing and virtualization.
- Instruction Set Architecture (ISA): It is the embedded in programming language of the central processing unit. It defines the CPU's functions and capabilities based on programming which it can perform or process. This includes the word size, processor register types, memory addressing modes, data formats and the instruction set that programmers use.
- Microarchitecture: It is known as computer organization. This type of architecture defines the data paths, data processing and storage elements, as well as the way they should be implemented in the ISA.

The modern computer acts in a similar way. A Keyboard or a mouse is used to input data. Then computer handles the input, stores result, and displays it via the monitor, speakers, printer, or other output devices. For example, when you request for a web page by typing its URL (Uniform Resource Locator), "http://www.iitu.kz", the computer processes your input by requesting the page via the Internet. Then it shows the requested page on your monitor as output.

In general, a computer system can be divided into hardware, software and network systems. Each subsystem will be discussed in detail in the next subchapters. The Figure 2.2 below illustrates main subsystems of a computer system.

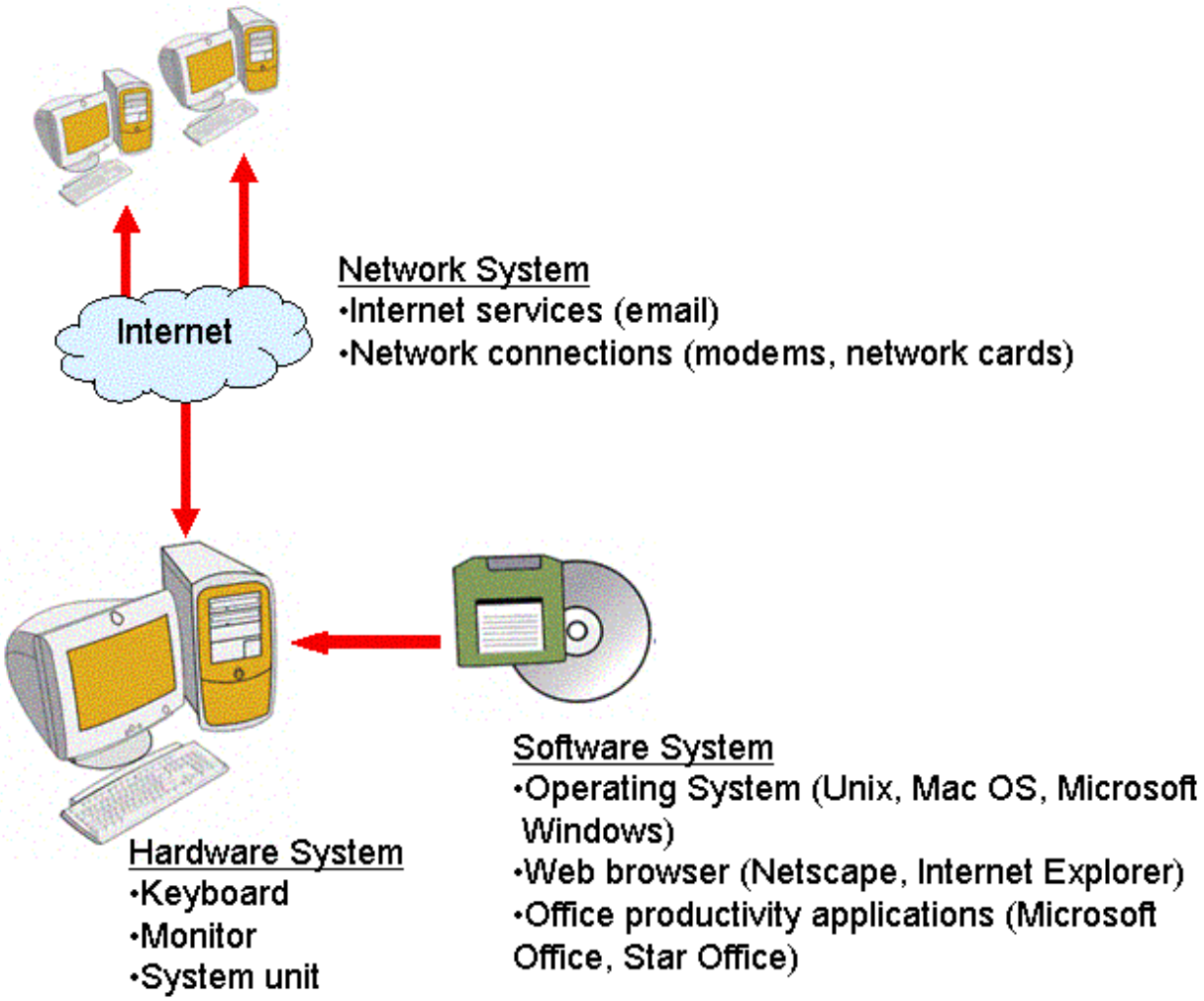

Figure 2.2 - Components of a computer system

Now let's consider each subsystem and their basic functions.

Hardware system

The hardware system consists of external and internal physical components that enable a computer to accept input data, process and store data, and produce outputs.

The Figure 2.3 presents some external hardware components of a computer.

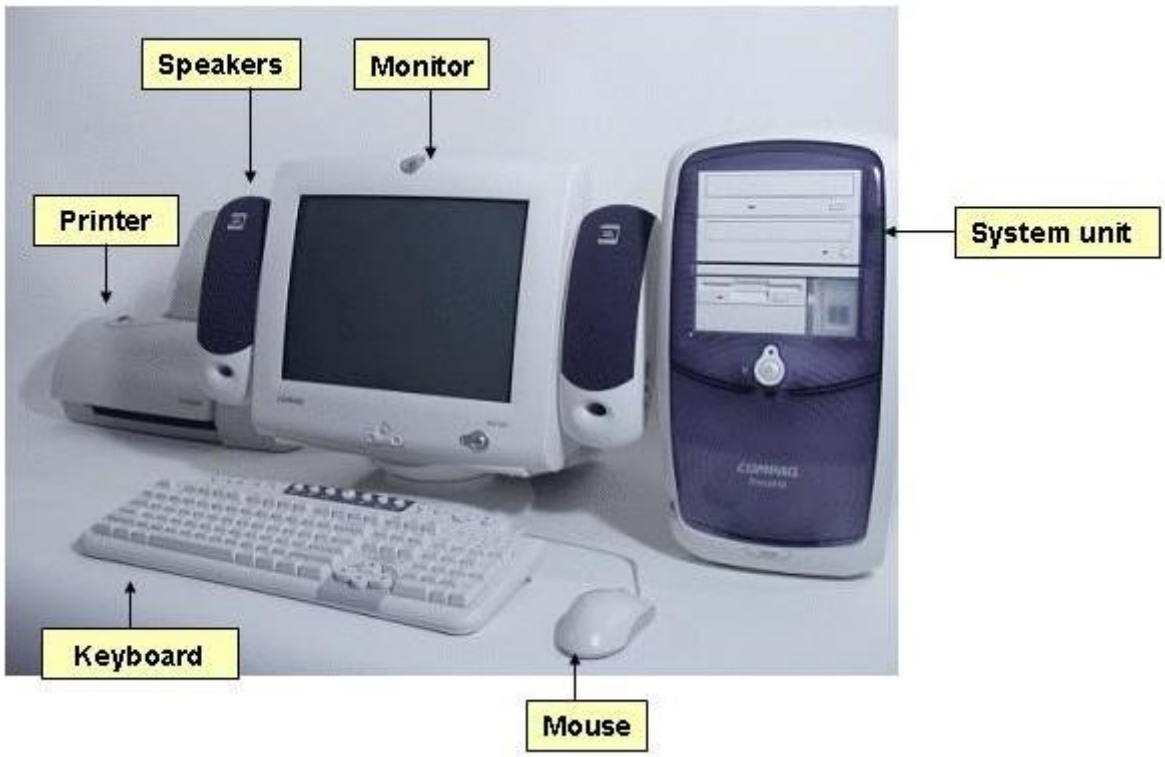

Figure 2.3 - Hardware components

The Figure 2.4 indicates the hardware components inside the system unit. Each of these components plays an essential role in the operation of a computer system.

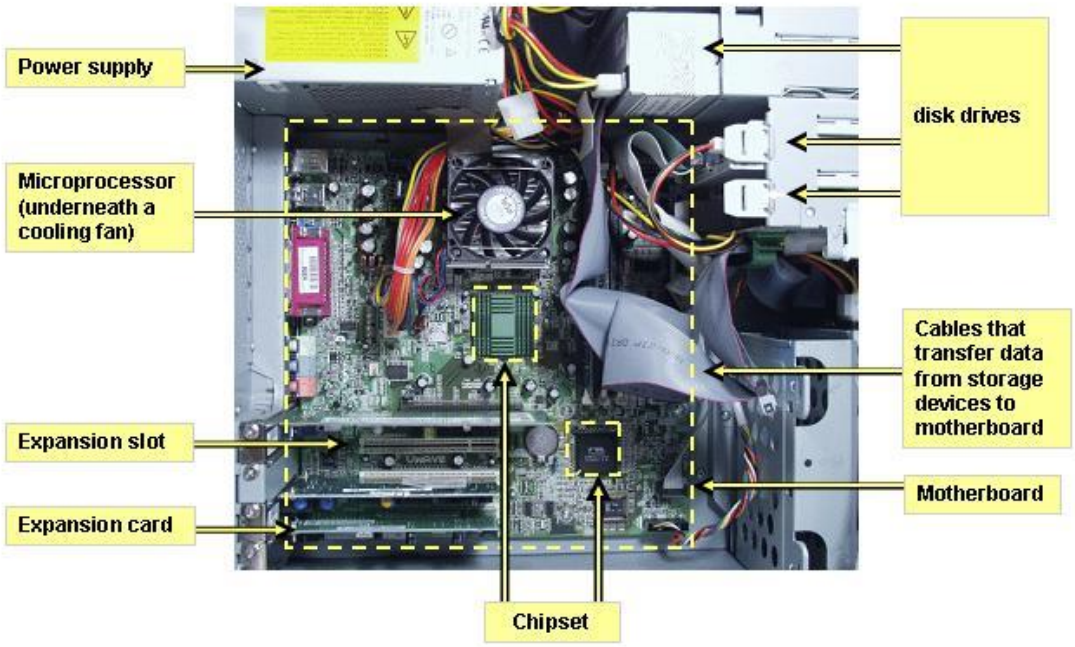

Figure 2.4 - Components inside the system unit

Hardware components provide physical interface in a computer system. However, they cannot function without instructions. These instructions are software programs.

Software System – Operating System Software and Application Software.

The two different types of software programs are (1) operating system software and (2) application software. The diagram (Fig. 2.5) illustrates the levels of interaction among users, application software, operating system software, and the hardware system.

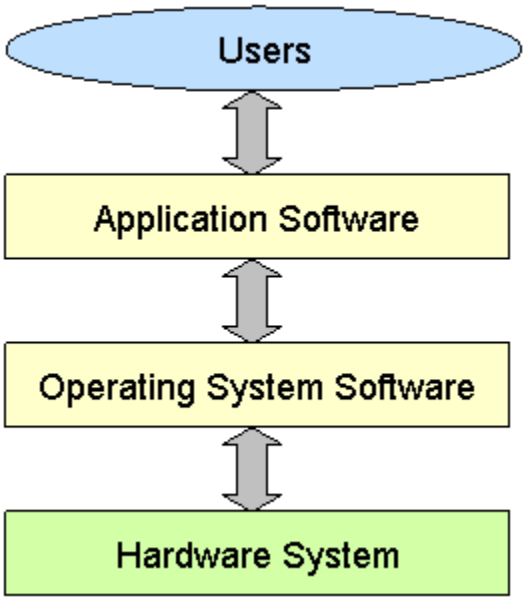

Figure 2.5 - Interaction among hardware system, operating system software, application software, and users

The operating system software serves as the interface between application software and hardware components. The application software interacts with the users of a computer system.

Operating system software provides instructions to hardware system components. Examples of operating systems are Microsoft Windows operating system and Macintosh operating system. While performing input, the operating system program provides instructions to send the input to appropriate hardware components for processing. Then, it provides instructions for the result to be sent to the appropriate output device. For example, when a user uses a keyboard, Microsoft Windows operating system takes the input sent through the keyboard and displays the typed letters on the monitor.

Application software provides instructions that enable the user to perform specific tasks such as creating presentations, document layout, and editing images. Examples of application software programs are Microsoft Word and Notepad. Application software instructions are handled by the operating system. For instance, when you open a file using Microsoft Word, first the application provides the user-interface to specify which file you want to open (for example, the menu

bar). Once you have selected the file, the application notifies the operating system that a certain file is needed. The operating system then requests for the file from the hard drive of the computer. Clicking on the Start button and selecting Programs allow you to see application software on your computer.

Network System

The worldwide system of computer networks is the Internet. Via the Internet computers on the network can access other computers. The Internet allows data to be moved from one computer to another.

The network systems manages the way data is transferred from one computer to another and work of different components of a network system. The diagram below (Fig. 2.6) illustrates necessity for communication with other components of the network computers via the Internet.

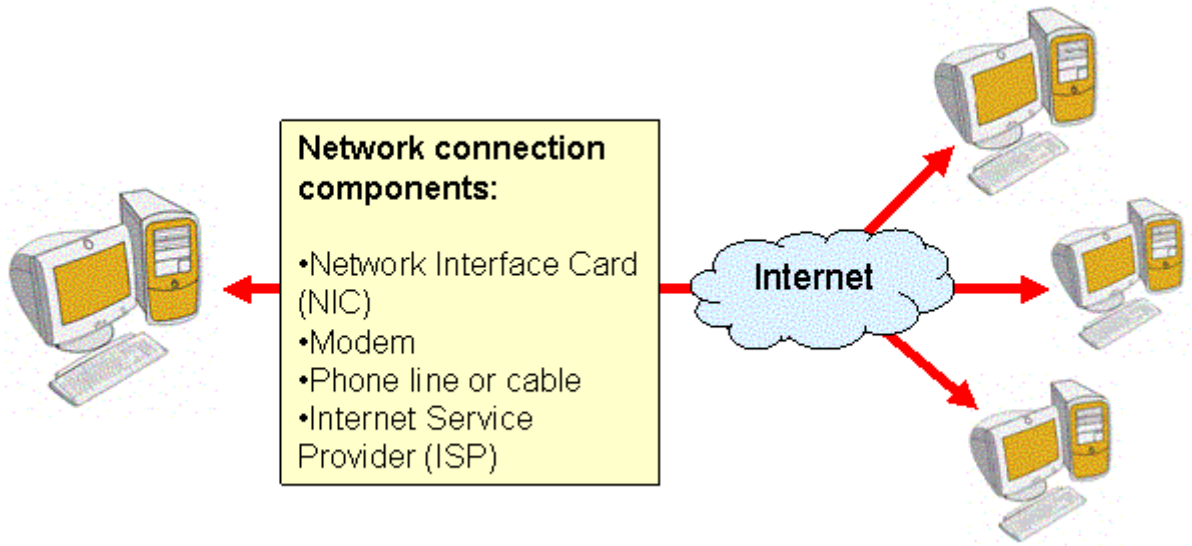

Figure 2.6 - Network connection components

A network interface card (NIC) sends data from a computer over a network, and collects incoming data sent by other computers. A modem is a device that enables data from a computer to be transmitted via phone lines or television cable lines to reach other computers on the Internet. In addition to these hardware network components, a computer also needs an Internet service provider such as America Online to enable its connection to the Internet. Application software such as Web browsers (for example, Internet Explorer and Netscape) and electronic mail (for example, Outlook and Netscape Mail) also enhance the usefulness of a network system.

2.2. Evolution of Computer Systems

In this subchapter the origin and advancement of computer technology are described. Innovative methods of computer use that enhance different aspects of

our lives are considered. Ways of computer use for personal interests, study, researches in medcal sphere, business management or entertainment are described. At the end of this subchapter, information about computer industry, major segment of the world economy, which creates career and business opportunities, is presented.

2.2.1. Brief History

1200s—Manual Calculating Devices
1600s—Mechanical Calculators
1800s—Punched Cards
1940s—Vacuum Tubes
1950s—Transistors
1960s—Integrated Circuits (IC)
1970s to Present—Microprocessor

As commerce developed in earlier societies, people began to realize necessity for a bookkeeping system to enable them to add, subtract, and record simple transactions. To facilitate the bookkeeping process, counting devices were developed. At first, people used fingers, stones, and sticks to count. Later on, mechanical calculators emerged, but they were slow and bulky. When electricity was discovered, electronic components replaced the bulky mechanical parts and enabled smaller, faster computing devices. Computers are continually evolving towards faster computations; capacity of storage devices is increasing, sizes are becoming smaller, thus they are in great demand.

With advancements in computing devices, computers have integrated in many aspects of our lives. Purchases are processed through computers. Products are designed using computers. Movies are made with computer simulations. The growth of the computing industry is driven by the numerous computing technologies that are used in such areas as commerce, communications, banking, and education. In the next subchapter ways of computer technology use are examined.

Stages of computer advancement in the field of computer application to solve problems of handling large amounts of data and calculations will be examined.

You will see how computing methods have evolved.

1200s — Manual Calculating Devices

Manual calculating devices required the use of hands to move components on the device.

The first calculating device, the abacus, was used in China. It involved manually moving beads for calculations. Below is a picture of the abacus (Fig. 2.7).

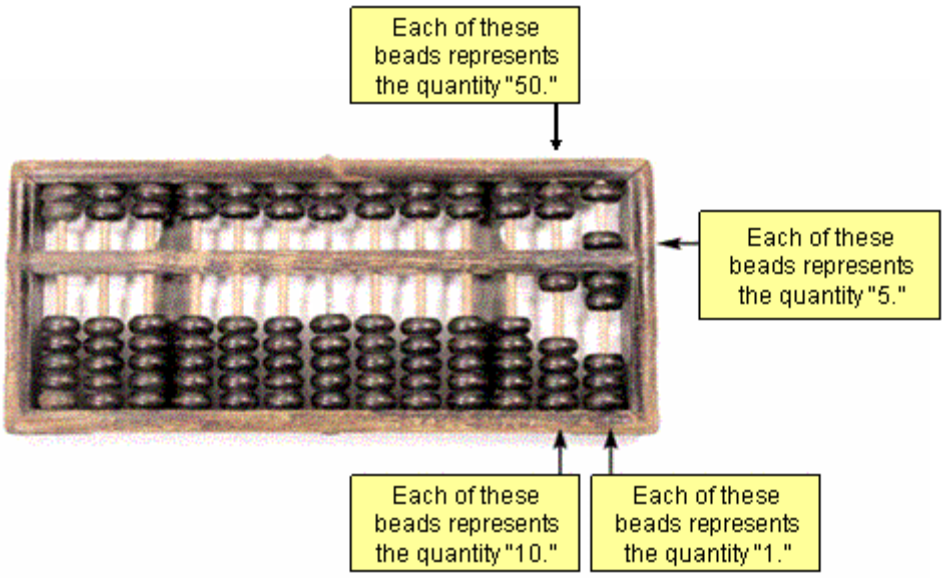

Figure 2.7 – Abacus

1600s — Mechanical Calculators

Mechanical calculators used wheels, gears and counters.

1642 – **Pascaline**

Blaise Pascal invented the Pascaline, which is a mechanical calculator. The machine used some principles of the abacus, as well as the wheels to move counters.

1800s — Punched Cards

Punched cards used holes following a specific pattern to represent the instructions given to the machine or store data. The idea of storing data and program instructions on punched cards came from the Jacquard loom. It used pasteboard cards with patterns of punched holes to produce large quantity of fabrics weaved in a variety of patterns. Each punched card represented a pattern and the punched card could be fed through the Jacquard loom to produce weaved fabrics of the pattern repeatedly. Similarly, different program instructions could be stored on separate punched cards, which could be fed through the computing machine repeatedly. Using punched cards, program instructions and data could be stored.

1834 – Analytical Engine

Charles Babbage designed a new general-purpose calculating device, the Analytical Engine, which is the ancestor of modern computers. It included the essential components of present-day computers, which are input, process, storage, and output of data. Babbage's assistant, Augusta Ada King, Countess of Lovelace and daughter of English poet Lord Byron, created the instruction routines stored on punched cards to tell the machine what to do. Instruction sequences used by the computer are known as "computer programs." Thus, she was the first female computer programmer, and in her honor, the U.S. Defense Department named the programming language ADA.

Below is an image of an analytical engine.

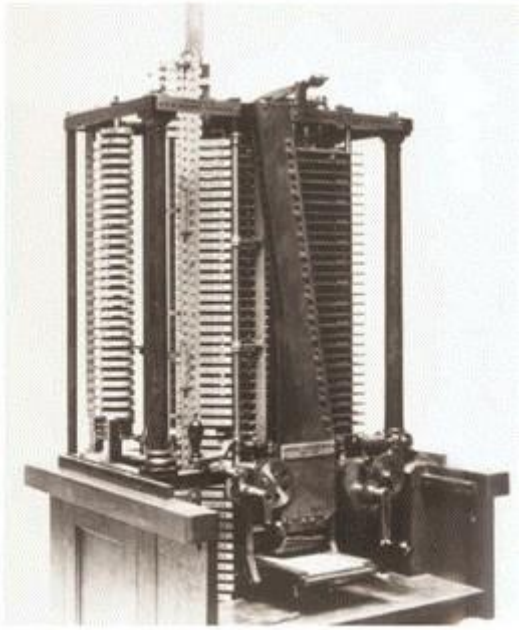

Figure 2.8 - Analytical engine

1890 – **Electronic punched card tabulating device**

Herman Hollerith designed an electronic punched card tabulating device that enabled the U.S. Census Bureau to tabulate the 1890 census in six months, which would have otherwise taken more than 7 years. Hollerith's machine used punched cards to store data instead of instruction routines.

1896 – Hollerith thought the business world could benefit from the electronic punched card tabulating device, and founded Tabulating Machine Company, which later became International Business Machines (IBM) in 1924.

1940s — Vacuum Tubes

Vacuum tubes are used to control the flow of electrons. Since vacuum tubes worked faster than mechanical components, faster computations were possible. But the tubes consumed a lot of power and burned out quickly.

Below is a picture of vacuum tubes (Fig. 2.9).

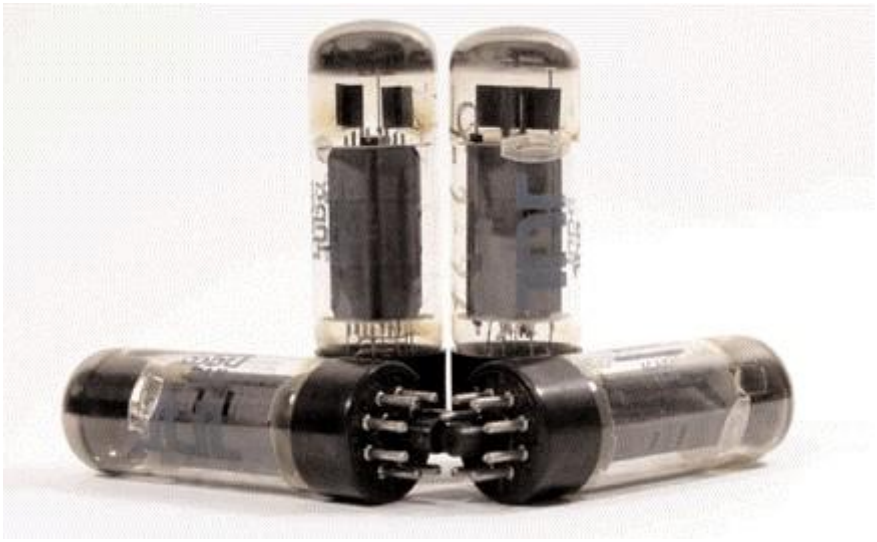

Figure 2.9 - Vacuum tubes

1945 – Electronic Numerical Integrator and Computer

The first computer prototype that used vacuum tubes, ENIAC (Electronic Numerical Integrator and Computer), was designed to calculate trajectory tables for the U.S. Army during World War II, but it was completed in three months after the war.

The machine was 100 feet long and 10 feet high and weighed 30 tons. It had over 18,000 vacuum tubes. But, in the first year, around 19,000 tubes were burnt out and replaced. The ENIAC could perform 5,000 additions per second, but its operations had to be programmed manually by connecting cables and setting 6,000 switches.

The first commercially successful computer, UNIVAC, was developed by Eckert-Mauchly Computer Corporation (later acquired by Remington Rand). The machine was 14.5 feet long, 7.5 feet high, and 9 feet wide. It could read 7,200 characters per second. It cost $930,000. Another important development was the invention of the compiler by Admiral Grace Hopper who was working at Eckert-Mauchly Computer Corporation at that time. A compiler enabled program instructions to be written in English and then translated into a language that was understandable for machine. This invention made the programming task easier and faster.

1950s—Transistors

Transistors performed functions similar to vacuum tubes but they were smaller, cheaper, and more reliable. Additionally, they consumed less power. The ability of transistors to replace vacuum tubes was first demonstrated in AT&T's Bell Laboratories. Transistor-based computers could perform 200,000 to 250,000 calculations per second.

Transistors were also used in other electronical devices such as the radio. Below is a picture of radio and transistors (Fig. 2.10).

Figure 2.10 - Transistors

1960s — Integrated Circuits

An integrated circuit, also called a "microchip" or "chip," is a thin slice of silicon packed with microscopic circuit elements such as wires, transistors, capacitors, and resistors. It was developed in 1958 by Jack Kilby at Texas Instruments and independently by Robert Noyce at Fairchild Semiconductor. Integrated circuits enabled the equivalent of thousands of vacuum tubes or transistors to be packed onto a single miniature chip about the size of your fingernail, reducing the physical size, weight, and power requirements for such devices as computers. Computers became ever smaller as more components could fit onto the chip. More information about the IC chip can be found at the Smithsonian Institute's Jerome and Dorothy Lemelson Center for the Study of Invention and Innovation.

1970s to Present — Microprocessor

The microprocessor combined computer components on a microchip. Before the development of microprocessor, each integrated circuit had to be manufactured for a particular purpose, but now a microprocessor can be manufactured and then programmed for various purposes and needs. Note, that millions of wires are etched onto an area that has a size of a fingernail (Fig. 2.11).

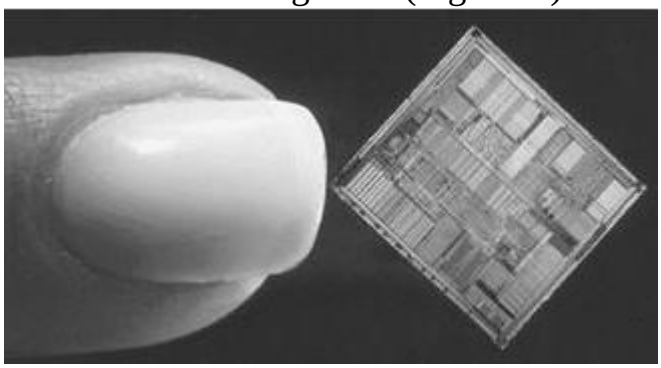

Figure 2.11 - Microprocessor chip

The first general-purpose microprocessor was the Intel 4004. It was developed in 1971 by Ted Hoff. The Intel 4004 enabled microprocessor-based computer systems to become faster, smaller, and less expensive than before.

Pace of Advancement

Transistors are still decreasing in size. As transistors become smaller, more transistors can be placed on the chip. This implies faster processing speeds and greater data storage capacity (Table 2.1)

In 1965 Gordon Moore, a founder of Intel, one of the largest microchip manufacturers, made his observation that there is an exponential growth in the number of transistors per integrated circuit. He predicted that the numbers of transistors put on a microchip will double every 12 months, until physical limitations are reached. This observation was termed "Moore's Law." Now the exponential growth has slowed down to doubling every 18 months, nevertheless, the rate of growth is still exponential (Fig. 2.12).

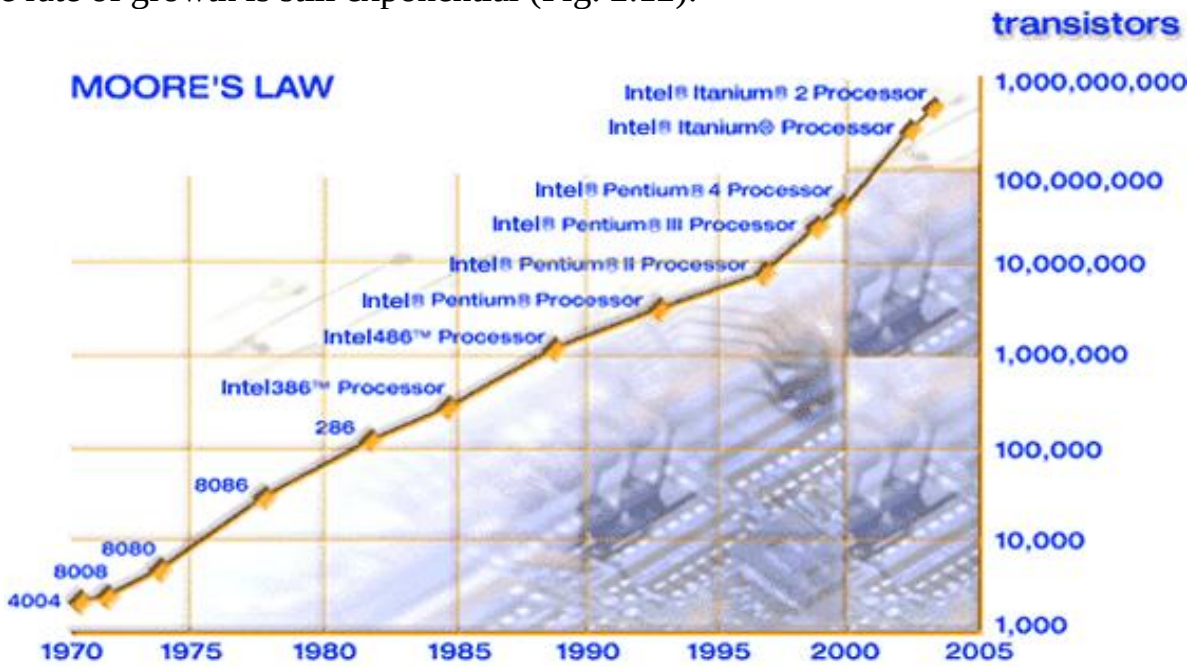

Figure 2.12 - Moore's Law applied to Intel processors [Moore's Law, The Future — Technology & Research at Intel]

Table 2.1 - Number of transistors used in Intel processors in different years

	Year of release	Number of transistors
4004	1971	2,250
8008	1972	2,500
8080	1974	5,000
8086	1978	29,000
286	1982	120,000
386TM processor	1985	275,000

486TM DX processor	1989	1,180,000
Pentium® processor	1993	3,100,000
Pentium II processor	1997	7,500,000
Pentium III processor	1999	24,000,000
Pentium 4 processor	2000	42,000,000
Itanium 2 processor	2002	220,000,000

Types of computers

Computers can be broadly classified by their speed and computing power. Some types of computers are presented in Table 2.2.

Table 2.2 – Types of computers

Sr.No.	Type	Specifications
1	PC (Personal Computer)	A single user computer system which has a moderately powerful microprocessor
2	WorkStation	A single user computer system which is similar to a personal computer but has more powerful microprocessor.
3	Mini Computer	A multi-user computer system which is capable of supporting hundreds of users simultaneously.
4	Main Frame	A multi-user computer system which is capable of supporting hundreds of users simultaneously. Software technology is different from minicomputer.
5	Supercomputer	An extremely fast computer which can execute hundreds of millions of instructions per second.
6	Microcontroller	Mini computer that enables the user to store data and execute simple commands and tasks.

- **PC (Personal Computer)**

A PC can be defined as a small, relatively inexpensive computer designed for an individual user. PCs are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. The most popular use of personal computers at home is playing games and surfing the Internet.

Although personal computers are designed as single-user systems, these systems are normally linked together to form a network. In terms of power, nowadays High-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and Dell (Fig. 2.13).

Figure 2.13 – Personal Computer

- **Workstation**

Workstation is a computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other types of applications which require a moderate amount of computing power and relatively high quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, large amount of RAM, inbuilt network support, and a graphical user interface. Most workstations also have a mass storage device such as a disk drive, but a special type of workstation, called a diskless workstation, comes without a disk drive (Fig. 2.14).

Common operating systems for workstations are UNIX and Windows NT. Workstations are also single-user computers like PCs but they are typically linked together to form a local-area network, although they can also be used as stand-alone systems.

Figure 2.14 – Workstation

- **Minicomputer**

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously (Fig. 2.15).

Figure 2.15 – Minicomputer

- **Mainframe**

Mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports many simultaneous executions of programs (Fig. 2.16).

Figure 2.16 – Mainframe

- **Supercomputer**

Supercomputers are one of the fastest computers currently available. Supercomputers are very expensive and are used for specialized applications that require immense amount of mathematical calculations (number crunching). For example, weather forecasting, scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting) (Fig. 2.17).

Figure 2.17 – Supercomputer

- **Microcontroller**

These single circuit devices have minimal memory and program length but are normally designed to be very good at performing a niche task. Many such

systems are known as embedded systems. The computer in your car, for example, is an embedded system. A common microcontroller that one might come across is called Arduino (Fig. 2.18).

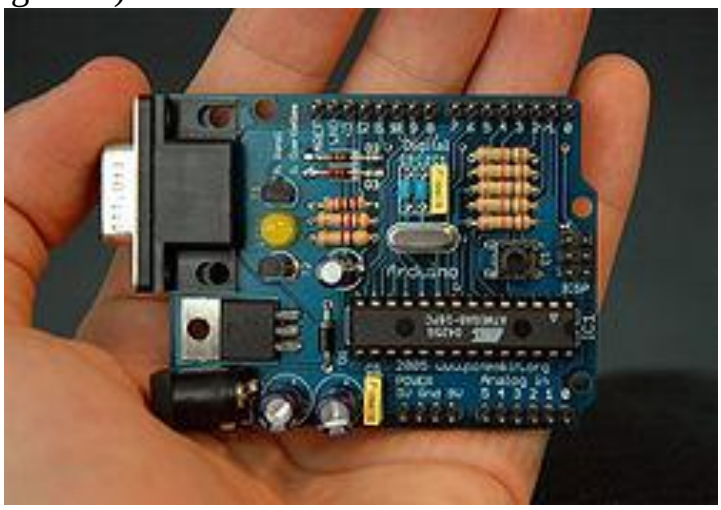

Figure 2.18 – Microcontroller

2.2.2. Applications of Computer Systems

- In Education
  - Multimedia-Facilitated Learning
  - Simulation-Based Education
  - Intelligent Machine-Based Training
  - Interactive Learning
- In Business
  - Supply Chain Management
  - Project Management
  - Customer Relationship Management
  - Sales and Marketing Using Electronic Commerce
  - Manufacturing Research
- In Entertainment
  - Movies
  - Video Games
  - Music
  - Digital Photography
  - Travel
  - Miniature Computer Systems

Computer systems help to improve our lives in many ways. Following examples show the innovative use of computers to enhance learning process, business and entertainment. As you begin to explore the applications of computer systems, think about how you can use or develop computer technologies in your own field of interest.

In Education

Multimedia-Facilitated Learning. Multimedia is defined by Wikipedia as "the use of computers to present text, graphics, video, animation, and sound in an integrated way." Software applications such as Microsoft PowerPoint allow lectures to be conducted with visual aids. Software applications for education can be used to enhance students' learning by providing an interactive, multimedia environment that can be more engaging. Students can click on the buttons on the computer screen to access different sections of the learning material. An example of this can be found on the Intel education site (requires Flash Player). Computers can help to enrich students' learning experience.

Simulation-Based Education. Computers can be programmed to generate images and animations that model other systems. These systems can be those that exist in the physical world in which we live (for example, people and objects), as well as those from the imagination (e.g. life on the moon and mythical beings). For example, the Sim Theme Park program allows users to design their own roller coasters, and provides the option to turn off gravity. Simulations can also be used to emulate scenarios that may be too dangerous to practice with real people. Pilots often use simulations when learning about new equipments. Furthermore, computers can be used to model elements that are hard to observe such as molecular structures. The following examples present the ways the simulations can help learning.

The Talking Head below demonstrates how it can be used in language training. The Talking Head realistically simulates the head of a human being, with a computer-synthesized voice that sounds human-like. Click on the image below to see a demonstration of how 3-D imaging and voice simulation can assist in language learning in ways that may not be achievable in the real world (Fig. 2.19).

Figure 2.19 - The Talking Head
Courtesy of Dominic Asarco, Professor of Psychology,
University of California- Santa Cruz

Other examples of simulation-based training discussed below are medical training, molecular modeling, and military training.

Medical Training. In the U.S. army, 3-D virtual reality (VR) software is used to measure and improve the effectiveness of medical training in the field. The software enables students to practice trauma assessment and treatment on wounded soldiers using computer. This would eliminate the need to send trainees to the field and expedite the training process. Details about the training software can be found in the article, "3-D Training Software Helps Army Compare Medical Training Methodologies".

A joint research project in surgical simulation was conducted by Millers University's Haptics research group and Penn State University's College of Medicine. The project was aimed at developing software that can be used to simulate a suite of surgical procedures. Using a virtual reality surgical simulator that provides sensitive touch feedback along with realistic 3D imagery (virtual reality), medical students and surgeons will be able to practice and test their surgery skills. This would decrease consumption of resources such as organs and physical surgery spaces.

Below (Fig. 2.20) is an image of a medical student performing deformable organs simulation using a pair of scissors.

Figure 2.20 - The Student is using simulation tool

The student sees the image below - a deformable stomach and the scissors that the student uses to interact with the visual simulation (Fig. 2.21).

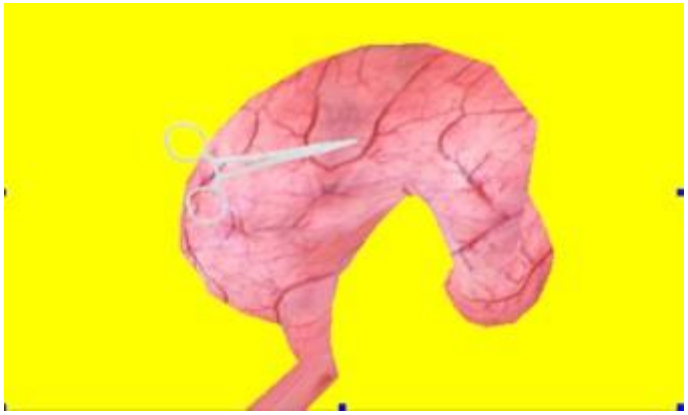

Figure 2.21 - Deformable stomach being manipulated by a virtual scissors
© Copyright 2002 Department of Computer Science, Millersville University

Molecule Modeling. Researchers from the Department of Biochemistry and Molecular Biophysics in Columbia University and the Howard Hughes Medical Institute use a software visualization tool, Graphical Representation and Analysis of Structural Properties (GRASP), to create 3-D models of chemical molecules and explore their properties.

Below is a screenshot of a DNA simulation (Fig. 2.22).

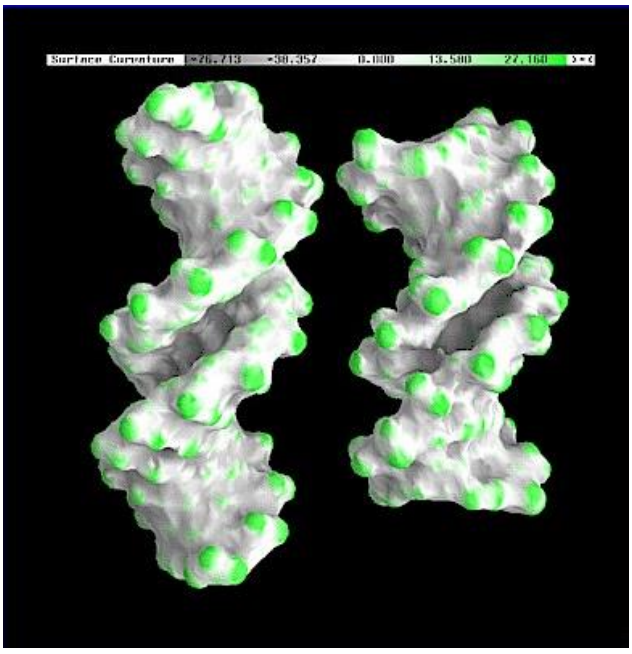

Figure 2.22 - DNA modeling
© Copyright 2002 Barry Honig's group in the Department of Biochemistry and Molecular Biophysics of Columbia University and the Howard Hughes Medical Institute.

Visual simulations of molecules can also be animated to show how they change over time. More information about visual simulations in Chemistry can be found at http://www.csc.fi/chem/gallery.phtml.

An interdisciplinary applied research center, CRS4 (Center for Advanced Studies, Research and Development in Sardinia), is developing simulation

techniques to create visual models in the various fields including medical imaging, fluid dynamics, environment modeling, and more. See CRS4's Animation Gallery.

Military Training. 3-D simulations can be used for building the virtual environments that replicate the interior of military crafts and for training engineering officers. Using simulations, physical crafts do not need to be used during training, and the number of people that can be trained at one time is not limited. Additionally, training can be provided to people in different geographic locations. You can learn more about the benefits of virtual reality simulations in training on the Education & Training Technology page from Research Triangle Institute (RTI)

Below is a screenshot of a virtual environment built by Research Triangle Institute (RTI) using 3-D simulation software from Sense8 (Fig. 2.23).

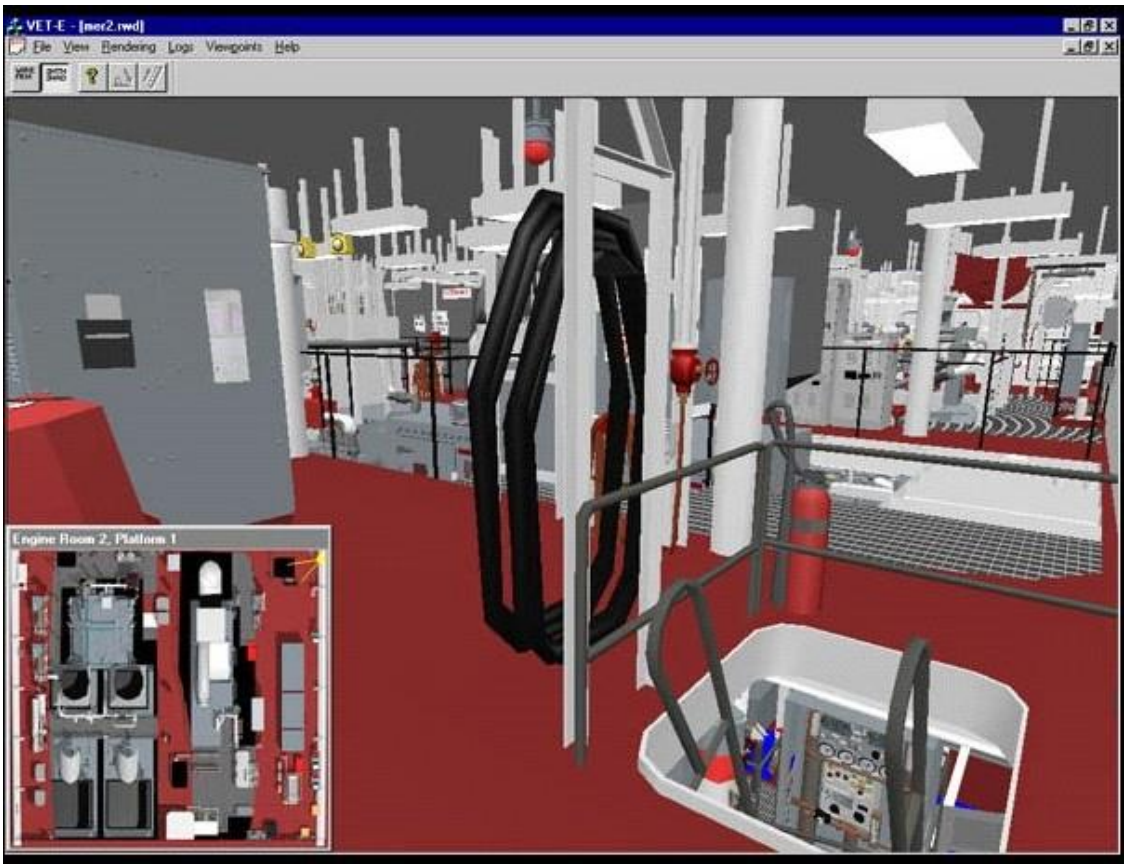

Figure 2.23 - Virtual training for military personnel

© Copyright 2001 Research Triangle Institute.

Intelligent Machine-Based Training. Computer systems can be programmed to react to the user's behavior. For example, in order to facilitate learning of a foreign language, researchers at Carnegie Mellon University developed Fluency: Automatic Foreign Language Pronunciation Training software that can interpret pronunciations and provide feedback on our pronounciation of a word and correct it (Fig. 2.24).

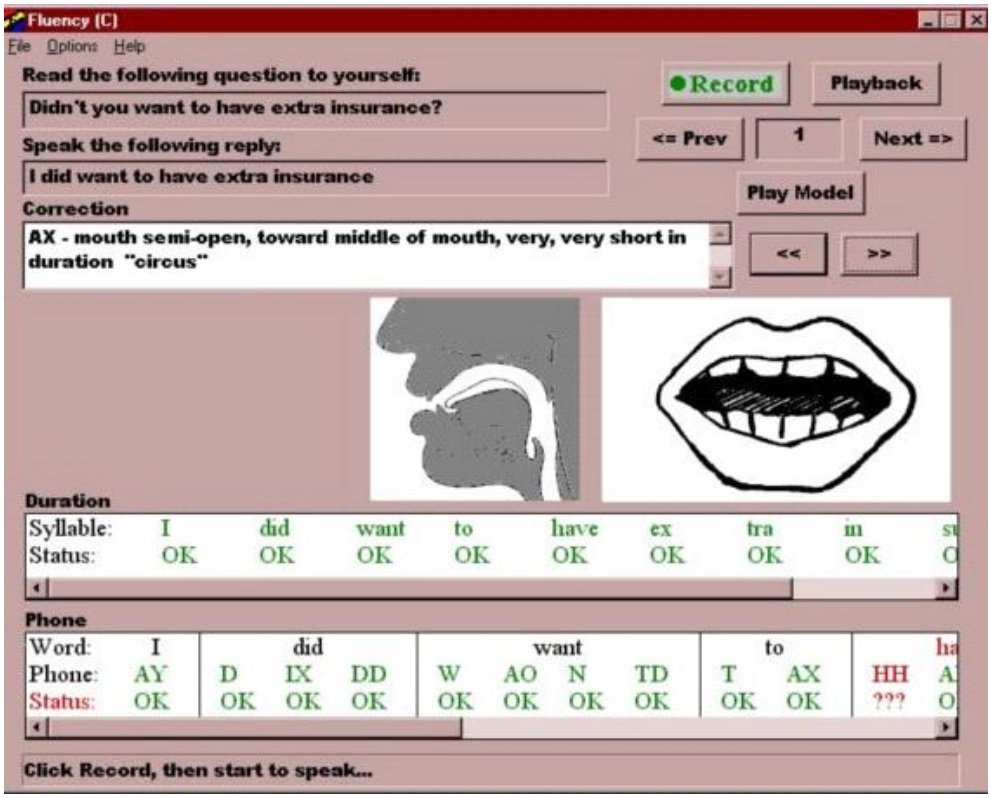

Figure 2.24 - Language training software

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(Note: This software has a patent pending and has been licensed through the CMU Tech Transfer Office exclusively to the Carnegie Speech Company, a spin-off of Carnegie Mellon University.)

Interactive Learning. Music composer and inventor Tod Machover at the MIT Media Lab and Media Lab Europe started Toy Symphony, an international music performance and education project aimed at introducing children to new ways of making music. The project involves the use of Music Toys in order to engage children in listening, performing, and music-composing tasks. Children can play along with some of the world's most accomplished musicians who are participating in this project. The Figure 2.25 presents one of the toys.

Figure 2.25 - Beatbug music toy
© Copyright 2002-2003 MIT Media Lab

In Business

Supply Chain Management. Supply chain management aims to manage and track the supply of raw components, their usage in the manufacturing process, and delivery of finished products to customers. Some supply chain management software applications use mathematical algorithms to improve the flow of the supply chain and minimize inventory. You can read more about Supply Chain Management.

Project Management. Product development information, which includes product requirements, work schedules, project milestones, budgets, and product design, needs to be organized and tracked to monitor the progress of the project. Software applications are capable of keeping track of the product database, work schedule, and budget of the project to help you pinpoint potential barriers to the timely completion of the project. You can see some project management software system demos provided by Microsoft (requires Macromedia Flash Player and Microsoft Internet Explorer).

Customer Relationship Management. Customer relationship management (CRM) is a process that gathers information about the customer base, marketing effectiveness, and market trends in order to learn more about customers' behaviors. CRM software system can collect information about customer demographics, and investigate customer-purchasing behaviors with the objective of predicting customer needs and increasing revenues.

CRM system may involve the use of an "Intelligent Agent," which is a program that collects information about user's behavior, and customizes the content on a website. For example, when you go to Amazon.com, the site can generate a personalized page that will contain advertisements of products that may interest you on the basis of your purchasing history. If you buy a novel in the Harry Potter children's fiction series, then your Amazon page may advertise other Harry

Potter volumes or other books about adolescent adventure that you have not purchased.

You can learn more about CRM by reading some CRM Case Studies.

Sales and Marketing Using Electronic Commerce. Using the Internet, commerce can be conducted online through the World Wide Web. To enable electronic transactions, a company would need software for generating purchase orders or quotation requests, process invoices, build marketing material, mechanism to respond to customers and process orders, and keep track of customer-purchasing behaviors. Additionally, some commercial websites allow you to customize your own product. For example, Nike's website enables you to purchase shoes designed by you. You can choose different color combinations for your shoe. You can even specify personalized text to be placed on the shoe.

Manufacturing Research. Computer simulation tools can be used to design products. For example, in automobile tire research, simulation tools can be used to estimate braking distances of tires under various road conditions and tire tread patterns. Researchers from Pusan National University (J.R. Cho, H.W. Lee and W.S. Yoo) have used computer simulation and published their results in a paper titled “A wet-road braking distance estimate utilizing the hydroplaning analysis of patterned tire” in the International Journal for Numerical Methods in Engineering. Volume 69, Issue 7.

In Entertainment

Movies. Computer-generated special effects have made possible the creation of award-winning films such as *Star Wars: Episode II*, *Jurassic Park*, *Men in Black*, *Jumanji*, *Forrest Gump*, and the *Perfect Storm*.

In particular, *Star Wars: Episode II* was the first major motion picture to be shot entirely on digital cameras. The production team saved time and money usually invested in film stock and photochemical processing by using digital cameras. Traditionally, images shot on film had to be scanned and transformed into digital media to incorporate visual effects. Digital cameras facilitated the process of transferring movie images from different stages of production.

You can read about how movie effects are incorporated using computer technology by Industrial Light & Magic, the company that created the visual effects for the first Star Wars movie.

Video Games. The video gaming industry has advanced greatly from the simple black and white dotted images of video game characters from the 70s to the life-like 3-D simulations of video game creatures. Video game systems are computer systems integrated with sophisticated video imaging technology to bring a world of fantasy to life on your computer screen. You can find the samples at gamespot.com

Music. Distribution of music in the 20th century has evolved from analog to digital form. Music can be downloaded from Internet sites and stored in hand-held

size MP3 players. This expanded the volume of music selections that can be stored and played. You can read about how MP3 Players work.

Digital Photography. More and more people are using digital cameras instead of conventional film cameras. All digital cameras have a built-in computer that records images in electronic form. Images can be viewed immediately after they have been captured, and they can be uploaded onto a computer or exchanged over the Internet. You can read about how digital cameras work.

Travel. Researchers at the School of Computer Science, Carnegie Mellon University have created software that reads Chinese signs and translates them into English using only a palm-size computer equipped with a small camera. Find out more about the sign translation technology (Fig. 2.26).

Figure 2.26 - Sign translation device

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Wearable Computer Systems. Computer systems can also be embedded in devices that are more portable such as a wristwatch or a headphone. For example, a GPS (Global Position System) can be embedded in your wristwatch to help you find directions to a specific destination. You can read about fashion-oriented accessories that incorporate technology being developed at Carnegie Mellon University, and wearable technology developed at MIT Media Lab. It is possible to get the information about additional applications of computer systems that are currently being investigated at Carnegie Mellon University and at MIT Media Lab.

2.3. Data Representation in a Computer System

Computers represent data using 0's and 1's, also known as **binary** numbers. Why do computers use binary notation instead of the more familiar decimal notation (using digits 0-9) that people use? Each digit, whether binary or decimal, must be represented by a voltage in the computer's circuitry. It is easy to build circuits that discriminate between two voltages. We could call these voltages "on"

and "off." It is much harder, though not impossible, to build circuits to discriminate reliably among ten different voltages.

2.3.1. Bits and Bytes

Data Representation Using Binary Digits

A piece of data, such as an alphabet letter, may be represented using a sequence of binary digits- 0's and 1's. There are several types of codes used to represent character data. For example, using extended ASCII (America Standard Code for Information Interchange) code, the alphabet letter "a" can be represented using a series of eight binary digits, "01100001." Each binary digit is called a **bit**. And, eight bits are one **byte**. Extended ASCII code uses eight bits (or one byte) to represent input characters. Below are binary representations of characters in extended ASCII code (Fig. 2.27).

Figure 2.27 - ASCII code

All data, including audio, visual, and program instruction data can be represented and stored using a sequence of binary digits, or a sequence of bytes. In other words a file is a collection of data. In some files, the bits of data directly encode individual letters, numbers, and punctuation symbols that make up words

and sentences. In image files, the bits of data need to be computed and transformed to images that we can interpret.

Most applications such as Microsoft Word or PowerPoint encode information in specialized ways that is not readable by humans. Thus, even though Microsoft Word is often used to edit text, a Word document cannot be properly displayed by a simple text editor like Notepad because the document includes information in a format specific to Microsoft Word. Therefore, it must be opened by Microsoft Word to be read. Some files have a header section that indicates which format is used to encode the data in order to allow the computer to reassemble the binary data back into the human-readable form of the document.

Increasing Need for Bytes

In the late 1970s and early 1980s, inexpensive personal computers were manufactured for the first time, and soon a large consumer market was developed. At first it was enough to have small amounts of memory, for example, thousands of bytes to handle the simple spreadsheet and perform word processing tasks. But then the users wanted to get software that would allow them to do more tasks such as creating drawings and generating complex page layouts. That's why there was an increased demand for better computing requirements. This demand led to new developments that expanded memory capacities. By the mid 1980s, the memory was increased up to millions of bytes. Today, office and home computers often have billions of bytes in memory capacity. Memory for data-intensive systems, such as the Geographic Information System (GIS), requires trillions of bytes. Below is a chart illustrating the storage capacity over the years since 1970s with their associated prefixes and abbreviations (Table 2.2)

Table 2.2

Decade	**1970s**	**1980s**	**1990s**	**2000s**
Order of magnitude in Storage capacity	Thousands	Millions	Billions	Trillions
Prefix	Kilo (10^3)	Mega (10^6)	Giga (10^9)	Tera (10^{12})
Abbreviation	K	M	G	T

To make it better in terms of storage, both data and programs can be stored in computer memory. Corresponding to the growth in storage capacity, memory capacity is also increasing. Moreover, memory technologies are getting smaller, lighter, faster, and available. You will learn more about storage and memory technologies in the next subchapter.

2.3.2 Number Systems

The world of computing uses several number systems to represent data. The decimal system, also known as base10, is familiar to people, as it is the numbering system used in everyday life, the binary (base2) and hexadecimal (base16) are common number systems used in computing today.

Decimal

We will start our discussion on number systems by examining the decimal system as an example of a number system. The decimal number system contains ten values- 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Each number in the decimal number system can be broken into digits by their "place" in the number. Let's examine the number 43,872 as an example. 2 is in its 0th place, 7 is in the first place, 8 is in the second, 3 is in the third, and 4 is in the fourth. Each place has a value that can be represented either exponentially or by its decimal values. The following Table 2.3 shows the exponential and decimal representation for each place in the number 43,872.

Table 2.3 - Exponential and decimal values corresponding to a digit's place in a number

Place	4th	3rd	2nd	1st	0th
Digit	4	3	8	7	2
Exponential value of the place	10^4	10^3	10^2	10^1	10^0
Decimal value of the place	10,000	1,000	100	10	1

Note that the exponential values are increased to a power corresponding to the place of the digit. For example, the exponential value of the 4th place is 10^4.

To determine the value of the number, multiply the digit contained in a column by the value represented by the column. The following is a sample calculation for the previous example.

$4 \times 10^4 + 3 \times 10^3 + 8 \times 10^2 + 7 \times 10^1 + 2 \times 10^0 = 4 \times 10{,}000 + 3 \times 1000 + 8 \times 100 + 7 \times 10 + 2 \times 1 = 40{,}000 + 3000 + 800 + 70 + 2 = 43{,}872$

While performing these calculations on a decimal number which seems trivial, it demonstrates a pattern, or a formula that can be used to convert a number from any numbering system to decimal.

$d_p(b)^p + d_{p-1}(b)^{p-1} + \ldots + d_0(b)^0$

Where p is the place, b is the base, d_p is the digit in the highest place in the number, and d_{p-1} is the next highest place in the number, and so on.

Using the number example above, $d_p = 4$, $d_{p-1} = 3$, $b = 10$, and $p = 4$.

$4 \times 10^4 + 3 \times 10^3 + 8 \times 10^2 + 7 \times 10^1 + 2 \times 10^0 = 43{,}872$

The formula above can be used to compute the decimal value of any number in a given base. Below is the calculation for converting 21_4 to its decimal value:

Table 2.4 - Exponential and decimal values corresponding to a digit's place in a number

Place	1st	0th
Digit	2	1
Exponential value of the place	4^1	4^0
Decimal value of the place	4	1

$2(4)^1 + 1(4)^0 =$

$2\times 4 + 1 \times 1 =$

$8 + 1 =$

9

So far, we have only discussed converting numbers to decimal. It is also important to be able to convert numbers from decimal to other numbering systems. Using the base$_4$ system, let us convert 89 from decimal to base$_4$.

First, find the value p, where $4^p <= 89 < 4^{p+1}$. In this case p = 3. p is the value of the highest place.

Now we can proceed by filling out the following chart:

Table 2.5 - Converting numbers from base 10 to base 4

Place	3	2	1	0
Exponential value of the place	4^3	4^2	4^1	4^0
Decimal value of the place	64	16	4	1
Calculation	$89 \div 64$	$25 \div 16$	$9 \div 4$	$1 \div 1$
Result	1	1	2	1
Remainder	25	9	1	0

Therefore, $89_{10} = 1121_4$.

Lte’s review binary and hexadecimal in detail.

Binary

Since all numbering-systems are treated the same, you have already have all the tools necessary to convert to and from binary. Let's review converting the number 10110110_2 from binary to decimal.

The highest place, p, is obtained by counting the number of places in the binary number, starting from zero. In this case, p = 7.

$1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 1 \times 128 + 0 \times 64 + 1 \times 32 + 1 \times 16 + 0 \times 8 + 1 \times 4 + 1 \times 2 + 0 \times 1 = 128 + 0 + 32 + 16 + 0 + 4 + 2 + 0 = 182$

For example, in 100110_2 the largest place is 2^p, where p = 5. As binary is the easiest numbering system to convert into decimal, it will help us later while converting hexadecimal numbers.

Binary takes more digits to express a value in binary notation than in decimal. For example, the number 99 in decimal is 1100011 in binary. Computer professionals have adopted hexadecimal notation as shorthand for binary so that they can express binary values more concisely.

Hexadecimal

Hexadecimal ($base_{16}$), or "hex," is most likely the largest numbering system that you will work with. In the modern decimal system, the Arabic number set 0-9 has to be supplemented by additional values to represent the decimal equivalents of 10, 11, 12, 13, 14, and 15. Instead of inventing new symbols to represent these numbers, the letters A-F are used. Hexadecimal is represented by the set of numbers 0-F. While both lower case and upper case letters can be used in hexadecimal for A-F. In this textbook upper case A-F will be used. Hexadecimal, however, is not usually represented by appending 16 as a subscript to the number. There are two different formats for representing hexadecimal numbers: prepending 0x or appending h. 0x will be used to denote hexadecimal numbers.

Table 2.6 - Exponential and decimal values corresponding to a digit's place in a number

Place	4	3	2	1	0
Exponential value of the place	16^4	16^3	16^2	16^1	16^0
Decimal value of the place	65,536	4096	256	16	1
			7	E	1

There are two methods for converting hexadecimal into decimal. There is the direct approach using the formula:

$_p(b)^p + d_{p-1}(b)^{p-1} + \ldots + d_0(b)^0$

Where d_p is the digit in the highest place in the number, and d_{p-1} is the next highest place in the number, and so on. *b* is the base and *p* is the value of the highest place.

The conversion is as follows:

$4 \times 16^3 + A \times 16^2 + 3 \times 16^1 + F \times 16^0 = 4 \times 4096 + 10 \times 256 + 3 \times 16 + 15 \times 1 = 16{,}384 + 2560 + 48 + 15 = 19{,}007$

This method is particularly useful for larger hexadecimal numbers. However, for smaller numbers of one or two digits, it is often faster to convert the hexadecimal number to binary before converting it to decimal. Hexadecimal maintains a relationship with binary as it is a derivative of a base2 system. Each hexadecimal digit represents four binary places. The chart below presents the relationship between binary, hexadecimal, and decimal for 0x0-0xF.

Table 2.7 - Decimal, binary, and hexadecimal conversions

Decimal	**Binary**	**Hexadecimal**
0	0000	0x0
1	0001	0x1
2	0010	0x2
3	0011	0x3
4	0100	0x4
5	0101	0x5
6	0110	0x6
7	0111	0x7
8	1000	0x8
9	1001	0x9
10	1010	0xA
11	1011	0xB
12	1100	0xC

13	1101	0xD
14	1110	0xE
15	1111	0xF

Let`s convert 0x3B to decimal via binary. The first step is to find out what the individual hexadecimal number represents in binary. Replace the hexadecimal number with the binary number. Therefore, 0x3B becomes 00111011_2. As you remember from the previous subchapter of binary notation, the conversion of numbers from binary to decimal is much easier than in other systems because multiplying of binary bits by 0 and 1is a simple operation.

0x3B=

00111011_2=

32 + 16 + 8 + 2 + 1 =

59

The data byte (eight bits) can be written as two hex digits. For example, the symbol "N" in extended code ASCII has the binary representation 01001110. If we write it as two groups of four bits each, we get 0100.1110. Using table 2.5 above, we find that 0100 is 0x4 and 1110 is 0xE. Therefore, the corresponding hexadecimal code for 0100.1110 is 0x4E.

When setting up or maintaining a computer system, you will sometimes encounter hexadecimal numbers as representations of memory addresses, network addresses, or other hardware-related qualities. You may encounter them in the context of the operating system in case of failure and error messages.

Review questions

1. Outline the computer system components and the primary role of each subsystem.
2. List the components of a computer system and explain the process of work of each computer system component.
3. Give definition of a computer.
4. Explain what a computer architecture is on the example of Von Neumann architecture.
5. What is a hardware system and why does it play a crucial role in the operation of a computer system?
6. Arrange the levels of interaction among users, application software, operating system software and hardware system.
7. What is a network system and why does it play an essential role in the operation of a computer system.
8. List the network connection components.
9. Breakdown the evolution of computer systems into periods and point out the main advancements in computing devices matched to those periods.

10. Explain why the Moore's law states that the growth in the number of transistors has slowed.

11. Classify computers by their speed and computing power.

12. Give examples of applications of computer systems in different spheres of human activity.

13. What types of computers are possible?

14. What are the components of computer systems?

15. What are the main computer operations?

16. How is it possible to connect the additional device to the computer?

17. What is the usefulness of connection of computers with each other?

18. Why are devices similar to monitors, printers and keyboards called peripherals?

19. Explain how data is represented using binary digits.

20. Distinguish the number systems by their base.

21. Give examples of converting numbers from decimal to binary and hexadecimal number systems.

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CHAPTER 3. SOFTWARE. OPERATING SYSTEMS. APPLIED SOFTWARE

Software is a set of commands that controls the computer operations. Computer software helps us in implementing computing tasks in the computer. Software includes the following functions:

1. manage the computer resources of the organization;
2. provide the user with all resources necessary to solve computational tasks;
3. act as a mediator between the institutions and the stored information.

One of the key tasks of the managing personnel is selection of the appropriate software for the organization needs.

The program is a set of commands that performs a specific task on the computer. The process of creating or writing programs is called programming, and people who specialize in this kind of activity are called programmers. The term “program” is synonymous with the term "application”. To execute or run a program, it must be loaded into memory together with the data that has to be processed. When the program execution is completed, it is unloaded from the computer memory. All modern computers allow you to implement several programs simultaneously.

There are two main types of software: system and application. Each type of software performs a variety of functions. System software (system software) is a set of programs that manages computer components, such as the processor, communication and peripheral devices. The professionals developing system software are called system programmers. The application software is written for users or by users themselves for performing specific tasks on the computer. The examples of application software are: the order processing program or mailing lists. Programmers who write application software are called application programmers. Both types of software are connected and can be presented as shown on the diagram below (Fig. 3.1).

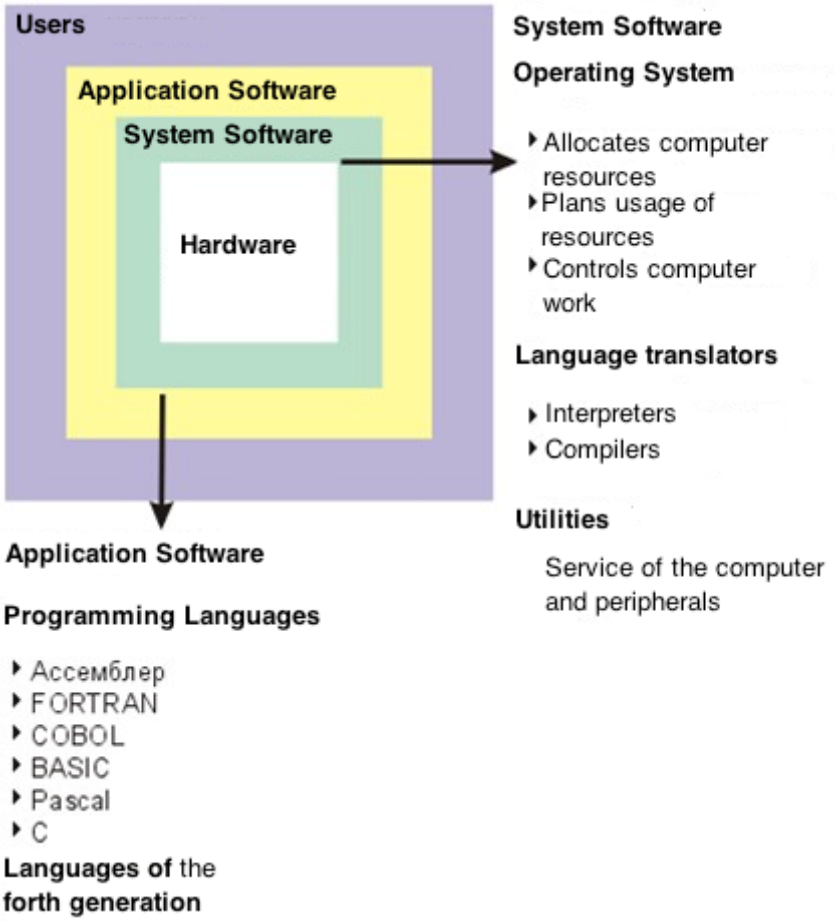

Figure 3.1 - The main types of software

As you can see, all types of work are closely connected with each other. The system software controls access to the computer hardware. The application software interacts with the hardware components through the system. End users mostly work with the application software. To provide hardware compatibility, each type of software is developed for a specific hardware platform.

3.1 Software operating systems

The operating system plays a very important role in the user interaction with the computer system. In this section, we will look at typical operating system functions, such as: device management, memory management, resource sharing and management processes. After analyzing the operating system, we will be able to find an apparent reason which slowdowns your computer and the steps you can take to solve these problems. We will also discuss the issues of computing environment settings in accordance with the requirements of the task at hand.

MS-DOS (Microsoft Disk Operating System) is a single-user, single-tasking computer operating system that uses a command line interface. Early versions of Microsoft Windows ran under MS-DOS. MS-DOS has a relatively small number of commands, and an even smaller number of commonly used ones. Moreover, these commands are generally inflexible because, in contrast to Linux and other

Unix-like operating systems, they are designed to accommodate few options or arguments (i.e., values that can be passed to the commands).

Some of the most common commands are as follows (corresponding commands on Unix-like operating systems are shown in parenthesis):

- CD changes the current directory (cd);
- COPY copies a file (cp);
- DEL deletes a file (rm);
- DIR lists directory contents (ls);
- EDIT starts an editor to create or edit plain text files (vi, vim, ed, joe);
- FORMAT formats a disk to accept DOS files (mformat);
- HELP displays information about a command (man, info);
- MKDIR creates a new directory (mkdir);
- RD removes a directory (rmdir);
- REN renames a file (mv);
- TYPE displays contents of a file on the screen (more, cat).

Microsoft created the Windows operating system in the mid-1980s. Over the years, there have been many different versions of Windows, but the most recent ones are Windows 10 (released in 2015), Windows 8 (2012), Windows 7 (2009), and Windows Vista (2007). Windows comes pre-loaded on the most new PCs, which helps to make it the most popular operating system in the world.

Mac OS is a line of operating systems created by Apple. It comes preloaded on all new Macintosh computers or Macs. All the recent versions are known as OS X (pronounced O-S Ten), and the specific versions include El Capitan (released in 2015), Yosemite (2014), Mavericks (2013), Mountain Lion (2012), and Lion (2011).

UNIX is an operating system which was first developed in the 1960s, and has been under constant development ever since. It is a stable, multi-user, multi-tasking system for servers, desktops and laptops.

UNIX systems also have a graphical user interface (GUI) similar to Microsoft Windows which provides an easy to use environment. However, knowledge of UNIX is required for operations which aren't covered by a graphical program, or when there is no windows interface available, for example, in a telnet session.

Linux is a family of open-source operating systems, which means they can be modified and distributed by anyone around the world. This is different from proprietary software like Windows which can only be modified by the company that owns it. The advantages of Linux are that it is free, and there are many different distributions or versions you can choose from.

3.2 Software Structure

Like hardware, the software of a computer system has its own structure. The operating system is not a separate object; it consists of many layers with their functions. The levels of the operating system and applications running by users are

considered as unique "tasks" or "processes", competing with each other for the access to the CPU and other hardware resources. The management of this competition through appropriate schedule processes is the primary responsibility of the operating system and can have a significant impact on the system performance.

Software systems consist of many levels or layers. In American society, for example, when you sign a check, when you pay for lunch in a restaurant by credit card, the company which provides credit card services does not care that you pay it for a meal. No details are any longer required. But the process of eating actually consists of several levels. This is the level at which the waiter needs to track your order, to know what food to bring and in what order. For example, the first one is a salad. The details of the preparation of a salad were processed on a different level - in the kitchen, where the chef mixed lettuce with tomatoes and croutons, which came from the outside, as the chef took care of it in advance. However, where does a toast appear from? They are bought from the bakery, where they were made from flour, yeast and spices. Flour came from a flour factory, where it was purchased as wheat and milled. Wheat came from a farmer who sowed the seeds and finally harvested the wheat. When you pay for your dinner, you pay (indirectly) about one-thousandth of a cent (assuming that you pay in US currency) to the farmer for the wheat in your toast. And you pay to thousands of other people who provide your meal in a variety of ways. Fortunately, you do not pay to all these people directly. You only pay for "dinner" and the details are sorted out at the lower levels.

When organizing relatively independent processes in the form of levels or layers, the system can maintain better control and can achieve high efficiency. In computer science principles to ensure these benefits are called encapsulation (encapsulation) and abstraction (abstraction).

3.2.1 Encapsulation and abstraction

Encapsulation (hiding or concealment of sales) means that each layer needs only limited knowledge to carry out its work, and none of the other levels have access to this information. The farmer does not know what wheat is to be used for. The baker does not know how to harvest the wheat. And you do not need to know that your toast contains wheat. In the world of software encapsulation means that your word processing program does not need to know how to manage drives, to open and save files - for this there is a corresponding lower software layer.

The term “encapsulation” in programming means a data hiding algorithm and implementing details from the user or the application programmer. In this case the application programmer is provided only by specification (interface) of the object. In medicine, the term "encapsulated" means "enclosed in a capsule shell, or" in the technical sciences it means –“protected from external influences”.

The term "abstraction" means the allocation of significant, important object properties for their subsequent implementation. In this context it is also interaction between software layers.

However, if the layers have been completely hidden, it would be impossible to communicate with the software layers located above and below. In order to exchange some, not too much information, the designer specifies the abstraction layer (abstraction), supporting them. Bakery supports an abstraction that is called "customer toast", whereby the customer can order X pounds of toast, a bakery fulfills the order and supplies of the toast. The customer does not see what happens inside the bakery. For example, a bakery may have a large and a small oven, and the manager must decide which one to use to fulfill the order. Sometimes, it might make sense to bake two little toasts instead of one large package. Sometimes one or the other furnace is turned off for maintenance. These parts are hidden from the client, just like information is hidden (encapsulated) in computer science terminology. In addition, even if the client knew that there were two ovens, you can not determine which oven to use in carrying out the order, as the order form does not provide a record of this information. In terms of computing we say that the abstraction of the order of toast does not support the choice of the oven.

The existence of clear abstractions for each layer means that the implementation can be replaced by one another without affecting the bottom or top layers. Toasts are sold by many bakeries. If they take one form of orders, it is possible to select another provider at the will. Your computer may do many implementations of software components and can switch from one to another. For example, your Web browser accesses the auxiliary program, when you want to run a sound file or video clip. There are several programs that can perform this function. All you need is to tell the browser which program to use. This division of functionality means that if a new program is available, it is possible to switch to it and there is no need to install a new browser.

3.2.1 Software layers (Layers of Software)

Let's look at the software layers that make up the computer (Table 3.1):

Table 3.1 - Software Layers

User-Written Scripts or Macros
The user interface
Application
Run-time Library
Application Program Interface
Operating System
Kernel
Device Drivers
BIOS

Hardware

Consider the layers from the bottom to the top:

- **Hardware** consists of physical components which make up a computer and is its lowest layer. Surely, there are several layers of hardware: the board contains the chips which include circuits which, in turn, are formed from transistors. However, from the software standpoint, these details are not important.

- **BIOS or Basic input/output system** is the basic layer of software. It deals directly with the signals that control the hardware components. Much of its work is performed when the computer is turned on.

- **Device Drivers** are supporting programs that the operating system uses to communicate with peripheral devices. To add a new device to the system, you must have the appropriate device drivers. Peripheral components are often supplied with a disk containing the necessary drivers. The driver for a hard disk, for example, knows how many tracks there are on the device, and recognizes the command to move to the desired track followed by reading or writing data. The advantage of this is that the seller of operating systems does not need to be responsible for the support of each device which is already developed or is being developed. The device manufacturer supplies the driver operating according to the rules that describe the interaction with the operating system.

- **The kernel** of the operating system is the basis, and performs the most important function. It manages memory, decides which task to perform next, processes the different types of possible interruptions. The kernel must always be in the memory, and because of its specific nature, it should work without protective mechanisms that protect against erroneous commands or illegal memory accesses. Therefore, it should be as small as possible.

- Another part of the **operating system** is much bigger than a kernel. It performs all the other functions of the operating system. For example, it includes the **file system** for managing files and folders on the disc. This level is linked with the kernel, when you need to perform basic operations, such as initializing the operation of data transfer to an external device.

- **Interface Application or API (application program interface)** is the level where the user programs (applications) are associated with the operating system. For example, suppose that the Web browser application decides that it takes more memory to display a large image file. The operating system is responsible for storing information about the programs that use part of the memory at any time. This information is hidden within the operating system; the application does not know anything about how the information is organized in the memory, since this is not necessary. The operating system defines an abstraction for memory management, known as **call API (API call**). All application developers need to know which interface to use to require more **RAM**. If a new version of the operating system supports the use of different methods of memory organization, the application will continue to work so long as the **API call** is the same.

- Library runtime (execution phase of the program library) - a collection of routines that affect the application programs. For example, if you write an application in C to open the file and read the data from it, you will use two standard functions called fopen and fscanf. These functions are selected from the library of I / O routines (I / O), called the stdio, you can use any program in C. They perform the corresponding call the API, for the operating system to do what you need. The header file stdio means that your program does not depend on the set of API calls, so you can run it on any machine that has a C compiler and the C-library. Most programs use subroutines of several libraries during the work. **Application layer** is routines that perform the actual work, for which the application has been created.

- Level of the **user interface** is responsible for communication between the application and the user. This is usually GUI (graphical user interface - GUI), composed of buttons and pop-up menus. Suppose that the user wants the application to open the file. This requires a dialogue which is processed by GUI. First, the user clicks Open in the File menu.. An open dialog box appears and prompts the user to select a file. Once the user selects a file, the GUI sends a request and the application opens the file and processes it.

- **Script (scripts) or macros (macros)** are routines that many applications allow users to create a set of built-in commands. Scripts and macros allow users to automate a sequence of frequently used functions. Example, a Microsoft Excel macro can open the file, copy the file from the group of numbers in a spreadsheet, perform calculations with them and write the results to another file. If these calculations are required every day, then perhaps it would be useful to collect the calculations in the script, which can be performed by pressing a few keys. Thus, the user may forget the details. Scripts are placed above the application layer in the software hierarchy because they are formed at the application level commands.

The computer industry today depends on the specialists in each of the above levels. Some people earn by creating BIOS software, while others concentrate on improving the GUI technology. But a large number of programmers is in the application layer, because people want to use computers for many different tasks.

3.3 Role of BIOS

Most of the course is related to the higher levels of the software hierarchy: file systems, operating systems and applications. But in this section we will look at the lowest level of software - BIOS, or basic input / output system. In BIOS, there are three main functions. It initializes the hardware when the computer starts, loads the operating system and provides basic support for devices such as a keyboard, a mouse, and serial ports (serial ports). BIOS is always present, but it is visible only when the computer is turned on, before the operating system takes control.

When you turn on your computer in RAM, there is no operating system. It is empty. (Recall that random-access memory (RAM) is a fickle memory, when you

turn it off, it loses the data stored in it). BIOS must reside in a different kind of memory to perform its function. Therefore it resides on ROM BIOS chip (ROM) on the motherboard. ROM is read-only memory; it retains data when power is turned off, when the processor automatically starts executing instructions from the ROM. Since ROM is a slower type of memory than RAM, the BIOS on most systems immediately copies itself from ROM into RAM. Then BIOS instructs the processor to take all further commands from RAM.

Another special type of memory which is used by BIOS is CMOS memory. CMOS (complementary metal-oxide semiconductor) is a chip technology, which requires very little energy. Clear the CMOS memory, often only 64 bytes, available on the motherboard (system) board to save the BIOS settings to control the hardware operation. For example, there is a parameter that controls the time it takes RAM to perform sample operations. If you buy a faster DRAM chips for your RAM, you can change the BIOS settings to the controller memory bus used by the highest DRAM speed. CMOS memory is not constant, but its contents after turning off the computer are kept on a special battery on the motherboard. As the battery recharges the motherboard, it can serve for many years; however, if it is disabled, the BIOS will return to the parameters used by the default. Therefore, it is important that CMOS has low energy consumption. The main disadvantage of CMOS technology is that it is slower than regular DRAM, but it does not matter if the memory is only used to configure the BIOS settings, because the content is necessary only during the system start up.

When you turn on the system, the power supply starts to run BIOS, BIOS initializes POST (Power-On Self Test) - a sequence of commands POST. To start, the video card (you will see the screen flicker) displays basic information about the type of video card installed, the name of the manufacturer and version of BIOS. Next, the number of DRAM is specified in the installed system and then a memory test can be performed. In any case, the test is run by BIOS parameters. The memory testing allows the computer with more memory systems to boot fast. Memory configuration and test results are displayed on the monitor. Then, after identifying the expansion cards and adapters, the BIOS initializes them. Finally BIOS POST-sequence displays information about the system configuration, for example, the type of processor installed, information about the cache memory of each type of drives, the addresses of all serial and parallel ports, and a list of other available expansion cards.

Once the POST-sequence is completed, the next task of the BIOS is to download the program, which will launch the operating system. For this BIOS must be aware of the drives to read data portion, which is called the master boot record (Master Boot Record) and MBR. This is the first sector of the first track on the disc. The MBR program loads the operating system and runs it.

Perhaps there are multiple drives in the system where you can load the operating system. Which one should be used? BIOS follows the search order (search order), to find an operating system to boot. The search begins with the

device named A. If there is no disk in the device or if it does not contain the master boot record, it accesses the B drive (the second drive), if it exists. If this fails, then it moves to the device C, which is usually the primary hard drive, and looks for a master boot record there. And so on.

The first check of the floppy-disk drive A is very useful, because in contrast to the hard disk, a floppy disk is a removable tool. So, if you do not want to load the operating system from the hard disk, you need to insert a bootable disk in the drive, and the computer will boot from there. The boot disk is a floppy disk that contains a copy of the operating system for self-loading. If the operating system version on the hard disk is spoiled, you can restart the system using a boot disk. Then you can restore the damaged data to the hard disk.

In modern computers *floppy disks* are not practically used. Instead, CD and DVD, USB, flash drives are used. In some cases, loading is done from the server on the LAN.

The computer loaded with the floppy-disc, CD or DVD cannot be completely safe. Files are usually protected by the operating system to restrict access to other users. But if someone inserts the boot disk into the drive, he will be able to download its own version of the operating system ignoring and denying access to the entire hard drive. The guaranteed protection against this type of attack is encoded disc. Another risk is associated with the boot disks - MBR viruses. These viruses exist in the MBR disk. If someone inserts an infected floppy disc in the disc driver after reading the feeder system, the virus can infect the hard drive.

Some BIOS allow you to change the boot sequence. This is useful if you want the default to boot from CD-ROM, DVD-ROM or LAN server instead of a hard disk. You can also disable booting from a floppy-disk or from CD, DVD, if you care for security.

To change the BIOS settings, you need to run the BIOS Setup Utility during boot by pressing a certain key or a combination of them, for example, F2, F8, CTRL / F8, etc. The starting BIOS message will indicate which key to press. The BIOS boot setup program displays the current BIOS setup and allows you to change it. The new settings are saved in CMOS-RAM and will be valid until the next system boot. Settings need ti be changed carefully, since incorrect settings may cause the computer malfunction.

3.4 Process Management

Another feature of the operating system is maintenance of the sequence of all the processes that are running at the moment, providing each execution with reasonable frequency. The process is a special case of the program. It includes a set of memory pages, a set of descriptors (descriptors) of open files (if the I / O process (I / O)), the process identifier (ID) and others. The kernel maintains a list of all processes in the system. These are programs launched by the user, the various programs operating outside the core operating system features, such as

printing and network support. Each process can be in one of the states: running (running), workable or blocked. Only one process of the CPU can actually operate at one time, although any number may be workable. A locked process is the one that is waiting for some event. For example, the print spooler is locked most of the time and becomes operational when the user selects the Print command, activating the process.

In Windows, when you call the Task Manager (Task Manager), you can see the list of current jobs. A task appearing in the Windows process panel is the application started by the user. *Task ensures the performance of one or more processes. In the UNIX operating system commands ps and top display the process information.*

The kernel maintains a queue (also called a queue of tasks or processes) for execution. A preemptive multi-tasking is used to create the illusion that all the processes are performed simultaneously. Compared to other types of multi-tasking, preemptive multitasking creates the illusion better than the rest. The trick is having a real time clock that can regularly generate interrupts. Timer interrupts let the kernel look at queue for launch and see whether any process can be run right now. If the answer is yes, the process is currently running, unloaded. Its rank changes from the running state to the runnable, and its implementation is noted in the contents of its register, so that the process could be resumed later. Blocked processes also generate these kinds of interruptions, but the answer to the last question for them is always "yes." Then, another process in the task queue is selected to work. If the kernel switches the process with sufficient frequency, it seems that all processes are performed simultaneously. Now you know the secret of illusion!

If the preemptive multitasking is a good idea, then why not switch the processes after each command? The reason is that the kernel does not switch from one process to another; this requires a context switch which requires some time. To perform context switching, the processor must terminate the sequence of commands to save the contents of all registers and load a new page table, etc. This requires a certain amount of expense for each priority interrupt. Therefore, the optimal strategy is to switch context only when it is needed to ensure an equitable service for all processes.

Some applications require multitasking for the performance of their functions. For example, a Web browser needs to create the process for each window to support multiple windows. But running multiple processes is expensive because each requires its own address space in the page table of the descriptor file, etc. Many applications that use multitasking, do not require the process separation. Therefore, the new versions of operating systems include lightweight processes, called streams (threads), which are in the same address space and share the file descriptors.

3.5 Device management and configuration

Another feature of the operating system is control of various I/O devices installed on the computer. Technical control at this level requires interaction between the kernel, device drivers and BIOS. Users can, in some cases, adjust their computer systems precisely by changing the parameters that determine how the operating system or device drivers are turning to external devices.

Interrupt Control

One of the important tasks of the kernel is handling the interrupts. Interruption is a signal to the processor that there are some events that require immediate attention. Often these events are associated with the Input / Output operations, but there are other types of interrupts. The kernel calculates what caused the interruption, and gives an appropriate response. It should act very quickly. To avoid losing information during the next interrupts, each interruption must be processed in less than a thousandth of a second.

To see how to handle interruptions, let's look at how it is done by people. Suppose you are at work, reading a manual. Perhaps this is a documentation of the new software that you bought. After you have read a few pages, the courier apologized for having interrupted you and asked you to sign for the parcel. To respond to this interrupt, you first put a bookmark in the manual to mark the reading place, and then set aside the manual. Now, when your hands are free, you have to sign for the package and put it on your desk to work with it later. Then you again take the manual, open it and continue reading.

The kernel interrupt management is almost the same. That's what happens in response to the keyboard interrupt, every time you press a key. Before you press the button, the processor is busy with some program or something else. Let's say you are using a computer to edit a web page, and the processor is busy with displaying the image file that you have just downloaded. While it is performing, you type "http" characters on the keyboard. As soon as you press the "H", the keyboard sends a byte of data through the keyboard PS / 2 interface on the motherboard. Then the interface has to interrupt the processor and transmit this data byte to keyboard driver. This must be done quickly, before you press the "T", otherwise there is a danger that the next press of the key will be lost.

The keyboard interface processor sends a signal called an interrupt request (IRQ - interrupt request). When the processor receives this signal, it ceases to run an application (a web page editor, in our example), recording the address of the last executed command. Then it goes to the keyboard interrupt handler and starts executing commands that are there. Since the processor registers contain all data manipulated by the user application, the interruption handler must save the contents of these registers before he can use the register for his own purposes. The state of the keyboard interface can be seen after saving the register and it is possible to receive the byte of the incoming data. This byte is placed in memory to be tested by the keyboard driver when it works the next time, perhaps in a

millisecond. Then, the keyboard interrupt handler restores the saved registers and passes them to the previously performed task control (editing application Web page), resuming execution exactly at the point where it was interrupted. All this happens within a few hundred of microseconds; the application does not even know that there was an interruption.

The priority of interrupts and built-in interrupts

Two additional concepts will finalize our discussion on the interrupt.

Firstly, the concept of interrupt priority. Suppose that two people come to your office at the same time, or someone comes first and before you pay attention to him there immediately enters second one. If one of them is an important and impatient customer, and the other is a seller, you first satisfy the impatient customer needs, and the second man is asked to wait. The customer has the highest priority. The processor also assigns priorities to different types of interrupts. Low-speed devices such as the keyboard have a low priority. High-speed devices, such as SCSI disks, have a high priority, since they need a fast response for optimum performance.

Secondly, there is the concept of **nested interruptions (nested interruptions**). Suppose that you are reading the manual, and someone comes to ask you questions. You put the manual aside and listen to the question and then you will take a directory to find the answer. At that time the phone rings - it's another interruption. Then you mark your place in the directory, put it aside and answer the call. The man who is sitting at your desk needs to wait a bit. When your phone call is finished, you take the directory again and finish your answer to the question. Once this is done, and all left happy, you can take your manual and resume your reading. The second interruption was nested in the first.

Interruptions cannot be nested infinitely deep because the interrupt handler can only be interrupted by an interrupt with a higher priority. So, if you are already talking on the phone and someone has tried to contact you, the second opponent would have to wait until you have finished the first conversation. The same Input / Output devices may be rejected in immediate interruption of the CPU, if they have been already handling an interruption with a higher priority.

System interruptions and errors

Trap (trap) is an event of such interruption, except that instead of an external signal, the interruption is run by the processor commands. For example: the division by zero operation. If the user program attempts to divide a number by zero, the execution cannot be performed normally. System interruption of the CPU is like interruption of processing, but without time limit. The trap handler may give an error message and interrupt the user program or another possible way is to install the division command result forcefully - 0 and allow the program to work on. Traps are commonly used for an application to make a request to the operating system. The application makes a request that it wishes to receive data from the

register, and then uses a special interruption command to "listen" to the operating system.

The third type of event which you should know is called an error (fault). An error occurs when the technical means is asking for what can't be done, for example, for access to a nonexistent piece of memory. C programmers use pointers when facing this kind of "nonexistent memory" error until their code is debugged. Errors can also occur when a memory error correction circuit detects a fatal mistake, attempt to divide by zero, or if the program contains erroneous machine instruction. Errors and system interrupts are handled in the same way.

3.6 Hardware Specifications

Driver installation

As discussed above, each device must have a driver in the operating system to control commands, data transmission and error conditions in case they appear. Every operating system defines the interface to be used by the device driver. It means that for the normal operation of each device there must be an appropriate driver to the particular operating system. Even a version of the same operating system (Windows 2000, NT, XP, Vista, Windows 7, etc.), can use the interfaces requiring different drivers. Likewise, a similar product of the same company is likely to require its own driver because of some minor or major changes in the interaction with the software.

Drivers are supplied along with the distributed operating system files or device manufacturers. During the release of the next version of the operating system such as Windows, many of the most popular and well known devices (printers, modems, scanners) have been tested and included in the system. However, less known brands or devices manufactured later than the operating system were not included. That is why each device generally has a disk containing drivers for most operating systems available on the market. If the device has a driver, it is always better to use it than the one which is in the operating system; most likely the driver packaged with the device is recently updated, has better functions in fixing bugs.

The driver accompanying your device will allow you to correctly use it. However, many products can be produced just a few months prior to the sale and there is a good chance to get the latest version of the driver on the website of the manufacturer. Always check the company Web-sites for the presence of more recent versions of the drivers.

When you install a new device under Windows, it is likely to be detected after loading by the automatic installation control mechanism (Plug and Play - PNP). If your device supports PNP, Windows will inform you that the new device is found, and ask you about the location of the driver. The driver can be a part of Windows (Windows distribution disk is needed) file on CD, DVD-ROM or a folder on your

hard disk where you previously downloaded the driver from the Internet. If the correct driver is not found, Windows will not be able to use the device.

If you install the device, and Windows does not recognize it, you must use the wizard for adding a new device (Add New Hardware) to install the device drivers and for their identification by Windows. This wizard allows Windows to search for new devices or manually identify the device. There are several steps involved in the manual installation and the wizard performs the input of relevant information. There is an option to change the driver, "modify" it, associated with the manual device identification. The process is similar to the initial installation of the driver and the disc must have the appropriate files for the update.

Changing the driver configuration

The driver is designed for a particular operation, but it may also include a series of operations for setting its functions for a particular use or environment. Specifications can be changed in accordance with the requirements of the technical means, the system requirements (modem speed, the amount of data in the buffer, used protocols, etc.) and those that focus on the user (the resolution of your screen, wallpaper display, the mode of the mouse operation (lefthanded), etc.)).

Most of the devices and software modules in the operating system that control the resources, have the applet installed in the Control Panel (Control Panel), to enable the user to change the settings. Control Panel is in settings (Settings) in the Start menu (Start).

Others use the Device Manager (Device Manager) to change the driver configuration. You must right-click the icon for My Computer (My Computer), click on Properties (Properties), and then select the Device Manager (Device Manager). The Device Manager provides information about your computer as a whole and the individual hardware components. Choosing a particular device and its properties, you can change the various functions. If you are using Windows NT, you can view (but not change) the majority of settings using Windows NT Diagnostics, you can start by pressing the Program (the Programs) from the Start menu (Start), and then choosing Administrative Tools (Administrative Tools).

Since you became a home computer user and the administrator, all environment settings and user settings are under your control. However, you should be careful when making changes to the configuration of the device or the computer, because they can make the device or the computer as a whole unworkable that leads to reinstallation. The problems that may arise as a result of such changes, in the majority of computers the possibility of making such changes is locked for all users, except for the system administrator.

When you make a change in the system settings, the relevant data must be saved, so that they can be referred to the next time you reboot the system. Operating systems such as UNIX, retain all system configuration in text files, which the administrator can change via a simple text editor. Windows started from the UNIX like a variant, retaining the information in text files (such as,

WINDOWS.INI, SYSTEM.INI, CONFIG.SYS), but later combined all the configuration information (including information applications), located in several binary files that have a common name registry (Registry). The register has its own editor (or REGEDIT or REGEDT32) to view and change information. Due to its encrypted species novice users need to use tools such as the Control Panel (Control Panel), to modify its contents. However, some drivers and resource managers are setting items that cannot be accessed through the Control Panel, and can only be modified directly through the registry.

There are tools to support or restore the registry on a regular basis or before making any changes to the hardware, or before installing new applications on your computer. If the system becomes unusable after installing a new program or making changes through the Control Panel, you can restore the registry to its previous state, to make the system operational again.

3.7 The operating system configuration

The operating system is configured similarly to the lower level of BIOS. Each user operates differently to different requirements and usage styles. A proper operating system configuration can improve the aesthetics, usability and performance. The settings described herein are those of the Windows NT 4.0 operating system, but such features can be in other Windows applications.

The most obvious operating system configuration relates to esthetics. In Windows, users can set perception and view of the desktop and file system. It seems that there are no two identical desktops. You can customize the appearance of icons, the information in the file characteristics, such as file size and type. This is done in the View menu (View) My Computer (My Computer) or the Explorer (Explorer) by clicking the Settings folder (Folder Options). On the desktop directly, you can use a variety of color schemes and graphics positioning. To set the size of the viewing window, the resolution of the monitor, you need to right-click on an empty space on the desktop and then select Properties (Properties) in the shortcut menu.

Menu appears in different places and is self-adjusting. Most menus contain shortcuts buttons, some contain a field where you can enter the Web-links, and even paths to files for quick access to them (right-click on an empty spot taskbar (taskbar), and then select either the Toolbars, or Properties).

Other elements such as styles and font sizes can be replaced by more convenient ones. Some users install large fonts for easier viewing, others like unusual fonts (right-click on an empty part of the desktop, then click Properties (Properties), and then - Appearance (Appearance)). You can select the sound themes, such as the jungle sounds and musical instruments (Open the Control Panel (Control Panel) and select Sounds (Sounds)).

For convenience, users can start with a user startup folder (User Startup Folder), which is the first launch of the folder that appears in the Programs

(Programs) in the Run menu (Start). Program icons, usually shortcuts that are in this folder, will be launched automatically each time a user logs in (log on). For example: users who read mail after login, can place a shortcut in the Start email client folder, and it will automatically start after login. Shortcuts - Form settings, allowing the user to initiate programs and launch files from different locations in the file system (right click on the icon and click on the "Create Shortcut" (Create Shortcut). You can customize the properties of the mouse (open Control Panel and click Mouse (Mouse) and frequency, the keyboard repeat rate (open Control Panel and click the Keyboard (Keyboard). Some users have difficulty double - clicking, they can adjust the speed of double-clicking. Some mouses and keyboards have gone further by allowing the user to assign a specific function key, mouse or keyboard. This functionality is provided by the software suppliedwith the mouse and keyboard.

Specifications can be changed in the operating system. Clicking on the System (System) from the Control Panel (Control Panel), you can select the default search path, the virtual memory settings and other parameters. The search path tells the system where to find the application. Streamlining directories during search may increase the time of search for the executable module. Reducing the amount of the provided virtual memory will mean less memory to open files and running programs, it can also reduce the performance of the system itself. These settings are usually left for experienced users, as well as the default settings are usually optimal for most settings. Even the reduction in the number of display colors and resolution may speed up the process, although not too much, just for games and applications with powerful graphics.

3.8 Distribution of resources

In this subchapter we consider the operating system as a mechanism for allocating resources. Many aspects of the OS operation can be explained by this mechanism. In the course of explaining the distribution of work, this module covers most of the components of a computer system. The computer system distributes not only a lot of internal resources, such as the CPU time, but also external resources, such as access to the hard drive.

Memory Management

Memory management system is an important part of the kernel work. A standard personal computer today has 1 GB or more of RAM (DRAM). A part of it is reserved for the operating system, but most of them are available for user programs. For example, a user launches a Web browser, an editor and a computer game. Each of these programs needs a certain amount of memory, but neither of them needs all the memory. The kernel allocates some memory for each program and tracks which each software uses.

Modern operating systems such as Linux and the Windows provide virtual memory to increase the flexibility of the programs. We will talk in more detail about virtual memory later. To understand why we need virtual memory, we should consider how the older operating systems like MS-DOS worked. In those systems, all programs have worked in a real address space, yet there was no virtual address space.

Programs written in binary machine code contain instructions and data. Both instructions and data contain memory addresses. When you record a program in a machine code (or your compiler translates a high-level language into a machine code), you (or the compiler) must determine the address for each command, and each part of the data. For example, you start from scratch and keep all your commands and data sequentially. Suppose that your program takes a memory address from 0 to 8.462. Someone else writes the programs in the same way, starting from the address 0. Clearly you cannot run two programs that occupy the same memory address at the same time in this circuit. When you download the second program, it will overwrite over the first one.

Forwarding

The method existed before the invention of virtual memory was recording programs in a special way. Any memory location containing the address specifically noted in the binary file (binary file). When a user runs a program for execution, the operating system allocates memory for it in some available space, and loads the program into the memory. It is possible to fix all the specially marked reference addresses to show their actual location. For example, the original program contains a table of information, starting from the memory address 700. The other part of the program, for example, located at 210, includes a table address (the value of 700), specifically noted as containing the address. The operating system loads the program into memory, starting at the address 30,000. This changes the value posted at 30.210 from 700 to 30,700, and so on. This process is called redirection.

This scheme allows a computer to download a variety of programs in memory at the same time, as long as some part of the memory is available. An advantage of this approach is that it is relatively easily done and requires no changes to the hardware. But there are also serious drawbacks. Firstly, because of the redirection, memory which is allocated for the programs must be continuous (contiguous). Let’s suppose that a user performs 6 small programs at the same time. After that some of the programs have stopped to work, program 1, 3 and 6 were working. Now the user wants to perform a great app, but, unfortunately, there is no place to put it now. If the application cannot be downloaded to the place which is used by program 2 or program 4 and 5 together, it cannot stay in memory, even though the total number of nonadjacent (noncontiguous) free memory blocks can be even more than necessary.

Another disadvantage of this approach is that the size of a running program is limited to the amount of physical memory installed on the machine, minus additional space that the operating system has reserved for itself. But large programs generally do not use all their memory directly. A program with a larger address space may only need to refer to several thousands of teams and several thousand bytes of data at a time. It would be more efficient to distribute only a small portion of RAM at a time for such a program and to keep the remainder of the address space somewhere else, such as on a disk. That is what allows you to make virtual memory.

Virtual memory

In the virtual system of memory each program works in own address space. Therefore when the program boots in memory, there is no need for any readdressing. The virtual address space may be larger or smaller than the physical memory of the processor. Besides, in order to make this scheme work, the virtual memory needs the hardware support. First, memory is divided into parts under the name of the page (pages). The page is the smallest part of memory which can be distributed under the program. On the Pentium platforms a page makes 4 Kbytes. Secondly, the processor must be able to convert virtual addresses into real.

Processors that support virtual memory, such as Pentium, can operate in two modes. In the real mode addresses correspond to physical addresses of cells in a random access memory. Only the kernel has the right to work in a real mode. In the virtual mode, each address is converted to a physical address of a memory cell using a page table. For each page in the virtual address space the page table gives the actual address of the page in the random access memory.

Let's see what happens to the hypothetical program described above. This program will work in its own virtual address space, starting at the zero address cell. When the processor loads the program into the random access memory, starting at 30,000, it sets an input of the table of pages for the page value 30,000. When the command loads the address of the virtual location that is equal to 210, the address translation scheme of the processor actually causes data loading from physical location 30,210. The value read by the memory cell located at this address will be 30,700 (you remember, the cell address 210 contains the table address, that is – 700), the virtual address of the table. If another command then tries to address the table, using this 700th address, the mechanism of address translation will interfere again and will turn the link to the address 30,700. The user program works only with the virtual addresses; it has no idea in what part of physical memory it is executed. When the processor is in the virtual mode, the address translation happens all the time. Each link is translated. It occurs very quickly because the transfer happens directly in the microprocessor chip.

Within the scheme of virtual memory each program has its own table of pages supported by a kernel. And the physical memory distributed under programs shouldn't be continuous. The table of pages of our hypothetical program can tell:

"Zero page begins from the real address 30,000; the first page begins from 34,000; the second page begins from 62,000 and so on". The user program has no idea that it is scattered in physical memory because it lives in the virtual world and cannot see the real addresses.

With small effort, with the help of technical means, we can go in this scheme one step further and completely separate the virtual memory of RAM. For example, we do not want to load the whole program in the random access memory directly, we load only a couple of pages. For those pages that we do not want to load, we place a special marker in the table of pages which reports: "This page is not in the random access memory". The user program is launched, and it forces memory to address the zero page which translates perfectly. The memory refers to the first page, and the processor looks at the table of pages again and finds the corresponding physical address. Then the program refers to a memory address which gets on page seven which we did not load in the random access memory. The scheme of address translation scans the page table, finds the marker "Not in the random access memory" and the page fault generates an error. It is a type of interruption. The processor interrupts execution of the user program and provides control to the kernel. The kernel looks at certain registers of the status to clarify from where there arrived the absent pages and says "This process wants access to its virtual page seven. I will select some random access memory and I will load in it the seventh page of the program. Now I will correct the table of pages and I will give the program a chance to continue execution". Then control returns to the user program, and the program proceeds as if nothing unusual happened.

User programs with hardware support pages actually live in the virtual world. They do not know not only which parts of memory are used, they do not even know which pages are in memory now, and which are on the disk! Every time when the process tries to refer to the page on a disk, the page moves to the random access memory. And if the process does not address the page yet, it can be moved back to the disk. Providing the virtual storage, we provide to the user the programs with pure abstraction of memory. They don't need to worry about sharing the address space with an operating system or other applications. They don't need to worry about that how much physical memory the machine has. They have the continuous virtual address space, and can use it as they like, and the kernel cares of implementation details.

The disadvantage of using the hard drive for virtual memory is that the hard drive can be occupied so that access to other files is postponed. For systems which provide frequent addressing files and use the virtual memory, it is possible to place the swap-file (the file containing all virtual pages of memory) on a separate device.

3.9 Shared use of files and printers

Files and printers are computer resources which are shared in the network environment, allowing many users to address one device, file or printer remotely.

Files can be shared by applications, for example, when the diagram is created in Excel that is connected to the Word document. Files can be also shared by users on a network. But some files need to be held closed so that other users could not address them. For this purpose the operating system defines a set of access rights (permissions) for the file or the directory. These permissions, also called Access Control Lists - ACL, define who can read, write or execute the file. The read access allows the user to read the file. The write access allows the user to change or delete a file. The execute access allows the user to execute a special system of operations, such as directory browsing or program execution. In the Windows NT, you can look at access rights to the file, right-clicking on the file icon, selecting Properties from the shortcut menu which appears when clicking the Security tab.

Printers are shared by applications, users and computers. When it is necessary to print a file, it is transferred from a part of the operating system called the print server which maintains a queue of print requests. The server processes the requests one at a time. As soon as requests come, they remain on the process disk, known as spooling. Spooling provides at the same time operation with the peripheral device (printer) and swapping of data. Spooling allows the process which gave a print request, to move on to other tasks; it should not wait for completion of the document printing. If the print server allows communication on a network, then requests of the printing can be accepted from other machines. A common example is a computer laboratory where all computers share a single print server. It is more effective than installation of a separate printer for each machine.

3.10 File systems

File system is an abstraction providing data structure on the drive, for example, on the hard drive or an optical disk. The operating system of the computer controls file systems. This section highlights how files in the Windows operating system are organized and also how file systems work.

File organization

One of the main functions of the computer is storing and retrieval of information. Information is stored in one or more "files" which, in turn, are organized in "folders." The Microsoft Windows file system supports four types of objects: files, folders, and shortcuts to the devices. The Figure 3.2 below illustrates how to set up user files of the Windows operating system.

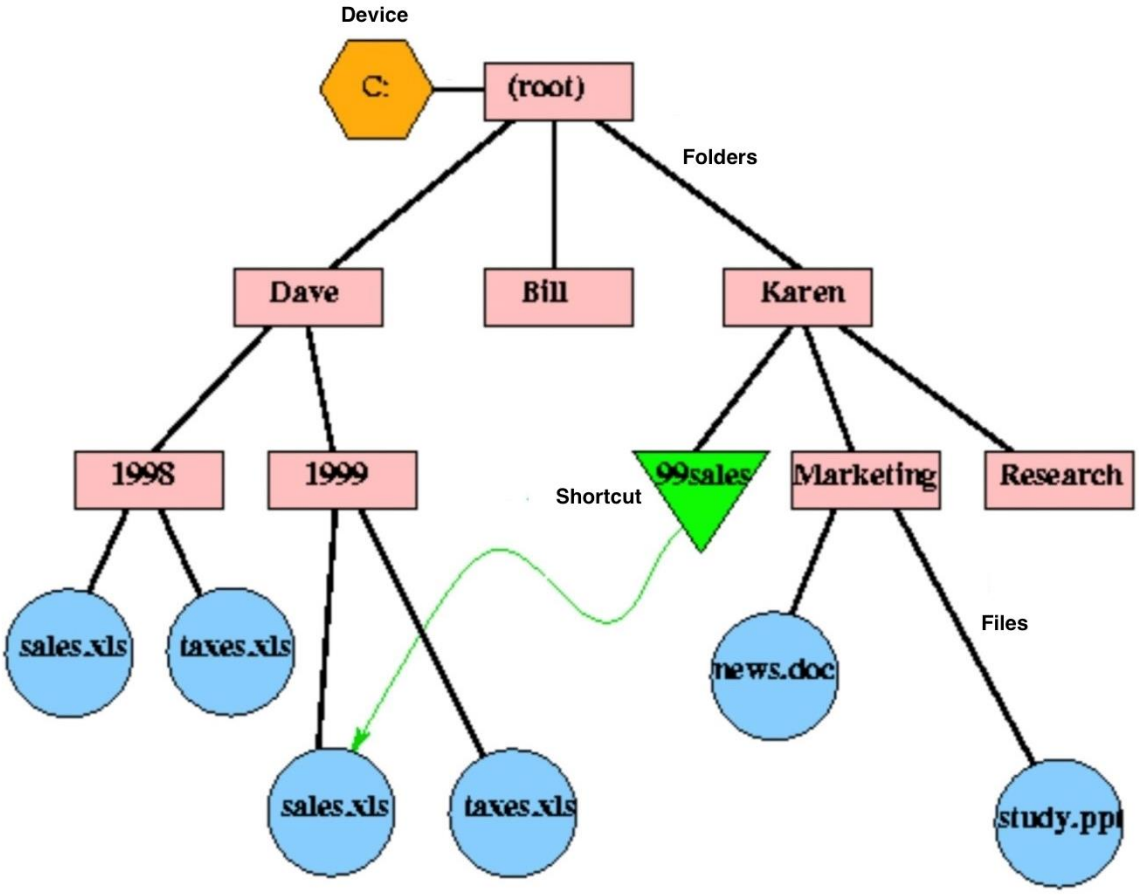

Figure 3.2 - Organization of files in the Windows operating system

Files

Each file contains some data. When the file is connected to a certain application, for example, Microsoft Word, Word, Excel or Power Point, it is usually called a **document**. Each file has a name. In Windows file names can be up to 255 characters long and may contain letters, digits and certain special characters, including intervals. Though Windows allows using both the upper and lower case in a file name, the distinction is ignored by the file system. Therefore if you create a file called *Friends*, you can also address it as friends or *FRIENDS* or even *fRiEnDs*. Other operating systems, for example, Unix/Linux, are sensitive to the register. In these operating systems the *Friends.txt* and *friends.txt* files are different files.

Each file also has a related property set. The most important property is the file type which specifies to the operating system what application needs to be used for operation with this file. Other properties include the size of the file, the date and time of the file creation, time when the file was last modified. You can look at the properties of a file, having right-clicked on the icon of a file and having selected Properties from the pop-up menu. If you have access to Windows, try to

make it. Another method to see the file types and sizes is to come into the View menu in the Folder window and to click Details.

Note. In the Windows XP for the same purposes it is recommended to select the Table. Besides, using the Choice of Columns menu item in the table, it is possible to customize the additional information display system (the author of the document, attributes, etc.).

Folders

Files permanently are in folders which sometimes are called directories. Folders have names and properties. And like files, each folder takes its own location: it settles down in another folder called its parent. It provides a file system with hierarchical structure, like a family tree. Therefore the term "parent" is used. Another good analogy is the chart of the organization of the company where each worker has the principal, except for the president on the top. The peak of a folder hierarchy is called the root.

The file system will not allow two elements to have the same name in the folder. You can check it, having created two files in your working folder with the names *file1* and *file2*. If you then try to change the name *file2* to *file1*, you will get an error message, and the change will not be made. In the figure above, there are two files with the names *sales.axles*, but they are in different folders.

Devices

Folders are placed on the computer. The computer can have many drives – the disk drive A, the disk drive C, the disk drive D, the device E, etc. The only way to address drives is double clicking the My Computer icon on your Desktop. This icon is usually located in the upper left corner of the desktop. After double clicking on "My computer" icon, you will see that each device is marked with an icon that indicates the type of agent that uses the device. For example, an icon of a hard drive – the image of a hard drive, and an icon of the optical device – the image of CD ROM. Clicking on the icon for the drive will puts you in the root directory of the device.

Paths

Also, as elements in different folders may have the same name and folders can be nested in other folders, we need to instruct the operating system or application on any object (file or folder) we refer to. We can specify the full path to the object from the root directory. In the sale file in the figure above, you can find this way C: \ Dave \ 1998 \ sales.axles. As you can see, the path contains the drive name, and the sequence of the folder names, separated by a backslash (\), and then, if we refer to the file, specify its name. The path to the root directory on the device is C: \. You can specify the Windows, to display the full path in the title list in the View menu box, select Options. Then, on the View tab, select the check box. *Display full paths in the title bar*.

Shortcuts

A shortcut is an alternative path to a file. Shortcuts are named and "live" in folders as well as files. But a shortcut does not actually contain any data. Instead, it has the ability to specify the path to the file where you can find data. This file is called the target shortcut. The target can be anywhere, even on a different device. The shortcut only refers to it; it is not a copy. However, when you open and edit a shortcut, you actually edit the file referenced by the shortcut.

In the upper figure of a folder hierarchy, Karen set a shortcut to data on Dave's 1999 sales. The addressee of this shortcut is C:\Dave\1999\sales.xls. Karen's shortcut is called 99sales. So you can reach Dave's file in another way - through the C: \ Karen \ 99sales. If Karen removes its shortcut, the destination is not deleted, Dave's file stays where it is. Moving or renaming a shortcut also has no effect on the recipient. But if Dave moves or renames a sales file, the shortcut that Karen has created would not be able find Dave's file.

Shortcuts can specify folders as well as files. To create a shortcut, right-click the mouse on an icon of the addressee file or folder and select "To create a shortcut" from the pop up menu. Note, that you cannot create a shortcut to another shortcut. If you try to do it, then receive a shortcut to the address of the first shortcut – the same effect, as when copying the first shortcut. Try to create your own shortcut and look at its properties.

Names and types of files

In the original file system of DOS used in early Windows versions, the names of files were restricted to eight uppercase characters plus the three-character extension separated by a point. Sometimes such style of file designation is named *style 8.3*. Extension defines the file type. For example, the list of purchases saved as a text file can be named SHOPPING.TXT while an abstract created as a Microsoft Word document, perhaps would have the name RESUME.DOC. Below is a list of extensions to the basic types of files (Table 3.2).

Table 3.2 - File extensions

.txt	Text file
.doc	Microsoft Word document
.htm	HTML (Hypertext Markup Language) document
.xls	Microsoft Excel table
.gif	GIF (Graphic Interchange Format) picture
.jpg	JPEG (Joint Photographic Experts Group) picture
.wav	Audio file
.exe	Executable file (binary code)
.com	Executable command MS-DOS
.drv	Driver (for peripheral device)
.bat	Batch (script) file for the DOS command interpreter

In recent versions of Windows, information about the file type extension is detected automatically. If you double-click a file with the extension .doc, it will open Microsoft Word; the extension .htm file will open the browser (e.g., Internet Explorer or Mozilla Firefox). Newer versions of Windows are usually hidden from the user's extension. For example, if you create a Word document named Wedding_Invitation under Windows NT, the actual file name will be Wedding_Invitation.doc, but the file icon will be called Wedding_Invitation. However, you can configure Windows to see file extensions. In the drop-down menu View, click Options, View tab, and uncheck the item "Hide extensions for known file types». Now, the icon will be Wedding_Invitation.doc.

If you try to open the file which extension Windows does not recognize, Windows will display a dialog box near the application and will allow you to select one of them for opening the file. Not all these applications will work with this file; you need to specify the suitable application. If you do not know what is in the file, then opening by a simple text editor like Notepad will allow you to see whether the file is readable.

3.11 File Allocation Table and NT file system

Disks are divided into tracks and sectors, as shown in the figure below (Fig. 3.3).

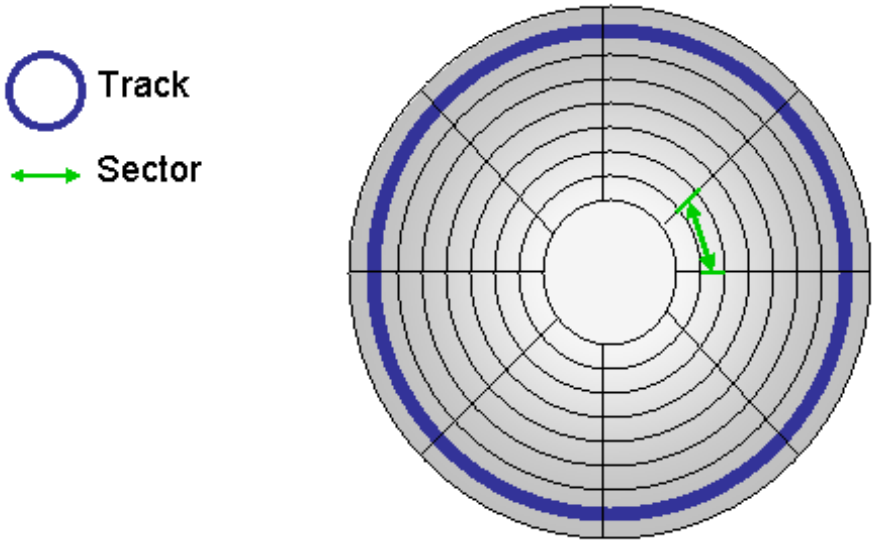

Figure 3.3 – Tracks and sectors of disc

Sectors contain a fixed number of bytes, usually 512. The one or more sectors are used to save the file. If the file contains only one or two lines of text, they will be placed in the segment of one sector. In this case, no residue of the left sector is used. The unused portion is called the slack space. If a file is large, possibly tens of millions of bytes long, it does not even fit on a single track. It requires thousands of sectors, a plurality of spaced tracks. Since the disk space can be hundreds or

even thousands of files and each needs one or more sectors, there is needed some resource utilization registration system. File systems differ in how they solve the problem of registration, but the basic principles are similar.

Since the sectors are small, modern computer systems group them into clusters and read or write the entire cluster at once. A cluster is the smallest size that the file may take on the disc. A cluster contains 4, 8, 16, 32 or 64 of adjacent sectors (the number is divisible by 2). Selecting the size of the cluster depends on the volume of the device, the larger the device, the larger the size of the cluster. A small portion of the disk is reserved for the file allocation table (FAT). For each cluster, which is a part of a file, FAT provides the number of the next cluster of the file. Thus, the clusters that make up the file are linked, so if you know the address of the first file cluster FAT, you can find all the others, following the chain. FAT Entry for the last cluster in a chain contains a special marker to indicate the end of the chain.

FAT16

In the early Windows versions and in MS-DOS which preceded Windows FAT used 16 bits (two bytes) on each cluster which allowed in the total 2^{16} or 65,536 of clusters. Now this scheme belongs to FAT16. As devices on hard drives became big, there arose the problem – FAT was too small to contain all available clusters, and allowed sections only up to 2GB. The following computation shows how the section limit in 2GB was received: 512 (2^9) bytes in sector * 64 (2^6) sectors in a cluster * 2^{16} clusters in FAT 16 = 2^{31} bytes = 2GB. Besides, small files with big clusters contain more unused gaps in a clustered file system, uneconomically using the place on a disk which could be used for additional files. For example, there are many files, 1000 bytes in size or less, but the section in 2GB in FAT16 will reserve 32KB of a disk space for each of such files: 512 (2^9) bytes in sector * 64 (2^6) sectors in a cluster = 32768 (2^{15}) bytes = 32KB.

One solution using the FAT16 hard disk that contains more than 2GB, is dividing the disk into multiple logical disks, such as C, D, and E - each with its own FAT. It works, but forces users to distribute files across multiple logical devices, even if they do not intend to do so. Also, if one logical disk is completely filled, no file on this logical disk can increase even if there are enough places somewhere in another part of the disk. Finally, some applications, such as a database require huge files, and even a complete FAT16 section may be insufficient, although generally discs can have enough memory.

Note. Nowadays, FAT16 has only historical interest and is not practically used.

FAT32

To solve these problems, Windows 9x/2000/XP supports FAT32file system. In this system there are 32 bits (4 bytes) for identification of each cluster, but the first 4 bits are reserved. Therefore, in the end perhaps $2^{(32-4)} = 2^{28} = 268435456$ clusters are possible. The FAT32 file system can be used instead of smaller

clusters of the large FAT16 cluster. This leads to a more efficient allocation of files on a FAT32 drive. FAT32 can support drives up to the size of two terabytes.

Note. Nowadays, FAT3, as FAT16 is not practically used.

NT (NTFS) File system

The modern NTFS file system (New Technology File System), is used in Windows 2000/NT/XP/7. In the NTFS the size of a cluster changes depending on the size of the logical disk. The cluster size is automatically defined by the NTFS format utility, thus it provides necessary flexibility. This flexibility is impossible in FAT16 or FAT32. These features of NTFS allow to distribute the disk space more effectively.

One important feature of the NTFS is recoverability. NTFS supports data sequence using journaling, keeping a record of each input / output operations (I / O), which changes the file system on a logical drive. If there is a failure in the system, a file structure can be restored on the basis of the history of I / O operations performed on the file system. Another feature of the NTFS on Windows 2000 / XP is the encoded file system (EFS). EFS allows encoding the data during saving to the disk. NTFS also supports access control to data and the right of ownership to restrict unauthorized access to data in a multiuser environment.

The table below compares the NTFS and FAT file systems.

Table 3.3 – Comparing *NTFS and FAT*

	NTFS	**FAT32**	**FAT16**
Operating system	Windows XP Windows 2000 Windows NT	Windows XP Windows 2000 Windows 98 Windows ME Windows 95 OEM Service Release 2 (OSR2)	All versions of Microsoft Windows DOS
The maximum volume size*	2 TB	32 GB	2 GB
Files Volume	~ 4 billion	~ 4 million	~ 64,000
Maximum file size *	2 TB	4 GB	2 GB

* The values refer to the limited size during the period of implementation.

Note. FAT32 supports volumes with the capacity ranging from 2 GB to 2 TB. Working under control of Windows XP, FAT32 can format volumes the size of which does not exceed 32 GB.

3.12. Application software

Applicationsoftware is a set of programs designed to create a specific information system. It is intended for the solution of specific tasks of the user or the organization exploiting the computing process or an information system in general. It consists of *application packages (AP*) that implement the designed operating model of the real object.

Application Packages

Currently, there are different APs in terms of functionality and implementation methods.

An application package is a set of programs designed to address a specific class of problems (functional subsystem, business application).

The following types of AP:

- general purpose (universal);
- the method-oriented;
- problem-oriented;
- global networks;
- organization (administration) of the computational process.

AP of General purpose is designed to automate the development and user's execution of the functional tasks and information systems in general. This class includes:

- text editors (word processors) and image editors;
- spreadsheets;
- database management system (DBMS);
- integrated packages;
- case-technology;
- expert system shell and artificial intelligence systems.

The AP designed to create and edit texts, documents, graphics, and illustrations, is called the editor. It is necessary for the workflow automation within the company.

Editors in their functionality can be divided into text, graphics and publishing.

Text editors are designed to handle text and perform mainly the following functions:

- posting text in the file;
- inserting, deleting, replacing characters, lines, text fragments;
- spell checking;
- text formatting;
- alignment of the text;
- preparation of tables of contents, breaking up the text on the page;
- search and replacement of words and phrases;
- inclusion in the text of simple illustrations;
- printing text.

The most widely used text editors are Microsoft Word, OpenOfficeOrg, LibreOffice, and others.

Graphic Editors are designed to handle graphics-intensive documents, including diagrams, illustrations, drawings, tables, and perform the following functions:

- controlling the size of shapes and fonts;
- movement of figures and letters;
- formation of any image.

Among the most famous graphic editors one can name Corel DRAW, Adobe PhotoShop and Adobe Illustrator packages.

Publishing systems combine the functions of text and graphic editors, have advanced formatting strips with graphic materials to be printed. These systems are widely used in publishing and typesetting systems. The most popular systems are the products of Adobe PageMaker and Ventura Publisher Corel Corporation.

Spreadsheets. AP is a name of the spreadsheet, designed for table processing.

The data in the table is stored in the cells located at the intersection of rows and columns. The cells can store numbers, formulas and character data. Formula values are set dependent on the contents of other cells. Changing the contents of a cell results in a change of values in the dependent cells.

The most popular spreadsheets include products such as Microsoft Excel, Lotus Notes, Quattro Pro, and others.

Database Management Systems. To create a database of information inside the machine people use special AP, the so-called database management system.

The database is a collection of interrelated data organized in a special way into sets stored on disk.

Database Management includes data entry, editing and manipulation, i.e., adding, deleting, removing, upgrading, etc. There have been developed database applications to ensure independent work with them on the specific organization of database information. These organizations are distinguished as network, hierarchical, distributed relational databases.

Most distributed databases are Microsoft Access, PostgreSQL, MySQL, MS SQL, FoxPro, Paradox (corporation Borland), and the Oracle database company, Informix, Sybase, and others.

Integrated packages. An integrated package is the AP which combines the functionality of various software components of general use of AP.

Modern integrated AP may include:

- a text editor;
- a spreadsheet;
- editor;
- a database;
- a communication module.

Also an integrated package may include additional modules, such as exports and imports from and to the file system, a calculator, a calendar, a programming system, etc.

The integration of the various components into a single system is provided by the unification of the various data formats and provides the user with undeniable advantages in the interface. However, increasing the RAM capacity may negatively affect the computer performance.

The following packages can be identified from the available systems: Microsoft Office, Framework, Startnave and others.

Macros

Software systems usually provide input and control methods that can help users to accomplish their tasks quickly and efficiently. The following applications will help you to gain some hands-on experience using features of software tools to increase productivity.

If you use such applications as word processors or spreadsheets, you may notice that there are certain operations that you do quite often when working with documents within these applications. For example, if you create reports using a word processor, you may need to create a header with your name and today's date and footer with the page number. This type of operation requires you to select certain functions or make choices within the word processor's menus, as well as typing some information from the keyboard. If you use an application that supports macros, you can have the application "record" of your actions with the keyboard and mouse, and refer to them later for "playback." The recorded sequence is called a macro. The application will use the macro to simulate your inputs and perform the desired actions when you ask.

The advantages of a macro are:

- It can reduce the amount of time required to create a document.
- It can reduce the chance of entering erroneous data.
- It can simplify a complicated set of interactions, so that other people can perform the operation without understanding all the details involved in the application interface. You can even place the name of the macro on the application's menu or toolbar, as if you create a function that is not provided by the application's developers.

Macros do not necessarily record your inputs directly into a data file. Instead, a brief computer program is created that interacts with the application to perform the desired actions. (Sometimes this is done in an application-specific macro language, but Microsoft applications use Visual Basic to implement macros). When you "execute" a macro, you are in fact running this program within the application. Unlike other programs that you run on your computer, a macro program has only meaning while running the application used to create it.

A consequence of macros actually being small programs is that documents that you typically think of containing only data can actually contain both data and

embedded programs. If someone gives you a document containing a macro, and you open the document and execute the macro, the macro could turn out to be a virus designed to harm the data on your computer.
The steps typically involved in creating a macro are:

- Activate the "create macro" function of the application.
- Give the macro a name so that you can refer to it later.
- A small window will appear on the application indicating that the macro is recording. Start performing the keyboard and mouse interactions for the operation to be recorded.
- Click on the macro window and stop the recording when you have done.

The only step required to execute a macro is invoking it. This is done either by selecting it via a menu using the mouse or via a key sequence known as a "shortcut." Shortcuts, if available, are normally established at the time the macro is created. If you use the menu selection method, click the name of the macro that you want to execute.

What about actions you perform frequently through the operating system's user interface, such as copying all word processing and spreadsheet documents from different folders to a CD disk? Is there a way to automate these actions so that you do not have to repeatedly point and click on various menus and dialog boxes? These actions can be simulated on the operating system by using something called a "batch file" or a "script." Unlike macros, there is typically no way to record a series of actions into a batch file; instead, you must create the batch file with a text editor. Batch files are actually small programs that use the operating system's command-line interface.

Example of creating a macro in MS Word:

Macro facilities are typically found in more sophisticated application software. For example, Microsoft Word supports macros, while the text editor Notepad does not. This learning exercise leads you through the steps involved in creating and executing a macro using Word. If you do not have Word on your computer, try to find another application that supports macros and performs similar actions.

- Start Microsoft Word. On the **Tools** menu, click **Macro** and then click **Record New Macro**.
- The **Record Macro** dialogue box will appear. Type "ICTmacro" in its **Macro name** box. However, do not type the quotation marks. (Note that the **Record Macro** dialog box allows you to assign a keystroke shortcut to the macro or to assign the macro to a menu. It also allows you to specify whether the macro is just for the document you are creating or for any document. If the macro is created to be shared by other documents, it would be placed in a library of macros available for use by other documents. However, we will not use these features as part of this learning exercise.) Click **OK**. You will see the small **Stop Recording** window with buttons for pausing and stopping the recording

process appeared on the desktop or on the Word toolbar. If necessary, this window can be moved to different locations on the desktop.

- Suppose, we want to create a macro that consists of your name, the class name, and today's date. You might want to include this information at the beginning of each exercise. Type your name, press ENTER, type "ICT Exercise", and then press ENTER. On the **Insert** menu, click **Date and Time...**, and then select an appropriate format from the **Available formats** box.
- Click the square button of the **Stop Recording** window to stop recording the macro. Create a new document by clicking **New** on the **File** menu or by using the **New** icon on the Word toolbar.
- To execute the macro in this new document, on the **Tools** menu, click **Macro** and then click **Macros...**. Select "ICTmacro" from the list of macros; then click **Run**. You should see the result of the macro appeared in the new document.
- If you want to view the program (that is, the macro) which was created during the recording process, on the **Tools** menu, click **Macro**, and then click **Macros...**. Select "ICTmacro" from the list and click **Edit**. The **Microsoft Visual Basic** window will then appear displaying a sequence of Visual Basic programming language statements, which is the macro you have just created. You will have to close the **Microsoft Visual Basic** window to proceed.
- To delete the macro you have just created, on **Tools** menu, click **Macro**, and then click **Macros...**. Select "ICTmacro" from the list of macros, and then click **Delete**. Click **Yes** when Word queries you about deleting the macro, and then close the **Macros** box. Finally, close Word, and do not save any of the documents you have created as part of this exercise.

Batch Files

Like Macros batch files automate tasks. The term batch file originally meant non-interactive. In early computer systems, users submitted programs on decks of punched cards, which were collected into batches and run. The output was then printed and returned to the users. As operating systems developed further, batch processing included a scheduling function, whereby the system chose which job to run next based on priority level and resources required. It was also possible to specify that a job should run at a particular time of a day (for example, backup disk at night), or repeatedly, such as a weekly inventory report or monthly payroll processing at a company. The central idea, though, was that batch programs were self-contained and did not rely on user interaction.

A batch file under Windows or a "shell script" in UNIX performs a similar function. It consists of a sequence of commands to run programs and manipulate files. It is possible to construct completely autonomous batch files that require no user interaction to run, but this is not strictly necessary. The DOS command-line processor, which executes batch files, is provided for some simple forms of user interaction, as you will see.

A batch file under Windows is a plain text file (not a Word file), with the extension .BAT. A batch file contains DOS commands and names of programs to execute. The file may also contain flow control commands that give the command to processor to loop (repeat certain instructions) or to handle error conditions in a particular way.

A common use of batch files is to write new commands. For example, here is a batch file SWAP.BAT that swaps two files by renaming them:

- REM Here is the source to SWAP file1 file2
- @ECHO OFF
- REM Remember that / precedes a switch.
- REM Use HELP DEL or DEL /? to find out about /Q
- DEL/Q TEMP
- MOVE %1 TEMP
- MOVE %2 %1
- MOVE TEMP %2

The notation %1, %2, etc., refers to the arguments to the swap command. If the user types "SWAP A.TXT B.DOC" to the command line, then SWAP refers to a new command defined by our batch file, and while the batch file is executing, the %1 is equivalent to A.TXT, and the %2 is equivalent to B.DOC. It is also possible to introduce named variables in a batch file, such as %NAME%, by using assignment statements.

Creating a batch file is actually a type of programming using a "language" that is very limited. One unusual feature of this language is that a syntax error in one line does not stop the execution of the file. If a syntax error is encountered, an error message is displayed and the batch file continues the next command. This could have unintended consequences. Just as with other types of programs, it is important to test a batch file thoroughly before using it in any critical application.

Commands

The following is a list of command-line features commonly used in batch files:

rem remark

This designates anything that follows the rem command on the line (remark in our example) as a comment.

echo message

This command displays message to Standard Output. The echo command can also be used with output redirection to send a message to a file. For example, echo starting stage three.

echo

Notice the period (.) at the end of the echo command. This is a special variation of the echo command which displays a blank line to Standard Output.

@echo off

This stops commands in the batch file from being displayed to Standard Output. By default, each line of text in the batch file encountered by the command processor is displayed to Standard Output. While this default mode is useful for debugging purposes, the resulting display often confuses users, so most commands written as batch files begin with @ echo off.

pause

This command interrupts the execution of the batch file and displays the message "Press any key to continue...." Execution resumes when a single keyboard key is pressed. This command is useful if you want to make a batch file stop and wait for the user to perform some action (such as inserting a floppy disk) before it continues executing.

: label

Any line in the batch file that starts with a colon (:) is considered a label. Labels are used by certain flow control commands to repeat or skip over certain lines in the file. After the colon (:), provide some appropriate name as the label name. The name should not contain any embedded spaces.

goto label

This command causes the command processor to execute the first command line after the label referenced by the command.

if exist filename command

This command evaluates the current working directory for a file or subdirectory. In the example above, if the statement is true (that is, if a file named filename exists), then the command (command in our example) is executed. Therefore, a command that reads if index.html del index.html exist determines if a file named index.html exists and, if it does, deletes it.

CASE-technologies

CASE-technologies are used to create complex information systems which are usually required for project teamwork, which involves a variety of specialists: project managers, systems analysts, designers, architects, testers and programmers.

CASE-technology is a collection of automated information system development tools, including the methodology of domain analysis, architecture design, programming, testing and operation of the IT (information tools).

IS CASE-technologies are used in all phases of the system development life cycle (from analysis and design to implementation and maintenance), greatly simplifying the solution of emerging problems and reducing risks.

CASE-technology allows you to separate the design of the information system of the actual coding and implementation process: the system designer is designing at a higher level, without being distracted by the details. This makes it possible to identify risks at an earlier stage of development and get better software products. This technology covers all stages of the development of IT focusing mostly on the analysis and design phases.

Often, the use of CASE-technologies is beyond the scope of design and IP development. The technology makes it possible to optimize the model of organizational and management structures of companies and allows them to better perform tasks such as planning, financing, training. Thus, CASE-technology makes it possible to produce a radical transformation of the company, aimed at the optimal implementation of a project or an increase in overall business performance.

Project teamwork involves the exchange of information, control over the execution of tasks, tracking changes and versions, planning, communication and management. The implementation of these functions is based on the most common project database, which is usually called a *repository*. In essence, a repository is an information archive which stores information about the processes, data and relationships of objects in your application.

In various CASE-technologies a repository is implemented in different ways and may contain descriptions and a data model as well as their processing rules. A repository is a critical component of the CASE toolkit and is the source of the information needed to automate the construction of the designed systems and generated applications. In addition, CASE-based products allow developers to use the repository to the project and other tools, such as rapid programming packages.

Currently, CASE-technology is one of the most dynamically developing branches of computer science, bringing together hundreds of companies. The following CASE-technologies are available in market:: Application Development Workbench (ADW) company Knowledge Ware, BPwin (Logic Works), CDEZ Tods (Oracle), Clear Case (Alria Software), Composer (Texas Instrument), Discover Development Information System (Software Emancipation Technology), Rational Rose.

Modern CASE-technologies have been successfully used to create different IS classes: banks, financial institutions and large corporations. They usually have a relatively high cost and require extensive training and a radical reorganization of the whole IS process. Nevertheless, the economic effect of the use of CASE-technology is very significant, and most of today's major software projects are implemented with their help.

Integrated development environment (IDE) refers to a type of software application that provides computer programmers with inclusive facilities for developing software. This is also known as an interactive development environment. An IDE contains the following features: an editor for source code, a debugger, and tools for build automation. Certain IDEs also come with an interpreter and/or a compiler. More modern versions may contain an object browser, class hierarchy diagram, and a class browser. While there is a difference between an IDE and a software development environment, this boundary is often unclear.

Overall, the IDE is meant to make programming a more productive process because it contains a single program for all processes of development. The

components of an IDE have homogenous user interfaces for maximum efficiency. Furthermore, an IDE is intended to decrease the amount of configuration that is necessary for the developer to place many utilities of development together. Because all of these capabilities are placed together in the IDE, the development of software is much faster and more efficient.

While many IDEs have one specific language for programming, others provide support for multiple languages. There are also IDEs that are text-based, although most modern versions are graphical. IDEs are generally required for visual programming. IDEs that are visual in nature allow the creation of new applications through building blocks, moving programming, or code nodes. IDEs have also begun to move to an online format that functions within a web browser. This is due to the increase in cloud storage and computation via the cloud.

Expert Systems (ES). Constantly increasing requirements to the means of information processing in the economy and the social sphere have stimulated computerized solutions to heuristic (non-formalized) problems such as "what if", based on the experts' logic and experience. The basic idea in this case is to move from strictly formalized algorithms prescribing how to solve a problem to the logical programming with an indication that needs to be solved on the basis of the knowledge accumulated by specialists of subject areas.

The basis of the expert system is a knowledge base which is laid for the given subject area. There are two basic forms of knowledge representation in ES: facts and rules. Facts capture quantitative and qualitative indicators of the phenomena and processes. Rules describe the relations between facts, usually in the form of logical conditions, linking cause and effect.

To solve the problems of this class there are used the so-called expert systems.

Expert systems are knowledge processing systems in a highly specialized field of user training solutions at the level of professional experts.

Expert systems are used for the purposes of:

- interpretation of the systems;
- situations forecasting systems;
- diagnosis of the systems;
- target planning;
- elimination of violations in the system functioning;
- operation control process, etc.

As means of implementing a computer expert system there are used the so-called expert system shells. Examples of expert system shells used in the economy, are Shedl (Dialogue), Expert-Ease, and others.

The method-oriented AP is based on algorithmic implementation of some economic-mathematical method of solving the problem.

These include AP of:

- mathematical programming (linear, dynamic, statistics, etc.);
- network planning and management;

- queuing theory;
- mathematical statistics.

Problem-oriented AP. This is the widest class of software packages. Practically there is no subject area for which there is not at least one AP. Called as problem-oriented AP are software products designed to solve a problem in a specific functional area.

All the variety of problem-oriented AP can be divided into two categories: the packets intended for complex automation of management functions in the industrial and non-industrial areas, and AP domains.

Problem-oriented APs for the industrial sphere meet the following requirements.

Firstly, they need to plan production using advanced techniques (integrated production schedule, material requirements, capacities), to monitor the implementation of the work plan (inventory management, customer orders, purchase orders, purchase orders, and so forth.), manage routings, financial and human resources, and also carry out a number of "non-productive" functions: monitoring service, distribution and marketing of the finished products.

Secondly, they should be focused on the client-server architecture, built on the basis of multi-tasking, multi-user operating systems (UNIX type), and a relational database developed on the basis of CASE-technologies and have a graphical user interface.

Third, modern systems are capable of supporting different types of production: the development and manufacture of the product to order, assembling to order, small-scale and large-scale production, with a continuous production cycle, as well as mixed types.

In foreign markets of automation systems, complex AP perform hundreds of the industrial and economic activities. They can be divided into four groups:

1. Complex AP are integrated general-purpose applications for the automation of all activities of a large or medium-sized enterprise (corporation). These products are more expensive multifunctional higher class applications: for example, SAP, Oracle, Mac-Ras Open (A.Andersen), etc. Typically, these applications support the production of different types. Among Russian SPT of that class one should note the "Galaxy" system (New Atlas).

2. Complexes for production management applications of a certain type. These include: Genesic Manufacturing Suite (Edwards) - build to order, Trilior1 (Vaan) - different forms of discrete manufacturing, PRISM (Macam) - production with a continuous cycle, and others.

3. Specialized software: MMPS, MES (Fast System), allowing to make production more flexible, accelerate its adaptation to the market demands, compliance with dynamic scheduling material requirements, increase its production capacity and draw a flexible production schedule, control of workshops.

4. AP management of the entire process chain, from design to the finishing point of receipt of the finished product by the consumer: ERP-systems (Manugistics Numetrix) and others.

The cost of most complex problem-oriented PPP is high (sometimes more than 1 million dollars), but the majority of western companies still use complex problem-oriented PPP to automate their activities.

Problem-oriented AP for non-industrial spheres are designed to automate the activities of firms in non-material production (banks, stock exchanges, trade, etc.); the AP requirements of this class are very similar to those of a comprehensive AP for industrial areas created for integrated multi-level systems.

Standing prominent among complex non-industrial sphere APs are the packages that automate the banking, financial, legal sphere.

Banking AP to a large extent depend on the selected functional decomposition of information systems and usually consist of a set of packages of multi-module systems which address interactive, real-time, critical problems of financial operations and management of the bank as a whole and its individual divisions on the basis of a centralized integrated database. The technical basis of the implementation of integrated banking is RFP, a multicomputer network with different topologies to connect to the global computing network SWIFT, Reuter, Sprint, Internet, etc. Among the complex banking AP one should highlight packages developed by the following (usually American) firms:

- IBM in conjunction with a number of manufacturers of software products: IBIS AS, Midas ABS;
- DEC - DBS concept (Digital Banking System), implemented in the PROFILE, FMS - Financial Management System, PROFILE / IBS - Integrated Banking System, IBS-90 - an integrated banking system;
- NCR by implementing the concept of "open co-processing" and its architecture in the field of banking (NCR Bank View) in complex PPP type DBS-Bank;
- Hewlett-Packard proposed the concept of HAI Bank (in cooperation with the firm Diagram), implemented as a set of software modules;
- UNISYS company - FSA system, Finesse Financial Branch Automation (automation system for banking institutions);
- Siemens-Nixdorf company (Germany) - dialogue system «KORDOBA» (complex automation of the bank's activities);
- Olivetti firm (Italy) - banking platform (Platform for Banking) for automated bank (RFP of complex banking activities);
- Bull (France) - ICBS system for complex automation of banking activities.

Among the existing Russian complex banking AP one can note such systems as "Diasoft-BANK" (JSC Diasoft), RS-BANK (R-Style), «Va-Bank START" (FORS), as well as comprehensive RFP firms Programmbank, Inversion, Center of Financial Technologies.

AP of individual subject areas. One of the main directions of development of the software industry of late is the development of AP for different subject areas: accounting, financial management, legal, education, etc.

AP of legal reference systems is an efficient tool to work with a huge amount of legal information received on a continuous stream.

Almost all developed countries have legal systems of reference. In the US it Wru, Lexis, etc.; UK - Infolex, Prestel, Polis, etc.; Italy - Italguire, Enlex; Belgium - Creodor; Germany - Jurist, Lexinform etc .; Austria - RDB; Canada - Datum; France - Iretiv etc.

AP of global computer networks. The main purpose of global computer networks is to provide a convenient, reliable user access to geographically distributed network-wide resources, databases, messages, etc. Used for organizing e-mail, newsgroups, bulletin board, ensuring privacy of information transmitted in a variety of global computer networks are standard (in these networks) software packages.

As an example, one can name the AP standard of World Wide Web:

- means of access and navigation - Netscape Navigator, Microsoft Internet, Explorer;
- e-mail (Mail), such as Eudora.

In the banking business, widespread AP standards for preparation and transmission of data are the international SWIFT network, Sprint, Reuters.

AP company Bay Networks (USA), manager of data administration, switches, hubs, routers, traffic messages is used in more than 50% of the world systems f**or the organization of the computational process in the administration** of local and global networks used.

Thus, basic and application software in general is a tool for the development and exploitation of the work programs of the end users and the information system as a whole.

Moreover, in practice there are genuine problems which cannot be resolved by using the existing application software or AP. The results are obtained in a form that does not satisfy the end user. In this case, original software should be developed, taking into account the specific requirements and conditions for solving a particular problem.

Review questions

1. Give a definition of computer software.
2. List the main functions of computer software.
2. What is the main difference between the operating system and applications?
3. Classify software.
4. Explain why the operating system (OS) plays a crucial role in interaction between users and a computer system.
5. List the main functions of OS performs.

6. Give examples of OS.

7. Explain the meaning of the terms of encapsulation and abstraction and their importance in software structure.

8. List the software layers that make up the computer and explain the interaction among them.

9. Explain the role of BIOS in the work of a computer system.

10. List the types of computer memory.

11. Explain the role of MBR in the work of a computer system.

12. Explain the role of POST in the work of a computer system.

13. What is a process? What does a process include? Name the possible states that a process can be in.

14. What is a thread? Why are threads useful?

15. What is a context switch? What activities are performed by the processor during a context switch?

16. Explain what is happening in terms of preemptive multitasking and what effect it has to the user.

17. An interrupt indicates that the thread is not being run and should therefore be followed by a gray gap. How does the kernel handle an interrupt?

18. How does virtual memory work using a page table?

19. What is the primary purpose of virtual memory?

20. List three advantages of using virtual memory when executing a program.

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CHAPTER 4. HUMAN-COMPUTER INTERACTION

This chapter examines the practical aspect of human interaction with all kinds of devices, one way or another related to ICT. These include all types of hardware devices - computers, telephones, tablet PCs, a variety of e-books, smart-watches, robots, smart devices, etc. In addition, the object of study includes their software - operating systems, applications, monitoring and control tools.

The software should be user-friendly, since the end-user does not have to be an expert in computer science, but, nevertheless, it should be able to carry out all required tasks quickly, easily, and without noticing the technical aspects of the system.

4.1 Fundamentals of Human-Computer Interaction

Human-computer interaction (*HCI*) is a relatively new science that includes study, planning and development of interaction between people (users) and computers. Often, it is regarded as a blend of computer science, behavioral science, engineering, and other sciences. The interaction between users and computers occurs at the user interface level (or interface), which includes hardware and software; e.g., images or objects displayed on the display screen, the data received from the user via the hardware input devices (such as keyboard and mouse), and other types of user interaction with large automated systems such as aircrafts and power stations.

Another definition of HCI as "the discipline dealing with the design, evaluation and implementation of the interactive computing systems for human use, as well as the study of the related processes" was given in the Report of the group responsible for the development of recommendations to the educational program in Human-Computer Interaction (August, 1988). This group was formed from members of the Association for Computing Machinery (ACM). ACM and the IEEE Computer Society are the largest scientific and professional communities of specialists in computer science which played a key role in the development of computer science education programs. After this report, HCI module is a mandatory part of the Computer Science course.

Sometimes, human-computer interaction is called human-machine interaction and computer-human interaction. Thus human-computer interaction studies and takes into consideration both human and computer related factors. From the computer perspective it is important to consider computer graphics technology, operating systems, programming languages, development environments, engineering, and design. From the human side more attention is required to communication theory, graphic and industrial design, linguistics, sociology, cognitive psychology and human factors such as user satisfaction.

Therefore, in the design, development and use of devices and programs we should take into account the basics of physics, ergonomics, ecology, psychology,

chemistry, the conditions in which the interaction occurs, the purpose of the systems and much more.

Human-computer interaction is a relatively new discipline that dynamically evolves with:

- expanding the range of devices;
- expanding the scope of the interactive devices;
- increasing the number and complexity of the problems the mankind is facing today;
- increasing knowledge about the nature and psychology of the individual.

The main objective of the HCI is to understand the user, his motivation and the problem he is solving. Crucially important for its understanding is the perception of software and devices, because sometimes perception cannot be controlled solely by logic and reasoning. The main features of perception are vagueness, subjectivity and variability. In this regard, perception should be clearly distinguished from logic and intelligence. The first is the prerogative of professionals in the creative field (theater, poetry, painting, music, dance). The second is the instrument of scientists (physics, mathematics, economics, public administration). Nevertheless, perception has its own logic and mechanics - neurological basis, and we are getting closer to understanding it.

Modern computers with appropriate software are able to perform most of the logic operations, data processing and analysis necessary for solving many problems and making proper decisions. The initial data and parameters for all kind of programs solely depend on the data uploaded into the computer by the human. In turn, this process depends on our perception, data selection and technical competence. No matter how powerful a computer is, no matter how intelligent is the program, the results of the work will entirely rely on the initial data.

This statement is confirmed by the data processing inequality of information theory.

If $X \to Y \to Z$, then $\mathrm{I}(X;Y) \geq I(X;Z)$, where X, Y and Z is the sequence of the interdependent environment states, $I(X;Y)$ is information of Y and X about each other.

This inequality could be interpreted as follows: if we think of Z as being the result of some processing that is done on the data Y, that is $Z = f(Y)$ for some function, deterministic or random, then there is no function that can increase the amount of information that Y tells about X. Thus, no matter what processing you do on some data, you cannot get more information out of a set of data than was there to begin with.

For example, consider the economic model. Its values rely in the correct selection of the components and the connections between them. All these are a matter of perception and measurement carried out on the basis of data selection. If the computer processes the data based on false perception, the results can be inappropriate or even dangerous.

History of Human-Computer Interaction development

The ideas of creating digital computers appeared in the late XVIII and early XIX centuries, but the computer technology became available only in the mid XX century. The first electronic computers were intended to perform labor-intensive mathematical calculations with the assistance of specialists.

The program and data were uploaded into the first ENIAC computer (1943) by means of switches and flexible cables with plugs inserted into the right connectors (Fig. 4.1).

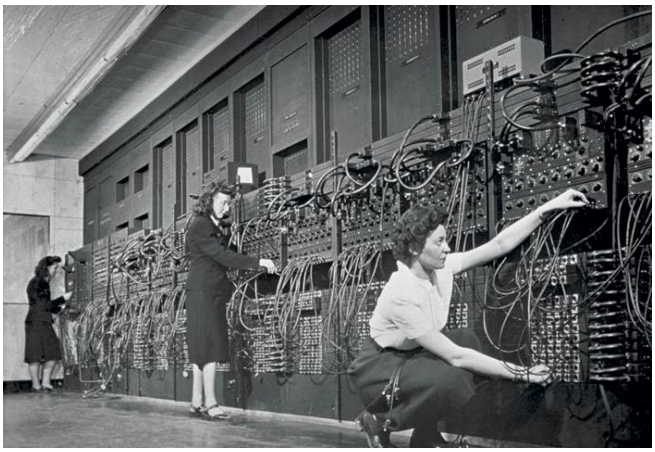

Figure 4.1 - Interaction of human and ENIAC computer (IBM's archives)

In 1945, punched tapes with the programs on them were used for interaction with a computer. Punched paper tapes and punched cards were used as the media for many years (for storing programs and putting them into a computer) (Fig. 4.2).

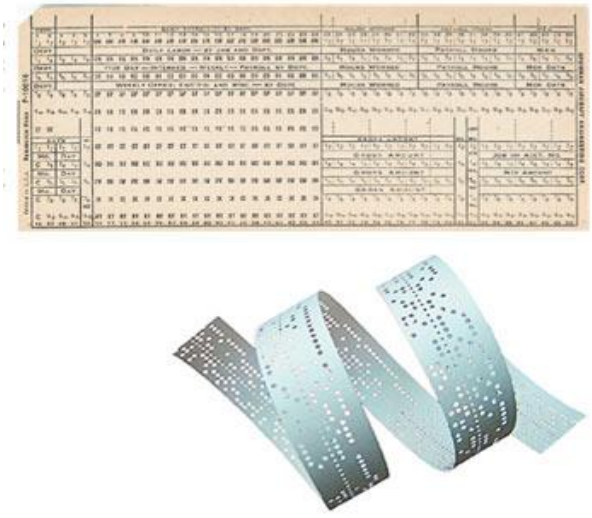

Figure 4.2 - Punched paper tape and punched card

In 1960 American computer scientist J.R. Licklider who lived in 1915-1990 formulated the idea of combining human intelligence and computer technology for information management. He also has made a huge contribution to the emergence

of the modern Internet. This contribution consisted of ideas and principles, not of technologies and inventions. The great scientist foresaw the need for networked computers with simple user interfaces. His ideas anticipated computer graphics, point-and-click interfaces, digital libraries, e-commerce, online banking, as well as software to be placed on the network.

He proposed interim targets, the achievement of which predetermines the realization of his ideas.

Immediate objectives:

– split time between computer users;
– electronic input/output of characters and graphic information;
– interactive system for processing real-time information and programming;
– large-scale storage and information search.

Medium-term objectives:

– coordination of an association of developers for the design and programming of large systems;
– ability to recognize speech of computer operator;
– ability of computers to recognize handwriting;
– possibility to use the the pen light as an input device for coordinates and pointers (pen light - light-sensitive device, allowing you to select the point of the display screen).

Long-term goals:

– understanding the natural language;
– ability of computers to recognize the speech of any user;
– heuristic programming, i.e., "intellectualization" of the program by giving it greater flexibility and heuristic thinking.

The development of computer technology, as history has shown, is consistent with the objectives of J.R. Licklider. In the mid-60s there appeared the first computer systems that allowed joint work of a certain number of users. Each of them had access to the individual terminal that allowed to interact with the system.

The first ideologist of the internet, an American computer scientist Ivan Sutherland, in 1963, developed the SketchPad – a graphic complex and the prototype of modern CAD, which has had a huge impact on the formation of the basic principles of graphical user interfaces. Its basic idea is to use the object-oriented model, where any drawn element represents the n-component structure, which could be copied, moved, rotated or scaled, preserving the basic properties. It was the first implemented algorithm for window drawing and trimming.

The pioneer of human-computer interaction, and the inventor of the mouse manipulator was an American scientist Douglas C. Engelbart), who lived in 1925-2013 years. Under his leadership in the mid-60s there was developed oN-LineSystem environment with the new operating system, e-mail, split screen teleconferencing and a context-sensitive help system. There was first presented the

WIMP-interface prototype that uses the concept of windows, icons, menus and pointers, which are key technologies for modern applications and environments. To interact with the WIMP-interfaces, the first computer mouse has been invented and created (Fig. 4.3).

Figure 4.3 - First computer mouse (1964 year)

The theoretical principles of personal computer creation have been developed in 1969 by American mathematician Alan Kane. Since 1971 he was engaged in the theoretical development of the personal computer prototype called the Dynabook in Xerox company in Palo Alto Research Center (PARC).

The Dynabook concept has described the device that is now known as a laptop or tablet PC. For Dynabook there has been designed and simulated graphic interface called Star GUI. Instead of the keyboard input, a new computer control usesre the input commands chosen by the mouse from the menu. The Star graphic interface has been applied as the prototype interface for Macintosh computers.

Despite the fact that the graphical interface has been described in the early 70s, and the idea appeared even earlier, in reality user interaction with a computer was provided by the so-called command-line interface (CLI) in the late 80s. Using CLI, the user had to know exactly which commands will perform the required actions, and he was to put them into the command line correctly.

4.2 Workplace ergonomics

The rapid growth of the number of users in recent years shows the increasing importance of the proper working space organization while using the computer. It is evident in the increasing number of young people with musculoskeletal problems, especially those with the spine.

Ergonomics - ergo (work) + nomos (law) is a scientific discipline, which studies the complex human functional capabilities in labor and domestic processes. The main objective is to identify and create optimal conditions for high life and

work efficiency. Other objectives of ergonomics are design, implementation and improvement of activities, means and conditions and special ways of preparing for them.

The goal of ergonomics is improving the efficiency and the quality of human activities in the system "human - machine - object of activity - environment" for maintaining the health and personal development.

Ergonomic requirements are the requirements to the system "human - machine - environment" set in order to optimize the human operator activities, taking into account their socio-psychological, psycho-physiological, psychological, anthropological, physiological and other features.

Ergonomic properties are properties of machines or objects which appear in the system "human - machine - environment" as a result of ergonomic requirements.

Factors determining the ergonomic requirements

Social and psychological factors suggest that the machine design (hardware, equipment) and the organization of workplaces should be congruent with the nature and extent of group interaction, as well as the nature of interpersonal relations.

Anthropometric factors determine compliance of the structure and the size of equipment, facilities and shapes of their elements with the dimensions, weight and anatomy of the human body.

Psychological factors determine compliance of the equipment, technological processes and environmental capabilities with particularities of perception, memory, thinking, and psychomotor skills of the working person.

Psychophysiological factors determine compliance of the equipment with visual, audial and other human capacities in a comfortable environment.

Physiological factors determine compliance of the equipment with physical properties of the person, his power, speed, energy and biomechanical capabilities.

Hygiene (health-related) factors determine requirements for illumination, ambient air composition, humidity, temperature, pressure, dust, ventilated, toxicity, intensity of electromagnetic fields, various types of radiation, noise, ultrasound, vibration, acceleration and gravitational overload.

Sedentary work (especially long) is harmful to human, in principle: you slouch or lean forward, your spine is deformed, injuring spinal discs. You raise your shoulders and bend your arms, keeping them on their toes, and, of course, they start to hurt. Pinch blood vessels, overload the heart, the hand tendrons are stretched, leading to painful consequences, and the vision is getting worse. Pose, consequently, productivity and health depend largely on the size and design of the workplace.

A human keeps sitting on average for about 80 000 hours in his life! We sit at work, while studying, eating, in the car, on the plane, watching TV, in the theater and even during our spare time. Action is disappearing from our lives. Nature has

created the human body for action, dynamics and constant motion, for which the rest state is not typical. The sitting posture puts a strain on the back muscles, and only when a person leans back, the load is somewhat reduced. If we assume that 100% of the load on the spine is in the upright position with the shoulders back, hands at one's sides, then at a typical sitting position is on the edge of a chair with your back flat the spinal load increases to 130%. If you lean forward when sitting on the edge of a chair (typically when working at the computer), the load increases to 200%. However, tilting back in the chair decreases the load to 75%.

Prolonged sitting leads to pains in the spine, legs, and headaches. Here is the statistics of complaints caused by long improper seat: headache - 14%; pain in the neck and shoulder blades - 24%; pain in the spine - 57%; problems in the coccyx - 16%; pain in the thighs - 19%; pain in the knees and feet - 29%.

General view of a properly organized workplace when working on the computer is shown in Figure 4.4.

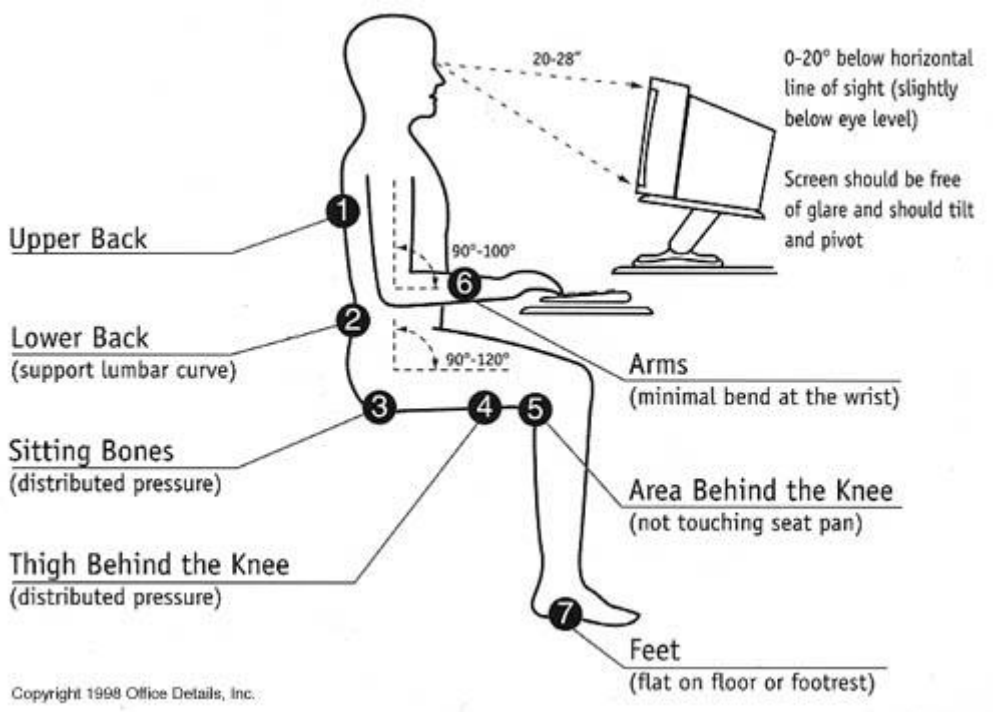

Figure 4.4 - General view of the properly organized workplace

Incorrect hand position during printing on the keyboard results in chronic wrist sprains. It is important to push the keyboard from the edge of the table, put the wrist on a special platform and keep your elbows parallel to the table surface at the right angle to the shoulders. The keyboard should be placed 10-15 cm (depending on the length of the elbow) from the edge of the table. In this case, the load goes at the more "fleshy" part of the elbow and not on the wrist in which the veins and tendrons are close to the skin surface.

The keyboard should move freely on the work surface, however during its use it should stay fixed. The keyboard slope from the surface should vary from 0 to 25

°. It is important to be able to adjust the angle in order to achieve the most comfortable position of hands. The surface of the keys and the keyboard should be brushed to eliminate glare. The horizontal size of the key surface must be at least 12 mm, the distance between the centers of the keys should be 18-19 mm horizontally and 18-20 mm vertically.

The height of the chair should be adjusted to the horizontal position of the hips and vertical position of the thighs. Feet should be placed firmly on the floor. The seat adjustment range should not be less than 38-52 cm in height. It is important to provide a footrest, which should have a slight inclination (5-15 °) and be heavy enough to be firmly fixed on the floor. The surface of the seats should be at least 45 cm wide and 38-43 cm deep.

The seat cushion should provide even pressure on the thighs and buttocks, and have a maximum 1.2-2.5 cm depth of punching. It is desirable that the front edge of the seat has a rounded edge and is slightly elevated. The back of the chair should provide the ability to tilt back to 125-130 °. It is preferred to have a high back that supports the entire back and neck. The recommended backrest height is 45-51 cm. In order to prevent deformation of the lumbar spine (which suffers most during a prolonged sitting) it is recommended to use a chair with a curved backrest with a lumbar flexure.

The height of the working surface above the floor, as well as its size and shape are important factors influencing human performance. Failure to comply with the working surface requirements leads to increased fatigue, physical discomfort, a range of medical problems, and as a consequence a decreased productivity. Physiological disturbances occur in the neck and shoulder area, in the area of the forearm and hand, in the lumbar spine, the hip area. These problems increase significantly in case of the following violations:

– the keyboard height above the floor is too big or too small;
– the forearm and wrist have no proper support and, therefore, do not rest;
– the operator's head is overtilted;
– due to the lack of space for the operator’s legs the thighs are bent under the table.

In general, the recommended settings of the working surface depend on the current tasks. As practice shows, the most common height of the work surface is 76 cm above the floor, which is too high for the average human height. It is desirable to have two working surfaces - one for the keyboard and one for the monitor, reading and writing. If there is only one working surface, its height should be adjusted within the range of 60-80 cm. For the majority of cases, the optimum height will be 70 cm above the floor, but the height-adjustable seat allows to adjust the height of a person for any height of the working surface. In the case of two independent surfaces the keyboard holding surface height should be regulated in the range of 59-71 cm, and for the monitor - 90-115 cm. Below the working surface it is necessary to provide sufficient space for the operator's feet. The minimum width of legroom is 51 cm, preferably it should be 61 cm. The minimum

depth of this space at the knee level should be 38 cm from the edge of the working surface, and at the level of the feet - 59 cm.

All surfaces in the visual field of the operator should be evenly illuminated. This refers to the temporal and spatial homogeneity. Fluctuations in ambient light in the visual field severely degrade the operator's performance. Such fluctuations may occur when the operator by the nature of the work should constantly move his eyes from and to bright and dark surfaces. The perception of luminance change requires a certain delay (there is a refractory period, when the perception is blocked), in certain oscillation frequencies the accommodation does not have time to adapt and as a result visual sensation is being disturbed. The most important aspect of the information perception from monitor is the general and local lighting. Slow performance will occur as a result of insufficient illumination and over-illumination. The lack of illumination slows down manual data input and excessive light exposure - increases the rate of errors.

4.3 Human-computer interface

Software and hardware with which the user interacts have the so-called interface.

Interface is a set of software and hardware tools that support user interaction with the computer. This is the basis of interaction of modern information systems, the border of various elements' interaction. For example, when the man interacts with TV, he is dealing with a remote control, the interface for interaction of human and application consists of graphical elements of the program on the computer screen (Fig. 4.5).

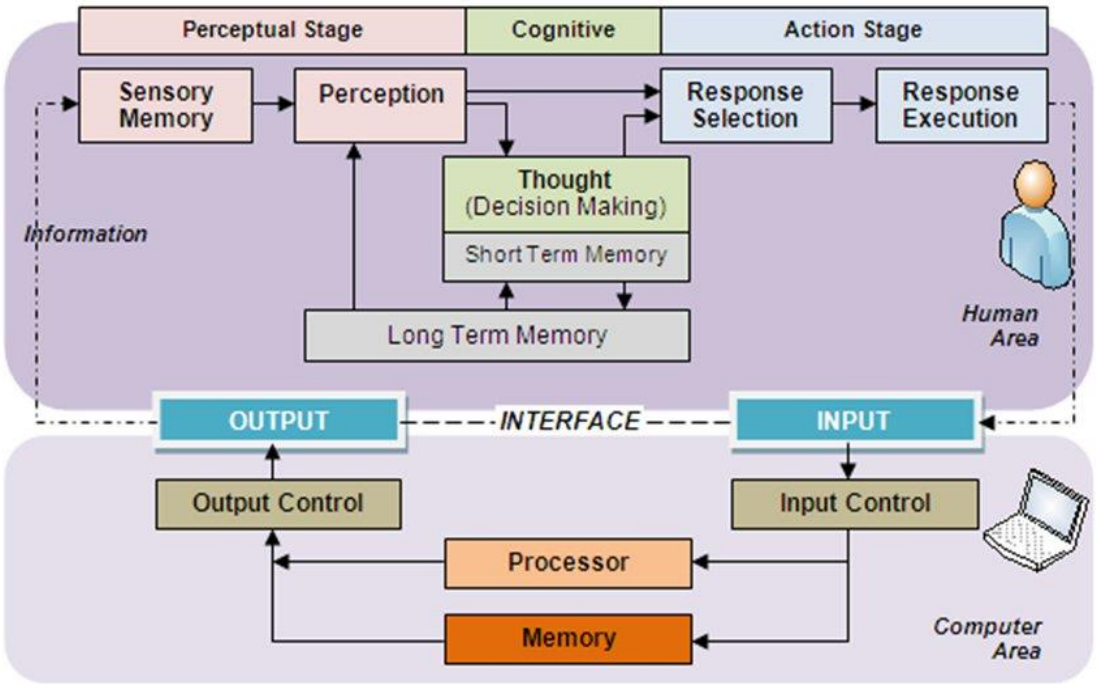

Figure 4.5 - The process of human and computer interaction

Creation of a high-quality human-computer interface is the ultimate purpose of the human-computer interaction study. The cost of a user interface development usually ranges from 5 to 50% of the product price. The benefits of a good UI development are the following: guarantee of success of the product, reduced development costs (paradoxically), cheaper product support, stronger competitive advantage, reduced probability of critical situations and the most notable and obvious - increase in economic benefits from the use of the product.

There are different kinds of available interfaces. For example, adaptive, tactile, gesture, etc. Selection of a certain interface depends on various factors: technology that we currently utilize for the information processing, motivation for product use and emotions that this product should cause, methods of visualization, design and context. For example, it is necessary to consider whether the device or the program is used for individual or collective work.

Firstly, the interface should be practical and reliable. User interfaces that underlie many of modern systems and programs are a misleading factor for most of the users. Software developers should pay careful attention to improvement of the reliability and usability of each developed system. The frequency of the system reboot, application failures, and incompatible file formats often prevent users from efficiently performing their tasks.

Modern HCI goes far beyond the simple interfaces, which are typical of the early systems based on the keyboard touch and mouse manipulation. An effective modern interface allows the use virtual and augmented reality, remote control, gestural and tactile interfaces. When developing the interface, one should bear in mind that the dynamic nature of perceptual-motor interactions (interactions between feeling, motion and perception) has a significant effect on the interaction of hardware and software. Consequently, the sensitivity to the actual movement needed to perform an action should be balanced and the user actions assessing system should have the lowest latency.

All incomprehensible instructions, cryptic menus, dialog boxes and notifications that are used in modern software should be reviewed in order to enable users to complete their work quickly and confidently. User behavior during HCI is also affected by the following factors: Web page load time, stability of the session for network applications, as well as disorders caused by junk mail (spam) and destructive viruses. T the growth in the number of active users aggravates these problems.

Secondly, modern interface must satisfy different purposes.

People from diverse backgrounds should have an equal opportunity to become successful: old and young, men and women, beginners and experts, users with different disabilities and people with low motivation, low self-confidence.

People with poor reading skills, with different levels of language proficiency and from different cultures should be able to become full-fledged members of the

modern information society (various online communities, e-commerce, e-learning, etc.).

Attention to human-computer interaction is important because a poorly designed interface can cause many unexpected problems. A classic example of this is the Three Mile Island NPP accident. Investigation of this accident revealed that at least partial responsibility for the disaster lies with the interface design. Similarly, many aircraft accidents occur due to manufacturers' decision to use non-standard solutions of devices and/or location of the devices on a dashboard. Although it was assumed that the new designs are more suitable for main human-computer interaction, the pilots were used to the "standard" location of devices. Thus, a conceptually good idea did not bring the desired results.

Reliable versatile technologies will provide vital services: medical, legal, banking, military, police, transportation, and training. Content providers can create a really useful e-business, e-learning, e-health, e-government, and many other applications on the basis of available technologies.

The specialists and researchers in the field of HCI are developing new technologies that address national and international issues and allow raising the living standards of society.

The user interface and its types

In computer systems interaction may be at the user, hardware and software levels.

The user interface allows the user to control the program or operation of the computer system and obtain the desired results. In fact, the user interface is a channel used for the program and user interaction. The user interface implements interaction of a person working with personal computer by means of special interaction elements.

An interaction element is a user interface element with the help of which the user interacts directly with the program or computer system.

There are active and passive interaction elements.

A passive interaction element is an element of a user interface through which the user has no direct access to the system or software resources, i.e. cannot manage or modify its resources directly and immediately. Passive interaction elements include information messages, prompts, etc.

An active interaction element is an element of a user interface through which the user has direct access to the system and software resources with the ability to directly control and change them. Active interaction elements include system configuration and program management tools, file system commands, etc.

According to the conventional classification, the existing interfaces can be divided into the following types:

- Command line interface;
- Graphical interface;
- SILK-interface.

1. The command line interface. One of the major and the oldest is the command-line interface. The command (command line, CLI, Command Line Interface) interface has received the greatest development in the heyday of large multi-user systems with alphanumeric displays. The user interacts with the computer via the command line, in which all commands should be entered in a certain format, and then transmitted to the execution (Fig. 4.6).

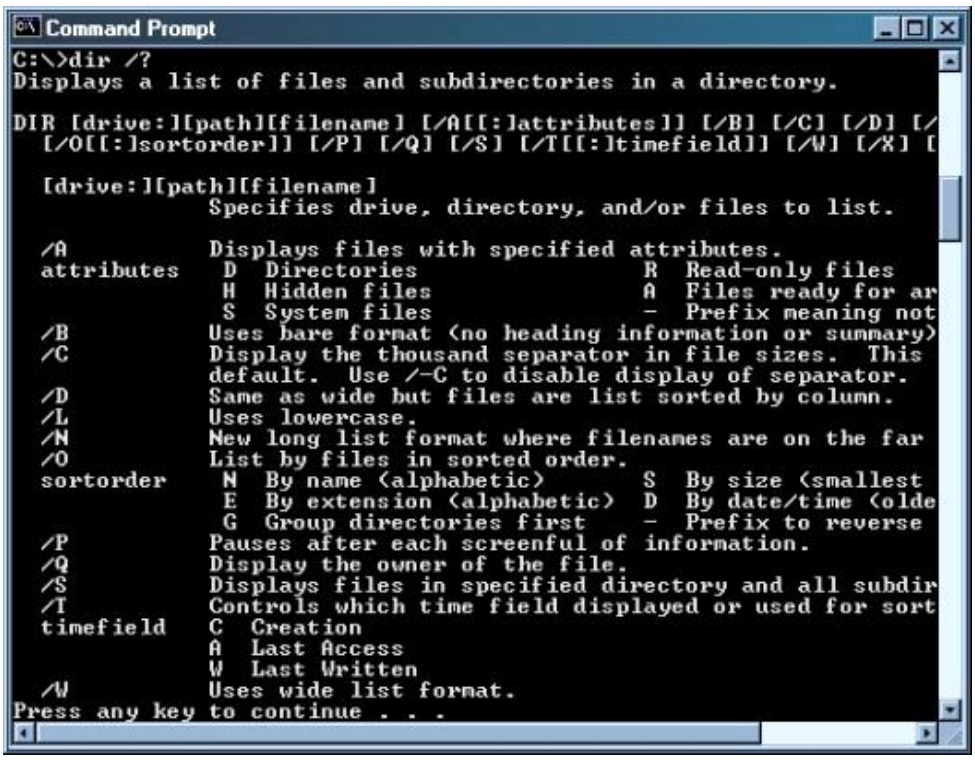

Figure 4.6 - Command line interface

Command line is a means that help the user to input direct instructions to the computer. It is commonly used with a variety of function keys, individual symbols, abbreviations or commands consisting entirely of words. This is a direct access to the system, often combined with a set of additional tools for increasing flexibility: a lot of options and parameters that can be applied to many items at once, eliminating the repetition of commands. The command line scheme can be represented as follows:

command - option... argument 1 ... argument 2 ...

A command line is a very powerful tool as it takes much less computer memory and does not require middleware program. However, the speed and power are associated with difficulties to learn and memorize the language of interaction.

2. The Graphical User Interface (GUI) is a required component of most modern software focused on the end-user work. The main advantages of the GUI are clear and intuitive user perception, as well as a standard and common interface, designed specifically for operation in a graphical environment. The user that has learned to work with one program can easily start working with all the others.

The most commonly used GUIs are implemented for the interactive user mode and constructed with the system of pull-down menus that allows of manipulation with the mouse and the keyboard. Users work with on-screen forms that contain control objects, the toolbar with icons to perform variety of instructions.

The graphical interface allows the user to communicate with computer through different types of dialogues (the exchange of information messages between participants, when receiving, processing and sending messages in real-time) (Fig. 4.7). The most common types of the dialogue organization are the following:

- Menu (fixed, context, pop-up);
- Template;
- Command;
- Natural language.

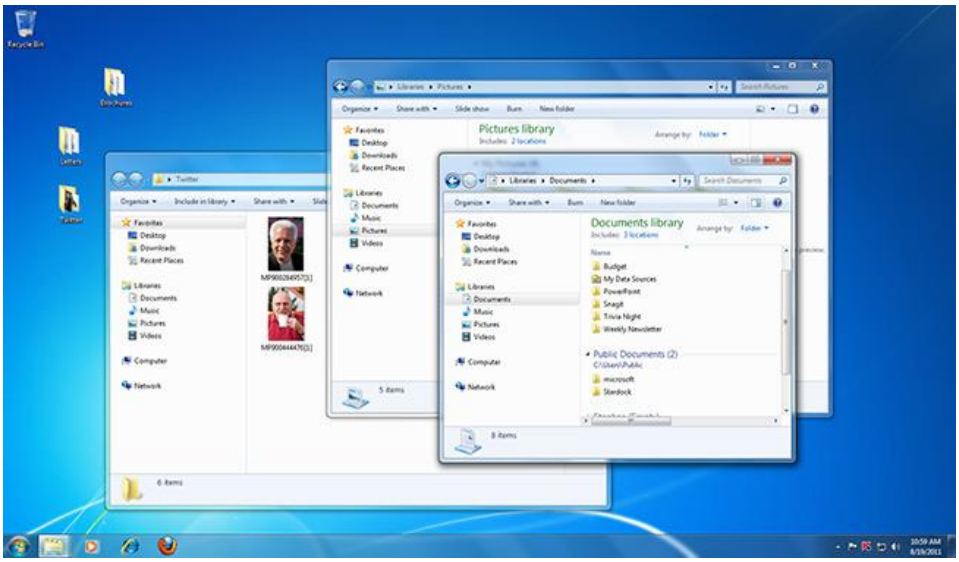

Figure 4.7 - Windows 7 Graphical User Interface

Using a natural language in the menu is convenient for users and developers. However, there is a problem - many words of a natural language are vaguely defined. Language is, in fact, a hierarchical system of generalizations. As in any hierarchical system, the processing of the input data depends on its classification. However, practically every word could be distributed in a set of classes, i.e. there is ambiguity or polysemy of almost every word.

WIMP-interface is the most common graphical user interface. All Microsoft products and many products for UNIX operating system are based on it. Abbreviation WIMP stands for Windows, Icons, Menus, Pointers. Note that in addition to these elements there are widely used buttons, dashboards, palettes, dialog boxes, and others.

Windows. The windows can be placed in different ways, to be superimposed on each other, or cascaded, resized, deployed on the entire screen, rolled up into an

icon. An important part of the window is the presence of the scroll bars to drag and drop content from/into the visible part (which makes the window analogous to the real window).

Icons. An icon is a little picture "representative" of the closed window, allowing the user to deploy it when necessary. This picture - a reminder of the existence of the window - saves space on the screen. Icons are also used to display other elements of the system, being their "wrapping", such as trash, different drives, folders, and so on. Representation of icons can be very different and serves as mnemonic rules, allowing to understand what is actually hidden under the icon.

Menus. The menu helps to arrange all available commands in sets and display them on the screen. The user can select commands from menus with the mouse and /or alphanumeric keys. It does not require memorization of all commands and their options, thus interaction is facilitated. Most menus are organized hierarchically, making it easy to call the desired command. These menus consist of the list of action names in natural language or graphical icons.

Pointers. Pointers (appears on the screen as differently shaped cursor), is the basis of the WIMP-interface functioning. For example, an arrow or a vertical bar or the cursor changes shape when you change the function (the arrow is replaced by a cross when the line is being drawn). The pointer can also inform about the state of the system (e.g. the shape of hourglass may inform you that the program is running and you have to wait). Shape of the indicator is similar to that of an icon with the so-called hot-spot (the active area) which should be evident to the user. If the pointer is in the shape of arrows (any type) then the center of the active area is on the tip of the arrow, if the shape is a finger, the active area will be on the tip of the finger.

3. SILK-interface (Speech, Image, Language, Knowledge) is an intuitive interaction between a human and an interface in a way natural for humans. It is an evolution in the field of computer interaction. Modern devices and computers have enough computing power to recognize desires and intentions of the user. Almost everything that the user is trying to resolve with the help of a computer, can be ordered through the recognition of facial expressions, voice and gestures. It is assumed that such interfaces should include dialogue with the user in a natural language containing symbolic elements, visual information (including facial expressions), and take into account such minor things as, for example the direction of user's sight (to localize his visual fixations).

Combination of different sensors capabilities allows the computer to see the world in three dimensions and recognize voice and emotions, bringing a range of completely new type of interactive applications and devices (Fig 4.8).

Figure 4.8 - Example of natural-intuitive interaction

This type of interface has become more popular and demanded. The most convincing illustration of this is the spread of virtual reality, a range of 3D applications, augmented reality. In general, a spatial interface is usually combined with WIMP-interface features, for example, shading (for buttons, scrollbars, etc..). Optimal use of the three-dimensional effect allows you to highlight an active (or any desired) area. The spatial interface objects are usually flat, however a sense of distance, proximity and three-dimensionality could be created by changing their size, lighting angle, superimposition, sailing and shading.

The term "virtual reality", or "virtual environment" means that a computer-generated image is intuitively perceived by human as natural and correlated with previous human experience. Virtual reality differs from many other computer images in following features:

• a graphic image should allow to perform spatial transformations, for example, depending on the spatial position of the user;

• all three axes describing the position of objects in space must be active;

• changes of objects on the screen should match their real change in the three-dimensional space;

• most intuitively possible interactions with the object in the real world should be implemented;

• there should be a possibility to use all real or desired degrees of freedom of objects;

• reaction of objects to any impact should be immediate.

The general idea of a virtual reality from the perspective of HCI is to create a stand-alone software application whose abstract representation focuses more on user imagination rather than on real objects. It is appropriate to remember that an unrealistic transformation can take place in virtual reality. Implementation of an absolute imitation of the natural world with its infinite variety is impossible, because it would mean the creation of a perfect mental model of the world.

We should also mention the new devices and software solutions, "enriching" reality (Augmented Reality) (Fig. 4.9). The user of such a system is able to read the texts, watch the pictures and listen to the music from the surrounding reality. Looking at the sky, it will be possible to read the flight number of a flying aircraft and going to the restaurant, know what is on the menu today and at what price. A driver, repairing a car, will see and learn during the repair the functions and circuit parts of the engine; a policeman, looking at pedestrians will be able to identify and track people; architects will be able to see the new area of the building in different contexts and at different angles.

Figure 4.9 - Example of Augmented Reality technology

4.4 Technical support

Many important engineering problems could be resolved by the integration of new advanced sensors in PCs, ultrabooks, tablets and smartphones. For realization of the naturally-intuitive interaction goals new devices must be equipped with a certain level of "intelligence" and "abilities".

Cameras that can assess the objects' depth and volume; microphones - define the sound direction; pressure-sensitive touchpads should be standardized and miniaturized.

An example of a successful technical solution is the camera from Creative (Fig. 4.10.), which can hardly be called a camera. Rather, it is a set of sensors. It includes two microphones to significantly improve the speech recognition quality, built-in RGB and infrared cameras (depth sensor) to detect gestures at a short distance.

Figure 4.10 - Creative Interactive Gesture Camera

Specifications of CREATIVE Interactive Gesture Camera:

- RGB Sensor resolution: 720p (1280 x 720)
- IR Depth sensor resolution: QVGA (320 x 240)
- Viewing angle (degrees): 73
- Frequency (fps): 30
- Operating distance from 15 cm to 1 meter
- Power supply: USB 2.0 (<2.5 W)

Another example is a contactless controller Kinect, developed by Microsoft. Kinect allows the user to interact with an Xbox or a PC under Windows without any other contact game controllers through verbal commands, body posture and recognition of objects or images. This device consists of two depth sensors, a color camera and a microphone array (Fig. 4.11).

Figure 4.11- Kinect controller

Features of Kinect camera:

- 3 cameras:
- 1 - colored MT9M112, 1280x1024 resolution, 15 frames per second (30 fps at 640x512);
- 2 - colored MT9v112, 640x480 resolution, 30 frames per second;

- 3 - IR depth sensor MT9M001, infrared black and white 1280x1024, 30 frames per second.

- operating distance - from 1.2 meter to 3 meters.

The Kinect camera functions at long ranges (from 1.2 to 3 m). In turn, the CREATIVE Interactive Gesture Camera works at short distances (from 15 cm to 1 m). Therefore, the purpose of cameras varies. The CREATIVE Interactive Gesture Camera is more suitable for gesture and voice recognition, identification, synthesis and tracking of objects, hands, faces. The Kinect functionality is aimed at the identification and recognition of human gestures and body in the home environment. The Skeleton tracking system can simultaneously recognize up to six men, two of which may interact with the controller as active players. The Kinect monitors 20 focus points of each active player and can substitute users on the screen by their images (Live-avatars) (Fig 4.12).

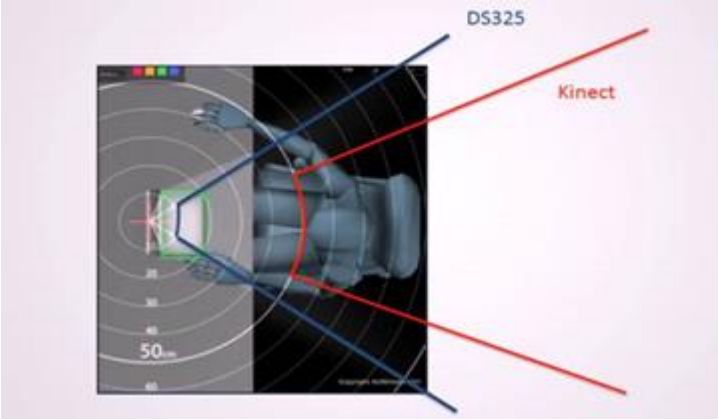

Figure 4.12 - Comparison of Creative and Kinect cameras viewing angles

Technical characteristics of these cameras are also different. Despite the fact that the CREATIVE Interactive Gesture Camera is designed for short distances, it has wider vertical and horizontal viewing angles in comparison to the Kinect camera.

The helmet of virtual reality is the device worn on the head. It consists of two displays placed right in front of the user's eyes and operating in conjunction with the head movement tracking system. Therefore, the picture on the screen always corresponds to the direction in which the person looks. All this makes the helmet suitable for games or immersive panoramic video (a movie that goes on around you, and you can look around, as in life) (Fig. 4.13).

Figure 4.13 - Helmet of virtual reality

Below are listed some other modern technical developments.

Contactless controllers interact with the computer: Kinect, The Leap, The Xtion. Different controllers interact with the computer: Razer Hydra, Virtuix Omni, PS Move, Wii Remote, IMotion, The 3DRudder. Gloves' virtual reality: Peregrine, 5DT Data glove, DG5 glove, CyberGlove. Glasses and helmets of virtual reality: Control VR, Oculus Rift, Google glass, Recon Jet, VrAse, HoloLens (Fig. 4.14).

Figure 4.14 - Interaction of user with devices

To interact with a computer, all devices use standard interfaces for data (USB, Bluetooth, WiFi) and video (DVI / HDMI) communication. Thus, as shown in Figure 4.14, multiple data streams between devices are implemented:

1. The data from infrared and color camera, depth sensor, and the audio stream from microphones.
2. The data from the various controllers and joysticks react to pressed buttons, position and angle of controller tilt as well as signaling of the joystick vibration.
3. The data from the display devices depend on the position of the head.
4. Interaction of the user with contactless controllers: tracking the movements of all parts of the body, hands and fingers.
5. User interaction with controllers.
6. User's interaction with display devices.

Areas of application and examples of software

An example of modern approaches to HCI application is the use of natural-intuitive interaction in video games. For example, to interact with the three-dimensional game world, the player can use voice or/and gestures.

Recognition of fine-grained set of objects, such as ten fingers (Figure 4.15) in a relatively short distance from the computer makes it possible to simulate the capture of a three-dimensional virtual object, move it or point to the object. Recognition of hand movements and gestures can be interpreted and used in order to communicate with a computer. For example, to switch tracks in the playlist, or flip pages of a book, such gestures as scrolling in different directions could be used (Fig. 4.15).

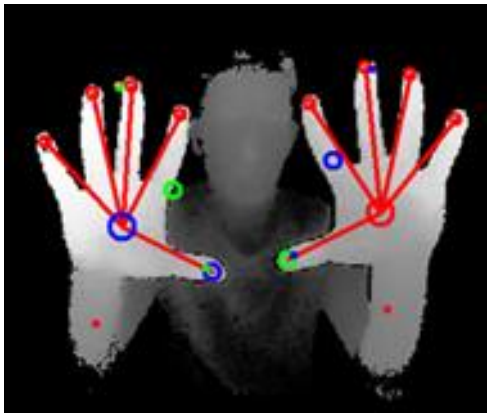

Figure 4.15 - Hands recognition

Face detection and special recognition control points on the face in order to determine the eyes, nose and mouth cold be used for many different solutions. It is possible to identify and analyze blinking, smile, recognise the gender and age group. Combination of different face parameters, voice and gestures can be used for accurate personality identification, evaluation of the behavior of different age group representatives or recognition of the emotional state of the person (sadness, joy, etc.) (Fig. 4.16).

Figure 4.16 - Face recognition

Using a depth sensor adds new features and experience in everyday activities such as Web-conferencing and remote communication. Segmentation based on the image depth allows to split the front and rear background. For example, to add

color to the virtual communication, the background can be replaced by any image, for example, a lunar landscape or a beach (Fig. 4.17).

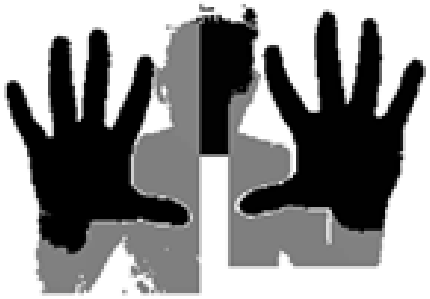

Figure 4.17 - Example of depth sensor use

It is possible to recognize three-dimensional objects of the real world and combine them with the interactive content. A three-dimensional camera can recognize the model of a real object and add virtual animation and sound effects to it. Thus, a new interaction model between objects is being built based on recognition of groups of objects, the position of the individual in relation to other objects and their behavior.

Realization of the natural-intuitive interaction functions in interactive applications will allow to:

- *reflect the reality, rather than to create a copy of reality.* Developing applications with functions of natural-intuitive interaction must be inspired by the real world. Natural-intuitive interaction is based on our natural skills used in everyday life. Every day we use our hands to manipulate objects, our voice - to communicate. In a virtual environment, all these natural human capabilities will allow to forget about the rules and make the interaction easier.
- *reflect real-world objects literally, not abstractly.* Instead of abstract controls usual switches and controllers are used for objects' manipulation.
- *create intuitive applications.* The user does not have to inspect long instructions in order to learn functions of an interactive application.
- *create robust applications* that do not react to accidental or false user actions.

Development of technologies for voice, image and video processing brings HCI to a qualitatively new stage. In recent years, the area of applying human-computer interaction has expanded. The ultimate goal of modern HCI is to make relationship between humans and machines similar to the communication between man and man.

Half a century ago most computer users (if we consider as a user a data center customer) did not have a real time computer interface at all. Just ten years ago the standard input-output devices for interaction with computer were the keyboard, the mouse and the display. Today we have a variety of alternative input devices.

In the near future, human-computer interaction will inevitably change. The widespread dissemination of embedded technologies makes enormous changes in the actual computer interface. These changes are needed to make interaction with a variety of computers easier and to ensure that citizens and society can take full advantage of computer technologies even without any direct work with computers. The term "interface" will change its value, and its current definition will be obsolete.

The trend to connect all devices to the network in order to enhance their features and consumer qualities gave rise to the term "hyperconnectivity". Today almost all computers, many phones and game consoles, as well as some other devices, televisions, camcorders, home appliances work within a network. As a result, the number of devices and applications connected to the network far outweighs the number of people using the network for data transmission.

With increasing degree of connectivity the amount of information stored in the electronic form is also growing (e.g. personal photos, logs and history of social networking, detailed summaries of actions etc.). It is important not only to store information in the electronic memory, but also make it available for analysis and decision making.

We should remember that all these changes are necessary first of all for people and society. The purpose of interaction of person with a computer is to make better our daily life, including family, health, work, education, communication with the community and mutual support.

Review questions

1. What is included in the concept of man-machine interface?
2. List the main means of man-machine interface.
3. Are there any fundamentally new breakthroughs in the development of human-machine interface? Describe them.
4. Is there any effective speech recognition system available? What are the shortcomings of speech recognition systems?
5. What does ergonomics study?
6. What are the main causes of fatigue in the design of jobs and the posture of the working person?
7. What are the main types of musculoskeletal disorders at work on a computer, their causes and ways of prevention?

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CHAPTER 5. DATABASE SYSTEMS

5.1 Concept of DBMS

There are various definitions of the database (DB). Most often, the database refers to a named set of structured data related to a certain subject area. However, in this case the database is very difficult to distinguish from ordinary records or document archives.

There are three features which distinguish the database from a simple set of data:

- The DB is stored and processed on a computer system.
- The data in the database is well structured, i.e. it highlights the main elements of the types and relationships between the elements, as well as the restrictions on the permitted operations.
- It provides data search and data processing.

The most common type of the database is a relational database. Its basic structural elements are:

- a field - a basic unit of data organization. The name, type, length, precision, etc. are used in order to describe the characteristics of the field;
- a corresponding column in the table;
- a record - a set of logically related fields. It matches a string in the table.

5.2 Database System

The Database System is a computerized system of structured data. Its main purpose is to store information and provide it on demand.

There is a single-user and a multi-user system. A single-user system is a system, in which the database can be accessed by only one user at a time.

A multi-user system is a system, in which the database can be accessed by multiple users at a time. The main objective of such a system is to allow the user to work with the database as a stand-alone.

Typically, the database system is divided into four main elements:

- Data.
- Hardware.
- Software.
- Users.

Figure 5.1 presents a simplified database scheme.

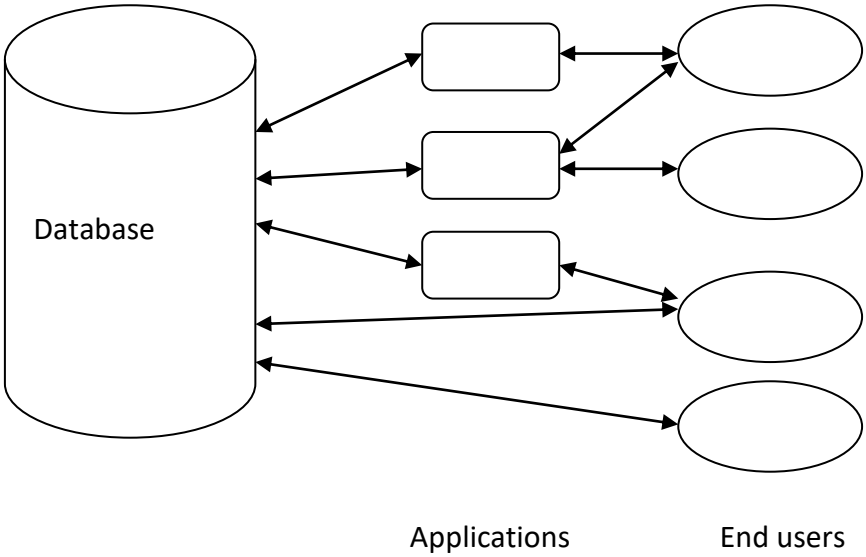

Figure 5.1 - Database system elements

- **Data**

Data in the database can be described as integrated and shared. Integrated data can be represented as the union of some separate files, totally or partially non-overlapping. Certain data sections of a general database may be accessible to several different users.

- **Hardware**

This includes:

- a storage facility for storing information together with I/O devices;
- a processor with the main memory, which is used to support the operation of the system software.

- **Software**

The main part of the software is a database management system (DBMS). The main function of the database is providing the user with an opportunity to work with the database without going into detail into the hardware issues. The DBMS supports a high level of user operations. These operations include operations that are performed using an SQL (Structured Query Language), which is a special database language. The main database is the main but not the only component of the system software, referred to others can be utilities, application development tools, reporting tools, etc.

- **Users**

There are three groups of database system users:

- Application programmers. For the application development purposes that use the database, they apply a variety of languages and programming environments: Visual Basic, C ++, Java, C # and others. Applications programmers

have an access to the database by issuing an appropriate request to the database (usually, SQL operators).
- End (ordinary) users. End users can access the database using one of the interactive applications. Many DBMSs provide not only the means to execute SQL queries but also graphical tools that let you create queries without the knowledge of SQL.
- Database administrators. They are engaged in the database server management.

- **Organizing data in the database**

  The following elements organize data:
  - data;
  - facilities;
  - communication;
  - properties.

- **Data**

Database data is commonly referred to as permanent, although certainly not in the conventional sense. It is called so in comparison with variable data - transit (intermediate results, input, output data). Input data is the information that is transmitted from the terminal or workstation to the system. When this information is stored in tables, it becomes a permanent part of the data or results in permanent changes in the data. Output data is a message and results displayed by the system on the screen, or produced by a printer and other output devices.

- **Objects**

Objects are tables (or relationships) in a relational database, which describe some real-world objects. Relational databases store data in tables only.

- **Connection**

Connections represent relationships between objects. As a rule, they are bilateral. Suppose there are two objects: Students and Groups. There can be two questions about the relationship between them:

- Which group belongs to a student?
- What students are included in this group?

The scheme, which displays objects and their relationship, is called an entity-relationship diagram or an object-relation chart (Figure 5.2).

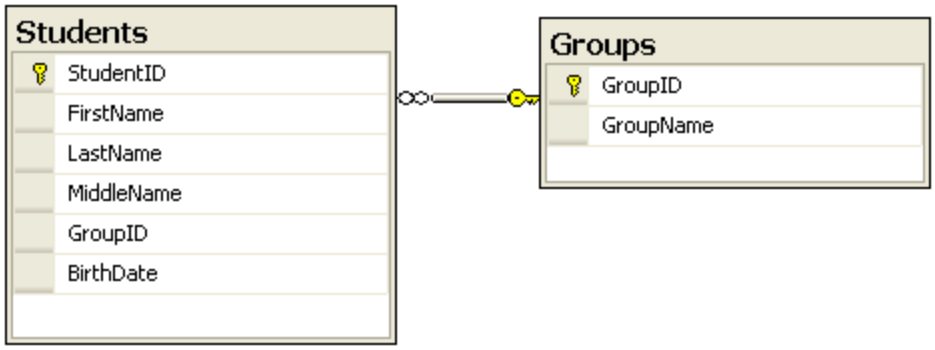

Figure 5.2 - Relationship between the “Students” and “Groups” tables

In communication the scheme may be indicative of the same object type. For example, the teacher is the mentor of a young teacher. In a particular set of objects there may be any number of links. Between the two tables there may be more than one link.

- **Properties**

All objects and connections have certain properties. Properties of objects are expressed in the table fields. Properties of connections are their characteristics inherent in them at the formation stage.

5.3 Data model

The core of any database is the data model, which is a set of data structures and their processing operations.

Let us consider the main types of the data model in which the object of research is the data itself, its structure and rules of formation.

In every computer, there is a simple but well-defined data model - computer data structure and the operations involved in their processing. With the help of the original DM it is possible to build more complex data models, i.e., to go to an abstract machine. Examples of abstract machines are the interpreters (and translators) of the high-level programming languages. Each programming language has a data model.

Fortran: types of data description: real, whole. All operators as well as algorithms of the language are divided into two main groups:

1. Declarative type (for data description).

2. Procedural type (for description of the sequence of operations on the data described above).

The algorithmic language data model, determined by the totality of its operators of procedural and declarative types, describes all admissible logical data structures that can accept, process and output the programs in that language.

That’s why the data model supported by the programming language can be characterized in the following way:

The types of logical data structures that can be represented in the DM are identified.

Specified: signs of structures of this type from the logical structures of other types; rules for processing this type of structures by the procedural operators.

All these can be attributed to the DM of any software data processing system. This also applies to DBMS. DBMS can be considered as an algorithmic language in which the tasks that must be completed are programmed. Its difference from the algorithmic language lies in the fact that the operators are divided and presented in the form of separate languages: data definition language (DDL) and data manipulation language (DML). The set of DDL and DML determines the model of the DBMS database.

In addition to these data structuresf, DBMS provides formation called data circuit. A data structure diagram is the description of data structure of a certain type in a formalized language. The scheme defines a set of properties specific to the type of data structure. Implementation of the scheme is the specific structure of the corresponding data type. Each implementation is called a copy of the scheme.

Construction of the data structures in each DM cannot be performed in an arbitrary manner. This is due to the limitations arising from the characteristics of the types of data structures used in the model and operations that can be carried out on these structures.

Consequently, the major components of the data model are: data structures, operations on the data, and constraints.

The main components of the data model are closely interrelated and implemented differently in various models.

Data structures. Structuring of data is based on the use of concepts such as "aggregation" and "generalization". Let’s consider the file systems that implement the "flat file" model with the conceptual basis of the four basic types of logical data structures: a) a field is the smallest named set of data, b) a record is a named set of fields, c) a file is a named set of records of the same type, d) a set of files or a library is a named collection of files that are processed in the system.

Aggregation is used for the composition of the fields in the record. Generalization is used to represent multiple instances of records of the same type and the same general structure of a higher level – a file. It is also allowed to unite the copies of records of specified types into a file.

Generalization is also used to retrieve records that satisfy specified criteria from a file.

Different types of structures allow using various forms of data representation scheme, including the usual representation in the form of source text of DDL.

For example, in a graph form the aggregates of attributes used to represent entities are represented as graph nodes and the connections between them as the respective arcs.

Another representation form, more convenient for understanding and interpretation, is a tabular presentation.

The table columns are used to set attributes. Files, records and fields can be used as the tables' analogues and their elements.

The basic operations on the data. The dynamic properties of the data model are expressed by a variety of operations that define allowable actions on the contents of the database to convert it from one state to another. This set of operations is related to the language of data manipulation.

Many operations define the types of treatments that may be a subject to the data model objects. These primarily include data sampling operation and the operations that change the state of the database.

Constraints. Logical constraints that are imposed on the data are called integrity constraints. DBMS must ensure the consistency of the data by the specified limitation in case of transfer from one state to another.

Let's briefly consider the main types of data models and identify their main strengths and weaknesses. We will also take into account the factors that characterize the principal features of the models, as well as factors related to the implementation of these models on a computer.

The hierarchical data model. It is a collection of elements connected by strictly defined rules. Objects connected by hierarchical relationships form a directed graph. The basic concepts of a hierarchical data model are: the level, the node (or the element) and communication. Such data model has the following properties:

- each node is connected only to one higher-level node, except the top;
- a hierarchical database model has only one top, the node does not depend on any other nodes;
- there is only one way to the top from each node;
- connection cannot be established between objects located through the level;
- connection between the nodes of the first level is not defined.
-

Examples

- **The file structure of information organization.**

The structure of organization (director, deputy, heads of departments, employees) (Fig. 5.3).

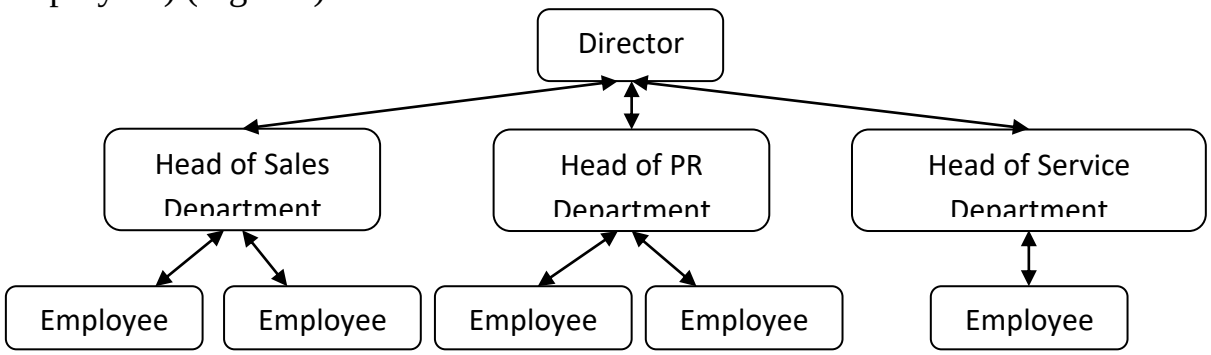

Figure 5.3 - The hierarchical data structure

We will take into account the factors that characterize the principal features of the models, as well as the factors related to the implementation of these models on a computer. A hierarchical data model represents a set of elements related by strictly defined rules. The objects related to hierarchical relationships form a directed graph. The basic concepts of a hierarchical data model are: the level of the node (or element) and communication. Such a data model has the following properties:

- Each node is connected only to one higher-level node, except the top one;
- A hierarchical database model has only one peak, the site is not subject to any more nodes;
- From each node there is only one way to the top;
- The connection cannot be established between objects located through the level;
- The connection between the nodes of the first level is not defined.

Benefits:

- simplicity;
- minimum memory consumption.

Disadvantages:

- lack of flexibility - not all the information can be expressed in a hierarchical data model;
- an exceptional navigation principle of access to the data;
- access to the data through the root member only.

Network data model

The elements of this model are level, node and connection. The main difference is that an element of one level can be connected with any number of elements of the neighboring layers, and there is no subordination between levels.

Properties of the network model:

- The connection can be established only between the objects located at adjacent levels.
- The connection between the nodes of the first level is not defined.

As an example, consider the work on a project:

There are three kinds of objects - staff, projects and customers (Fig. 5.4).

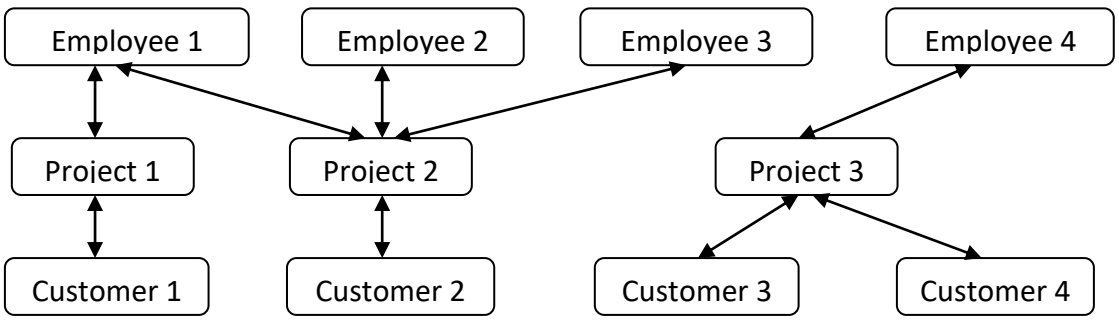

Figure 5.4 - The network data structure

Benefits:

- universality;
- ability to access the data through multiple values relations.

Disadvantages:

- complexity - abundance of concepts, options for their relationships and ways of implementation;
- validity only for the navigational principle of accessing the data.

Relational data model

The relational data model is a way of presenting the data in a tabular form. The features are: a field (column), a record (row) and a table (relation). In the future, we will consider a relational data model used in relational systems. The relational system is understood as a system based on the following principles:

- The user data is presented only in the form of tables;
- The user is provided with the operators that generate new tables from old ones (for sample data).

Example: Consider the connection of Students and Groups:

Students:

StudentID	LastName	FirstName	MiddleName	GroupID
1	Kazakov	Petr	Vladimirovich	1
2	Vasilyev	Ivan	Arkadievich	2
4	Shishkina	Daria	Sergeevna	1

Groups:

GroupID	Supervisor
1	Tsarev S.M.
2	Pestov D.N.

Benefits:

- simplicity. In this model, only one information structure formalizes the table view. It is the one most familiar to the user.
- theoretical justification. There are strict methods of normalizing the data in the tables.
- data independence. If you change the database, its structures need only minimal changes in the applications.

Disadvantages:

- low speed, due to the necessity of connection operations.

- large memory consumption due to the organization of the data in a tabular form.

The inverted lists system is an index system. The system of inverted lists can be viewed as a special case of a 2-levelnetwork data model. The main elements are the master file, the inverted list (file), and a list of links. In such a system, there are several major files with a single continuous numbering.

Example: Consider the objects – Employees and Salary

Employees:

Employee	Position
01 Ivanov	Programmer
02 Sidorov	Assistant
03 Shishkin	Teacher
04 Vasilyev	Teacher

Salary:

Employee	Date	Sum
05 Ivanov	1.10.2008	5000
06 Sidorov	5.10.2008	7500
07 Ivanov	3.12.2008	10000
08 Shishkin	3.12.2008	8000
09 Vasilyev	25.01.2009	5000
10 Vasilyev	27.01.2009	8750

An inverted list can be formed for any field of the basic lists. Each value therein correlates with the list of numbers (indices).

Example: Inverted list “Position”
Programmer - 01;
Assistant - 02;
Teacher - 03, 04
The list of connections is made only for the main columns.
Let us consider two lists of links.
Employees - Salary:
01 – 05, 07
02 – 06
03 – 08
04 – 09, 10
Salary – Employees:
05 – 01

06 – 02
07 – 01
08 – 03
09 – 04
10 – 04

Inverted lists form the basis for the creation of information retrieval systems (IPS). In the IRS the key attributes correspond to the keywords of the research topics.

Since the shortcomings of the relational data model are compensated by increasing the speed and resources of modern computers, it is now a most widely used model.

5.4 Database architecture

There is a database architecture proposed by the research team ANSI / SPARC and it is called the ANSI / SPARC architecture.

Not every database system is required to conform to this definition. For example, a ‘small’ system will not most likely support all the features of the proposed architecture. However, the considered architecture describes most systems (not only relational) with sufficient accuracy.

There are three main levels of the DBMS architecture:

- Inner layer (also called natural), the closest to the physical storage of information, i.e. storage means are associated with the information on the physical devices. The internal rate shows the physical elements for storing information. It is an infinite address space, from which information is projected onto the external media.
- Exterior layer (also called the user) is the closest to the users, i.e. it is associated with the methods of presenting the data for individual users (the application programmer or the end user). There may exist a specific DBMS language for each user. There is a programming language for the application programmer, and there is a language for the end user, which is a language based on a menu, forms, etc. But all of these languages include the language of the data, a built-in database. Each individual user may be interested in some particular part of the database. These parts, with which the user works, are called external representation.
- Conceptual level (also called logical), an ‘intermediate’ level between the first two. It views all database information in a more abstract form. At this level the actual data is stored regardless of its presentation. The conceptual view consists of a set of data instances. Data is presented as a conceptual schema. Except for the data, this scheme can include definitions of additional means, for example, rules to ensure integrity.

A detailed diagram of a database system is shown in Figure 5.5.

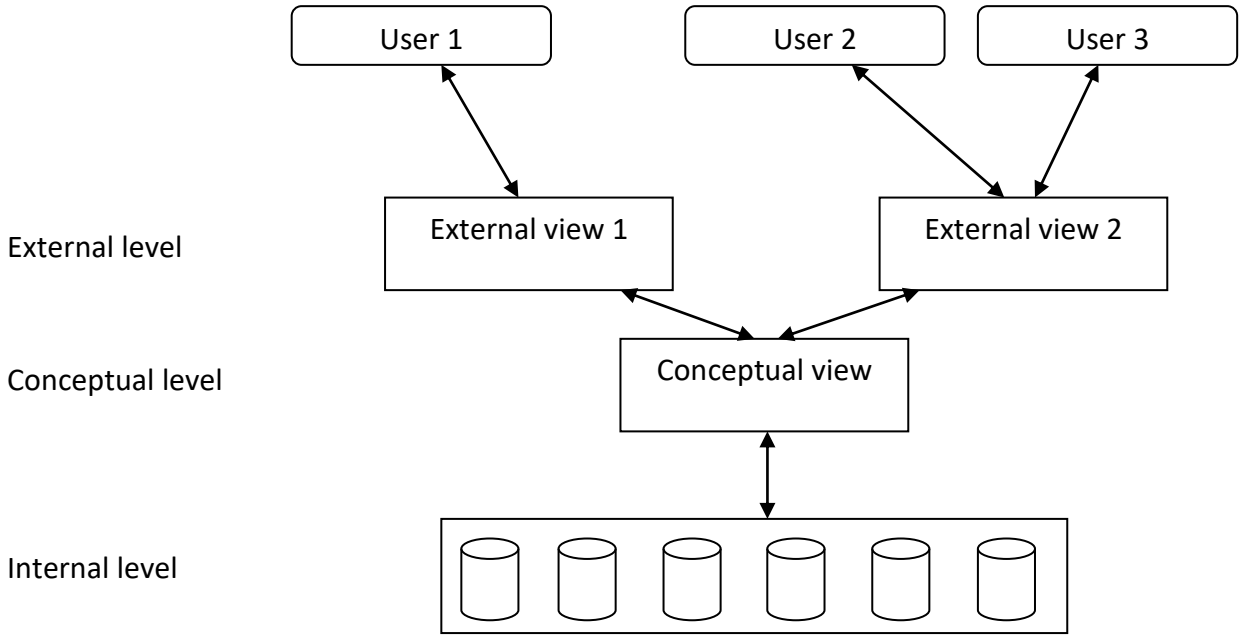

Figure 5.5 - Levels of the database systems architecture

5.5 Database classification

Databases are classified according to various criteria:

According to the processing technology

- It is centralized and is stored in the memory of one computer system.
- It is distributed and consists of several possibly overlapping parts, which are stored in different nodes of the computer network.

According to the method of access to the data

- It has a local access. A computer user has an access to such a database.
- It has remote (network) access and is available to all network users.

According to the architecture

- File server. It is a server which assumes allocation of one machine on the network as central (a file server) and stores a centralized shared database.
- Client-server. It has an allocated DB server, which in addition to the storage performs data processing. The database can be viewed as a system consisting of two parts: the server and a set of clients. The database as such is called the DB server, and clients are various applications that run on the database.

5.6 Operating modes of the DBMS user

In computer science, the term ‘treatment’ is defined as a specific operating procedure or condition of your computer or programs. All modern databases have a graphical user interface, through which the user can work with the database in three modes:

1) Through the menu of the system. It occurs most often in the form of different menus and dialog boxes, in which the user gradually clarifies what actions he/she wants to run and what kind of information is obtained from the database. You do not need to know the database language.

2) Command mode - interactive mode. This is a way of implementing language features, i.e. direct execution of commands. The system issues a prompt and waits for a response. After entering an appropriate command, the system performs a syntax control of the input command and (in the absence of errors) executes the command. The command in the course of its implementation may conduct its own dialogue with the user, or send specific messages. After performing the current command the system issues prompts (invitations) indicating its readiness to accept another command.

3) Program mode. It provides access to the data organization and management of applications. The users can write programs in the language of instruction, which the database maintain, debug and execute programs. You can enter a text using the built-in text or any other editor.

5.7 Database design

During the database design two major problems are solved:

- How to display the domain objects in an abstract data model when the objects on this map do not contradict the semantics of the subject area and are the best possible (efficient, convenient, etc.) This problem is often called the problem of logical database design.
- How to ensure the effectiveness of a query to the database, bearing in mind its specific features, by placing the data in the external memory, creating any additional structures (e.g. index), etc.? This problem is called the problem of physical database design.

In case of relational databases it is difficult to strictly prescribe their physical design. Too much depends on the database. For example, when working with the Ingres DBMS, you can select one of the following methods of physical organization of relations. While working with the System R you should first of all think about the clustering relationships and the required set of indexes, etc. Therefore, we restrict ourselves to the issues of the logical design of relational databases, which are essential when using any relational database.

Moreover, we will not deal with a very important aspect of the design - the definition of integrity constraints (except for the primary key constraint). The fact is that when using a database with developed mechanisms of constraints (e.g., SQL-based systems), it is difficult to recommend a general approach to the definition of integrity constraints. These restrictions can have a very general form, and their wording is more related to the field of art than to engineering prowess. What is generally recommended in this respect is an automatic check of the consistency of constraints.

So, we can assume that the problem of designing a relational database is based on the decision-making on the type of relationships within a database and the attributes of such relationships.

5.7.1 Relational database design by using normalization

First, the classical approach will be considered, in which the entire design process is done in terms of the relational data model by using the method of successive approximations to a satisfactory set of relations schemes. The starting point is representation of the domain in the form of one or more relationships, and at each step of the design, a set of schemes of the relations with better properties is produced. The design process is the process of normalization of relations schemes, when each consequent scheme possesses better properties than the previous one. Each normal form presupposes a certain set of restrictions, and the relationship is deemed to be normal form if it meets a set of inherent limitations. An example of a set of restrictions is the limitation of the first normal form - the values of all attributes are atomic. Since the requirement of the first normal form is a basic requirement of the classical relational data model, we assume that the initial set of relations already complies with this requirement.

In the theory of relational databases the following sequence of normal forms is recommended:

- First Normal Form (1NF);
- Second Normal Form (2NF);
- Third Normal Form (3NF);
- Normal Form Boyce-Codd (BCNF);
- Fourth Normal Form (4NF);
- Fifth Normal Form or Normal Form of projection connection (5NF or PJ / NF).

The basic properties of normal forms:

Each consequent normal form in some ways is better than the previous one.

During transition to the next property, the previous normal forms preserve their normal properties. The process of DB is based on the normalization method, decomposition of the relationship inherent in the previous normal form into two or more relationships that satisfy the requirements of the consequent normal form. In practice, the normal form of relations is based on the fundamental relational database theory and the concept of functional dependence. For further discussion, we need some definitions.

Definition 1. Functional dependence

Regarding R.Y is functionally dependent on the attribute of the X attribute (X and Y may be composite) if and only if each X value corresponds to exactly one Y value: R.X (r) R.Y.

Definition 2. Complete functional dependency

Functional dependence R.X (r) R.Y is called complete, if Y is an attribute functionally independent from any precise subsets of X.

Definition 3. Transitive functional dependency

Functional dependence R.X -> R.Y is called transitive if there exists an attribute Z, which has the functional dependencies R.X -> R.Z and R.Z -> R.Y, and no functional dependence R.Z -> R.X. (In the absence of the latter requirement, we would have 'uninteresting' transitive dependencies in any relationship which has several keys.)

Definition 4. Determination of a non-key attribute

A non-key attribute is any attribute relationship that is not a part of the primary key (e.g., primary).

Definition 5. Determination of the mutual independence of the attributes

Two or more attributes are mutually independent if none of these attributes is functionally dependent on others.

5.7.2 The second normal form

Consider the following example of relationship schema:
EMPLOYEES-DEPARTMENTS-PROJECTS
(EMPLOYEE_ID, SALARY, DEPARTMENT_ID, PROJECT_ID, JOB_ID)
The primary key is:
EMPLOYEE_ID, PROJECT_ID
There are also functional dependencies:
EMPLOYEE_ID -> SALARY
EMPLOYEE_ID -> DEPARTMENT_ID
DEPARTMENT_ID -> SALARY
EMPLOYEE_ID, PROJECT_ID -> JOB_ID

As can be seen, even though the primary key is the attribute EMPLOYEE_ID, PROJECT_ID, attributes SALARY and DEPARTMENT_ID are functionally dependent on the primary key attribute EMPLOYEE_ID. As a result, we cannot put in relation EMPLOYEES-DEPARTMENTS-PROJECTS the tuple that describes an employee who is not yet executing any project (the primary key cannot contain an indefinite value). When remove the tuple, we destroy not only the relationship of the employee with the project, but we also lose the information that the employee works in a certain department. When transferring the employee to another department we will have to modify all the tuples describing the employee, or get inconsistent results. Such an unpleasant phenomenon is called abnormalities of circuit relationship. They are eliminated by normalization.

Definition 6: Second Normal Form (in this definition it is assumed that the only key relationship is the primary key).

Relationship R is in the second normal form (2NF) if and only if it is in 1NF, and each non-key attribute is fully dependent on the primary key.

We can make the following decomposition of relations EMPLOYEES-DEPARTMENTS-PROJECTS into two relations: EMPLOYEES-DEPARTMENTS and EMPLOYEES-PROJECTS.

EMPLOYEES-DEPARTMENTS (EMPLOYEE_ID, SALARY, DEPARTMENT_ID)

For the first relation we have the primary key:

EMPLOYEE_ID

And also functional dependencies are:

EMPLOYEE_ID -> SALARY

EMPLOYEE_ID -> DEPARTMENT_ID

DEPARTMENT_ID -> SALARY

EMPLOYEES-PROJECTS (EMPLOYEE_ID, PROJECT_ID, JOB_ID)

For the second relation we have the primary key:

EMPLOYEE_ID, PROJECT_ID

And the functional dependencies are:

EMPLOYEE_ID, PROJECT_ID -> JOB_ID

Each of these two ratios is in 2NF, and they eliminate the abnormalities mentioned above (it is easy to see that all these operations are carried out without any problems).

Assuming the presence of a few keys, definition 6 takes the following form:

Definition 6: Relationship R is in the second normal form (2NF) if and only if it is in 1NF, and each non-key attribute depends entirely on each key R.

Further, we will not give examples of the relations with several keys. They are too ambiguous and refer to the situations which rarely happen in practice.

5.7.3 The third Normal Form

Let’s consider again the relation EMPLOYEES-DEPARTMENTS, which is in 2NF. We can see that the functional dependency EMPLOYEE_ID->SALARY is transitive; it is a consequence of the functional dependencies EMPLOYEE_ID->DEPARTMENT_ID AND DEPARTMENT_ID->SALARY. In other words, the employee's salary is actually a characteristic. It is the characteristic not of an employee, but of the department in which he/she works (this is not a natural assumption, but sufficient for an example).

As a result we cannot put into the database the information, which characterizes the department’s salary until there is at least one employee (the primary key cannot contain an indefinite value). When we remove the tuple, which describes the last employee of the department we are deprived of the information on the department’s salary. In order to change the department’s salary in a coordinated way we have to primarily find all the tuples describing the employees of the department. That means that in the relation EMPLOYEES-

DEPARTMENTS there are still abnormalities. They are eliminated by normalization.

Definition 7. Third Normal Form (The definition is again given assuming there is only one key.)

Relationship R is in the third normal form (3NF) if and only if it is in 2NF, and each non-key attribute intransitively depends on the primary key.

We can make a decomposition of relations EMPLOYEES-DEPARTMENTS into two relations EMPLOYEES and DEPARTMENTS:

EMPLOYEES (EMPLOYEE_ID, DEPARTMENT_ID)

The primary key is:

EMPLOYEE_ID

The functional dependencies are:

EMPLOYEE_ID->DEPARTMENT_ID

DEPARTMENTS (DEPARTMENT_ID, SALARY)

The primary key is:

DEPARTMENT_ID

The functional dependencies are:

DEPARTMENT_ID->SALARY

Definition 7. Each of these two relations is in 3NF and free of marked abnormalities.

If we give up the restrictions that the relation has a unique key, then the definition of 3NF will take the following form:

Relationship R is in the third normal form (3NF) if and only if it is in 2NF, and each non-key attribute is transitively dependent on any key R.

In practice, the third normal form of relations schemes is sufficient in most cases, and the process of designing a relational database typically ends. However, in some cases it is useful to continue the normalization process.

5.8 Techniques of working with databases

Techniques of working with databases involve several steps:

- Construction of an Infological base model;
- Creation of the structure of database tables;
- Processing data contained in the tables;
- Display of information from the database.

For the construction of an information-logical model it is necessary to select data sources, to determine by which parameters the database objects will be described, to specify the tasks solved by the database, and to consider the problems that should be addressed in the future. For example, suppose that a travel agency creates an information system that automates the process of taking into account agreements with clients and monitors the execution of travel orders. The information system database is likely to contain the following information: the name of the client, the contact data of the person, the description of the contract

subject (the country, the number of tourists, the tour), the date of contract execution, the contract expiry date, the date of payment. The agreement is fulfilled with the participation of the travel agency employee.

The IS functions include receiving the following information:

About the client:

- Customer data for the implementation of the contractual activities;
- Information about the regular customers;
- Information about the Customers bringing in the highest income.

About the contracts:

- Payments under the contract;
- Information on the most popular tours;
- Information on the tours that bring the highest income.

About the execution:

- Information on the volume of work performed by each employee;
- Information about contracts, which expire soon (this month).

Business analysis:

- A list of all stages, grouped by countries (regions, seasonal);
- Information about individual tours;
- Information about group tours;
- Information on the number of tours by regions;
- Financial statements and others.

After analyzing what kind of data will be received and the challenges that must be addressed, it is necessary to divide the data into the groups that subsequently become the database tables.

In our case, we can distinguish the following groups:

- Customers
- Contracts
- Countries
- Employees.

Creating a database schema involves identifying groups and types of data that will be stored in the tables, the size of the task fields in each table, and the definition of common elements in key tables.

Entering and editing of data can be done in two ways: by using special forms and directly into the table without the use of forms. Processing information in the database is done by querying, or during the execution of a specially developed program.

Query is a command addressed to the database, which contains a requirement to provide certain information formulated in the request. Queries are designed to retrieve information from the database according to various criteria. When dealing with requests, two stages can be distinguished: query design (creation) and query execution. Requests come in different types: for selection, removal, cross-sectional, final, parametric, and others.

When you run a query you have to select all the information from the database tables according to the query criteria. The result of the query is a table with the ordered set of data (dynamic set). Thus, a dynamic set of record fields may include one or more tables. The database information is retrieved from it based on the output produced. The data retrieved in tables is presented to the end-user in the form of a report. The report allows you to provide information, which can be printed in a convenient format. It can be supplemented with drawings and schedules that will make the report data more visible and attractive.

5.9 SQL Fundamentals

The SQL (Structured Query Language) is a standard query language for working with relational databases. The SQL language appeared after the relational algebra, and its prototype was developed in the late 70s at IBM Research Company. It was implemented in the first prototype of a relational DBMS by the IBM System R. company. Further it was used by many commercial database systems and due to its wide use it gradually became a ‘de facto’ standard for the languages to manipulate data in relational database languages.

SQL was initially developed in 1989 (hereinafter SQL/89 or SQL1). SQL1 was designed for managing data held in a database management system (DBMS). SQL became a standard of ANSI and ISO. Since then, the standard has been revised to include a larger set of features.

SQL (SQL/92 or SQL2), released in late 1992, was a new international language standard which was significantly more accurate and complete than SQL/89. Currently, most DBMS manufacturers have changed their products to meet the SQL2 standard.

SQL3 appeared in 1999. If the differences between SQL1 and SQL2 standards were largely quantitative, the standard SQL3 underwent serious qualitative transformations. SQL3 adds new data types to set complex structured data types, which are more consistent with the object orientation. Finally, it contains a section which introduces the standards to the events and triggers that were not previously addressed in the standards, but were widely used in commercial DBMSs. The standard defines clear specifications of the triggers as a set of events and actions. The action can be either a sequence of SQL statements and control operators to execute programs. To control transactions, the old transaction model was used, when a savepoint implements transactions by indicating a point within a transaction that can be "rolled back to" without affecting any work done in the transaction before the savepoint was created. This solution increases the flexibility of implementing complex algorithms of information processing.

Why do we need these standards? Why have they been invented and studied? The text of the standard SQL2 consists of 600 pages of dry formal text, it seems to be a very big volume. One may think that it is just the developers’ intrigues, but

not what is necessary for ordinary developers. However, database developers should not ignore the standard for some good reasons. Any information system is developed by using the database technology. It is a time-consuming process, taking several tens or even hundreds of person-months. One should be aware that it is impossible to develop a system within a few days. In addition, telecommunications systems, hardware and software are rapidly developing, so the project may become obsolete even before implementation. Real objects, whose behavior is modeled using database and procedures of information processing, are developing too. That is why the project of information system should be designed so that it could be extended and portable to other platforms. Most hardware and software vendors follow the strategy of supporting standards, otherwise users will not buy them. However, each provider strives to improve their product by introducing some additional features not included in the standard. Therefore developers should focus either on the specific features of the product or try to keep to the standard. In the second case, all the intellectual work invested in development becomes more secure, as the system acquires the properties of portability. If a more promising platform appears, the project which is more focused on the standards can be easier transferred than the one that is mainly focused on the features of a particular platform. In addition, the standards is the right benchmark for developers, as all DBMS vendors follow the standard in their future developments, and you can be sure that in the end, the standard will be implemented in almost all the advanced DBMS. It happened with the SQL1 standard, it is happening with the standard SQL2, and so it will happen with SQL3.

DBMS vendors consider a standard as a guiding star, which ensures the correct direction of the work. But effectiveness of standard implementation is a guarantee of success.

The SQL cannot be fully attributed to the traditional programming languages, it does not contain the traditional operators that control the program execution and describe the types. It only contains a set of standard operators for accessing the data stored in the database. SQL statements are embedded in the basic programming language, which can be any standard language such as C ++, PL, COBOL, and so on. In addition, SQL statements can be executed directly online.

5.9.1 Structure of SQL

Unlike relational algebra, where operations were only queries to the database, the SQL is a complete language. It contains not only query operations, but also the operators corresponding to Data Definition Language (DDL), which is a data description language. In addition, the language contains operators for managing (administration of) the database.

The SQL contains the sections that are presented in the following Tables 5.1:

Table 5.1 - Data Definition Statements (DDL)

Operator	Purpose	Action
CREATE TABLE	Create a table	Creates a new table in the database
DROP TABLE	Delete a table	Deletes a table from the database
ALTER TABLE	Change a table	Changes the structure of an existing table or its integrity constraints
CREATE VIEW	Create a presentation	Creates a virtual table in accordance with a certain SQL-query
ALTER VIEW	Change a presentation	Modifies a previously created presentation
DROP VIEW	Remove a presentation	Removes a previously created presentation
CREATE INDEX	Create an index	Creates an index for a table for a quick access by the attributes included in the index
DROP INDEX	Remove an index	Removes a previously created index

Table 5.2 - Data Manipulation Language (DML) operators

Operator	Purpose	Action
DELETE	Delete a line	It removes one or more lines according to the filtering conditions of the underlying table. In case the operator agrees with the integrity support principles, the operator cannot always be used correctly, even if it is syntactically correct
INSERT	Insert a line	It inserts a line in the base table. It is a valid modification operator, in which multiple rows can be moved from one table or query to the base table
UPDATE	Update a line	It updates the values of one or more columns in one or more lines in accordance with the filter conditions

Table 5.3 - Data Query Language (DQL)

Operator	Purpose	Action
SELECT	Select lines	The operator that replaces all the operators of relational algebra and allows to form the resulting ratio corresponding to the request

Table 5.4 - Transaction Management Tools

Operator	Purpose	Action
COMMIT	Complete a transaction	It completes complex interconnected data processing of information within a transaction
ROLLBACK	Cancel a transaction	It cancels changes made during the transaction

SAVEPOINT	Save an intermediate point of transaction implementation	It saves an intermediate state of the database, marks it in order to be able to later return to it

Table 5.5 - Data Administration Tools

Operator	Purpose	Action
ALTER DATABASE	Change a database	It changes a set of basic objects in the database, puts restrictions on the entire database
ALTER DBAREA	Change a database storage area	It changes a previously created storage area
ALTER PASSWORD	Change a password	It changes a password for the entire database
CREATE DATABASE	Create a database	It creates a new database, defining its basic parameters
CREATEDBAREA	Create a storage area	It creates a new storage area and makes it accessible for the data
DROP DATABASE	Delete a database	It deletes an existing database (only when you have the right to perform this action)
DROP DBAREA	Delete a database storage area	It removes the existing storage area (if the currently active data is not located therein)
GRANT	Provide rights	It provides access rights to a number of actions over a certain database object
REVOKE	Deprive of rights	It deprives of the rights of accessing an object, or performing some actions on the object

Table 5.6 - SQL programming

Operator	Purpose	Action
DECLARE	Define a cursor for a query	It specifies a name and defines the related request to the database, which corresponds to a virtual data set
OPEN	Open a cursor	It creates a virtual data set corresponding to the description of the specified cursor and the current state of the database
FETCH	Read the line out of a number of lines defined	It reads the next line, a set parameter commands from the virtual data set

	by a cursor	corresponding to an open cursor
CLOSE	Close a cursor	It terminates access to a virtual data set corresponding to a said cursor
PREPARE	Prepare a SQL statement for a dynamic execution	It generates a query execution plan corresponding to a given SQL statement
EXECUTE	Run the SQL statement, which was previously prepared for a dynamic execution	It performs a previously prepared query plan

The main purpose of the SQL language (as in other languages used in work with databases) is the preparation and execution of requests. A plurality of records, called representation, can be obtained as a result of data sampling from one or more tables.

The view is essentially a table formed by the query. It is a kind of the stored query. At the same table, you can construct multiple views.

All the SQL statements can be divided into three (at least) groups of operators. Query Language operator - SELECT, manipulation language data operators and operators of data definition language. (There are other groups, but these are the main ones to be used in the course)

5.9.2 SELECT operator

The query language in the SQL consists of a single operator - SELECT. SELECT statement syntax is as follows:

SELECT [ALL | DISTINCT] <*field list*> | *
FROM <*table list*>
[WHERE <*predicate condition-sample or compound*>]
[GROUP BY < *Results field list* >]
[HAVING <*Predicate-condition for the group*>]
[ORDER BY <*list of fields on which to regulate output*>];

SELECT is a keyword which tells the database that this command is a request. All queries begin with the word followed by a space. This may be followed by sampling method.

The keyword **ALL** means that the result set of lines includes all lines that satisfy the query. So in the resultant set there can the same lines. It is a violation of the principles of the relations theory (as opposed to relational algebra, where by default it assumes no duplicates in every resulting relations).

DISTINCT keyword means that the result set includes only different rows, that is the result of duplicate lines are not included in the set.

Field List is a comma-separated list of columns that are selected by the query from tables.

The * (asterisk) indicates that the result set includes all columns of the source table query.

The **FROM** section gives a list of source relations (tables) of the request. If there is more than one table name, implicitly it means that the Cartesian product is implemented on the tables listed above.

Sections **SELECT** and FROM are mandatory, all other sections are optional.

The **WHERE** section specifies the conditions of sampling or terms of the tuple connection of source tables, similar to the operation of conditional connections in the relational algebra.

The following predicates can be used in condition expressions in the WHERE:

Comparison predicates (=, <>,>,> =, <, <=), which have a traditional meaning.

Predicate Between A and B accepts the values between A and B. The predicate is true when the comparison value falls within a given range, including range borders. At the same time the opposite predicate Not Between A and B is set in the standard, which is true when the comparison value does not fall in a predetermined range, including its borders.

Predicate entry into the set IN (set) is true when the comparison value is included in a plurality of predetermined values. This set of values can be defined by simple enumeration or built-in subquery. At the same time there is the opposite NOT IN (set) predicate, which is true when the comparison value is not included in the set.

Comparison of predicates with LIKE and NOT LIKE pattern. The LIKE predicate requires setting a template, which is compared to a predetermined value, the predicate is true if the comparison value corresponds to the template, and it is false otherwise. The NOT LIKE predicate has the opposite meaning. The template can contain % (* for Access) to denote any number of characters; _ (? For Access) to denote any symbol.

The predicate comparisons with indefinite IS NULL value. Special standard predicates are used to identify the value equality of some attribute to undefined : <attribute name> IS NULL and <attribute name> IS NOT NULL

EXIST predicate of existence and non-existence NOT EXIST. It is used in nested queries to determine a non-empty or empty set, which is the result of the sample.

The **GROUP BY** section gives a list of groups of fields. **GROUP BY** includes data recording and it combines all data records containing the identical value in a specified field (or fields) into one record. **WHERE** defines which records should be involved in the grouping, i.e. it filters before grouping.

Using Group By differs from the use of Distinct. In the latter tuples that are identical in all fields (from the matching records there is only one tuple) in the

current view will be dropped. A grouping operation brings the source relation to the mode when all the fields requested are on the display, and are not specified in terms of grouping, then the aggregate functions are used (if they are not defined, then the request will not be executed).

Condition predicates are defined in the **HAVING** section, those are the conditions imposed on each group. **HAVING** is used to filter the records resulting from the grouping. **WHERE** specifies which records should be involved in the grouping, i.e. it filters before the grouping. **HAVING** determines which records resulting from the grouping are included in the resultant sampling, i.e. it filters records after grouping.

In the **ORDER BY** section a list of fields of the results arrangement is set, that is, the list of fields that defines the sort order in the resulting relation. For example, if the first field specifies the group code and the second one specifies the surname, the recordings in the resulting relation will be arranged in the ascending order of the group code and then under one recording group sorted by name in alphabetical order.

Adding tuples is performed with the command:

INSERT INTO table_name [(<column list>)] **VALUES** (<list of values>)

The list of columns and the list of values are separated by commas, and the values are added to the appropriate columns. If you want to add a tuple entirely (i.e. the value is for all fields and their order coincides with the order of the fields in relation), the description of the column list can be omitted.

Data **DELETE** statement removes one or more rows from a table in accordance with the conditions that are set for the rows to be deleted. **DELETE** statement syntax is as follows:

DELETE FROM <table_name> [**WHERE** <where condition>]

If selection criteria are not specified, then all rows from the table will be deleted.

Data update operation **UPDATE** is required in case of data changes which should be reflected in the database.

The request for update can change the whole group of records. This query consists of three parts:

- **UPDATE** statement, indicating the updated table;
- **SET** statement, specifying the data for update;
- Optional criteria of the **WHERE**, limiting the number of records that are affected by the update query.

SDL or DDL queries

Commands of data defining language of the schema (Schema Definition Language - SDL, etc. Data Definition Language - DDL) is a SQL instruction that allows you to create and modify elements of the database structure. For example, using the SDL, you can create, delete tables and change their structure, create and delete indexes.

Creating a table. A table creating operator is as follows:

CREATE TABLE <table name>
(<Column name> <data type> [NOT NULL]
[<Column name> <data type> [NOT NULL]] ...)

The mandatory operator operands are the name for the table and the name of at least one column (field) indicating the type of data stored in that column.

When creating a table for individual fields there can be indicated some additional rules for controlling input values in them. For example, NOT NULL design (not empty) is used to determine a required field.

To delete a table, the following instruction is used:

DROP TABLE <table name>

5.10 Directions of Database Development

The analysis of modern databases and their applications suggests the following areas of their development:

1. Search for more modern representation models and types of data in the databases.

The DBMS is of interest in this respect. It supports several models or one integrated model, and allows programming calculations in a convenient way, processing symbol and image information, working with knowledge, audio and video information, accessing distributed information, and others. Thus, many modern databases attempt to use different types of binary data type and hyperlinks.

2. Development of new DBMS architectures.

The modern ISs require the database capabilities to store and process petabytes of data volumes (1015 bytes). So, tertiary memory is used since there is a need to organize a new level of hierarchy carrier. Tertiary storage devices can be presented in the form of pillars of magnetic disks or tapes with automatically interchangeable supports. An example would be a VSM (Virtual Storage Manager) buffer system of Storage Tek Corporation. This system accumulates and stores the data on hard disks in the data buffer, where they are stored in the form of virtual tape volumes on the magnetic tapes (up to 100 000 volumes on each disk buffer). The maximum speed of data transfer is up to 45 MB/s.

3. Expansion of areas of the database application.

The new areas of application may include two groups of tasks:

- Very large volumes of information processing. An example is the Earth observation projected by IP EOS (Earth Observing System), the main element of which is the database EOS DIS (EOS Data and Information System), a system of data and information.

- Processing of distributed information in the network. The examples of tasks of this type are the tasks for search and selection of information in the Internet,

organization of collective design in geographically dispersed organizations, exchange of material, informational, financial and other resources with electronic design.

4. Improving the service for the end users, administrators and developers.

Perspective databases allow solving applied problems in the best way. It is necessary to rely on a more advanced element base (increased query performance, increased volume of stored data), to have more advanced software (distributed processing, security of stored information), to have a flexible and convenient interface for the developers, users, and a database administrator. One of the new requirements in the field of IT is to ensure non-stop operations. Some ISs operate continuously.

In modern conditions there is a need to provide information service to the mobile users. It is required to service the database in a central (stationary) way and on a portable computer. Herewith, it is necessary to have means of loading/unloading of the selected data from a central computer into a portable one as well as means of ensuring the consistency of information in both databases. These means could be, for example, the DBMS of Oracle Lite.

Review questions

1. What is meant by the database? What is the difference between a database and a simple set of data?
2. What is the database system? What are its components?
3. What are the main elements of the database?
4. What is the data model? What are the main components of the data model?
5. Name the existing data models. What are the differences between them?
6. What are the levels of the database architecture? Give definition of each level.
7. Name the main levels of the database design. What problems are solved when designing databases?
8. What is a normalization? How many normal forms are there?
9. What stages of work with database technologies are there?
10. What is the SQL language? What is the basic structure of the SQL language?
11. What are the basic SQL operators?

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CHAPTER 6. DATA MINING

6.1 Introduction

Knowledge can be defined as a set body of facts and principles (concepts, rules, methods etc.) accumulated by humankind or the Act, Fact, or State of Knowing (may be true, but far from complete).

The meaning of knowledge is closely related to the meaning of intelligence. Characteristics of intelligent people are having much knowledge.

In biological organisms, knowledge is likely stored as complex structures of interconnected neurons. The average human brain weights about 1.5 kg and contains about 1012 neurons (estimated potential of storage capacity is about 1014 bits). Knowledge should not be confused with data (e.g. physician treating a patient uses both data and knowledge) (What is the distinction between belief, hypothesis, and knowledge).

General scheme of knowledge representation:

Mental images - > Written text (Character strings, pictures) - > Computer devices store.

Actual activity in digital data acquisition and storage technology has resulted in the growth of large databases. This has occurred in all areas of human endeavour from the mundane (such as supermarket transaction data, credit card usage records, telephone call details and government statistics) to the more exotic (such as images of astronomical bodies, molecular databases, and medical records). It isn't a surprize, that interest has grown in the possibility of tapping these data, extracting information that can be valuable to the owner of the database. The discipline concerned with this task has become known as Data mining (DM).

6.2 What is Data mining?

Data mining is a process of performing automated extraction and generating predictive information from large data banks. DM includes analysis of (often large) observational data sets to find unsuspected, previously unknown relationships and summarize the data in new ways that are both understandable and useful for the data owner.

Relationships and summaries derived through a data mining are often referred to as models or patterns. Examples include linear equations, rules, clusters, graphs, tree structures, and recurrent patterns in time series. It should be noted that the discipline typically deals with data that have already been collected for some purpose other than the data mining analysis (for example, they may have been collected in order to maintain up-to-date record of all transactions in a bank). This means that the objectives of the data mining usually play no role in the data collection strategy. This is one of the ways in which it differs from many statistics in which data are often collected by using efficient strategies to answer specific questions.

DM, popularly referred to **Knowledge Discovery in Databases** (KDD), is the automated or convenient extraction of patterns representing knowledge implicitly stored or captured in large databases which can contain millions of rows related to Database subject, Data Warehouses, Web, other massive information repositories or data streams.

For example, Figure 6.1 illustrates the place of DM in the Data Warehouses (DWH) architectures.

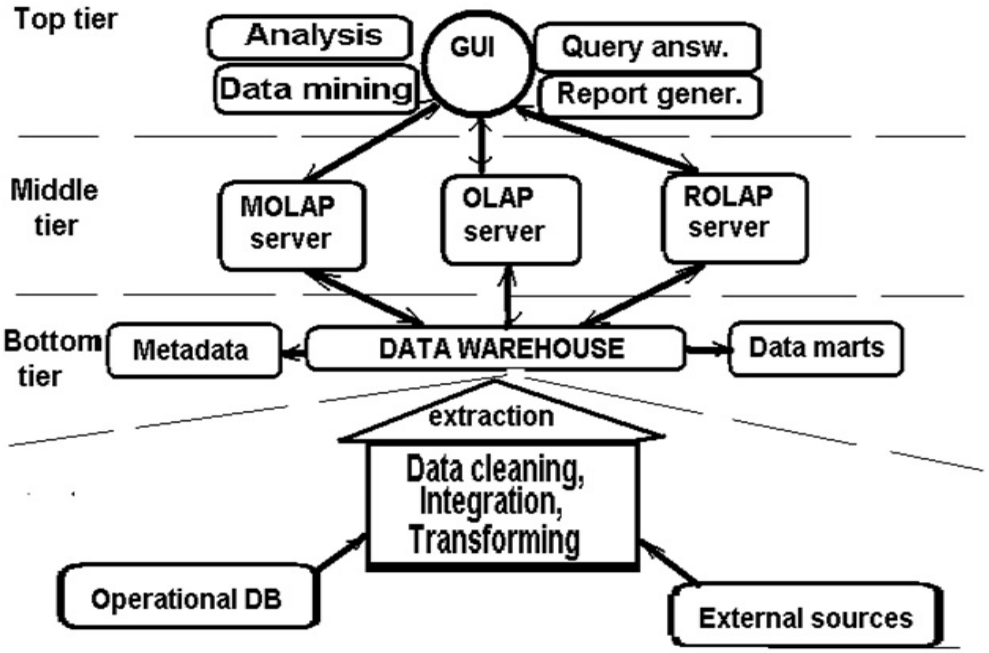


Figure 6.1 - General Data Warehouse architectures

So, readers (who we suppose know about Database system structure) can recognize main differences between conventional Database System and DWH which include **Data Mining, Analysis (**as parts of knowledge discovery in databases**),OLAP Engine** (Online Analytics Processes instead of or additionally to Online Transaction Processes**) DW/Marts servers** (set of servers for different departments of enterprises), **Back Ground process/preprocessing** (e.g. Cleaning – solving problem with missing data, noise data) and etc.

Remark about the history of terms

[from https://en.wikipedia.org/wiki/Data_mining]:

Gregory Piatetsky-Shapiro coined the term "Knowledge Discovery in Databases" for the first workshop on the same topic (KDD-1989) and this term became more popular in AI and Machine Learning Community. However, the term Data mining (1990) became more popular in the business and press communities. Currently, Data Mining and Knowledge Discovery are used interchangeably. The terms "Predictive Analytics" (since 2007) and "Data Science" (since 2011) were also used to describe this field.

Actually, we can say that DM is a step in the KDD process concerned with the algorithms, variety of techniques to identify decision-making knowledge in the data (DB) that can be used in such areas as decision supports, prediction,

forecasting and estimation using pattern recognition techniques as well as statistical and mathematical techniques.

The basic Data mining models and tasks:

DM involves many different algorithms to accomplish different task. All these algorithms attempt to fit a model to the data. The model that is created can be either **predictive or descriptive** in nature. Figure 6.2 represents the main DM tasks used by that type of model.

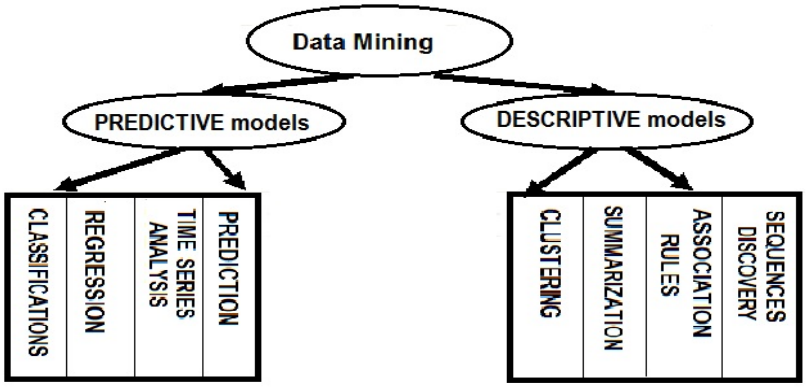


Figure 6.2 - Data Mining models and tasks.

Predictive model enables to predict the values of data by using known results from different sets of sample data.

• **Classification** enables to classify data from a large data bank into predefined set of classes. The classes are defined before studying or examining data in the data bank. Classification tasks enable not only to study and examine the existing sample data but also to predict the future behaviour of that sample data. For example, the fraud detection in credit card related transaction to prevent material losses; estimation of the probability of an employee to leave an organisation before project's end are some of the tasks that you determine by applying the technique of classification.

• **Regression** is one of statistical techniques which enable to forecast future data values based on the present and past data values. Regression task examines the values of data and develops a mathematical formula. The result produced on using this mathematical formula enables to predict future value of existing or even missed data. The major drawback of regression is that you can implement regression on quantitative data such as speed and weight to predict future behaviour of them.

• **Time series analysis** is a part of **Temporal mining** enabling to predict future values for the current set of values which are time dependent. Time series analysis makes to use current and past sample data to predict the future values. The values that you use for time series analysis are evenly distributed hourly, daily, weekly, monthly, yearly and so on. You can draw a time-series plot to visualize the amount of changes in data for specific changes in time. You can use time series

analysis for examining the trends in the stock market for various companies for a specific period and making investments accordingly.

Essence of a descriptive models is determination of the pattern and relationships in a sample data:

- **Clustering** is a data processing in some sense opposite to classifications which enables you to create new groups and classes based on the study of patterns and relationship between values of data in a data bank. It is similar to classification but does not require predefining the groups or classes. Clustering technique is otherwise known as **unsupervised learning** or **segmentation**. All these data items that resemble more closely with each other are clubbed together in a single group, also known as clusters. Examples include groups of companies producing similar products, or soils having the same properties (eg, black soil), a group of people with the same habits, etc.
- **Summarization** is a technique which enables to summarize a large chunk of data contained in a Web page or a document. The study of this summarized data enables to get the gist of the entire Web page or the document. Thus, summarization is also known as **characterization or generalization.** Summarization searches for specific characteristics and attributes of data in the large set of the given data and then summarizes the same. An example of the use of summarization technology is search engines such as Google. Other examples include document summarization, image collection summarization and video summarization. Document summarization, tries to automatically create a *representative summary* or *abstract* of the entire document, by finding the most *informative* sentences.
- **Association rules** enable to establish association and relationships between large unclassified data items based on certain attributes and characteristics. Association rules define certain rules of associativity between data items and then use these rules to establish relationships. Sequence discovery determines the sequential patterns that might exist in a large and unorganized data bank. You discover the sequence in a data bank by using the time factor i.e., you associate the data items with the time at which it is generated. The study of sequence of events in crime detection and analysis enables security agencies and police organizations to solve a crime mystery and take preventative measures. Similarly, the occurrence of certain strange and unknown diseases may be attributed to specific seasons. Such studies enable biologists to discover preventive drugs or propose preventative measures that can be taken against such strange and unknown diseases.

6.3 Techniques often used for data mining

Techniques (methods, algorithms) provide a way to use various data mining tasks such as classification and clustering in order to predict solutions of a problem. They (techniques) provide a level of confidence about the predicted

solutions in terms of consistency of prediction and frequency of correct predictions.

Data mining includes big number of different approaches such as statistical and information analysis, decision trees, similarity measures, neural networks, genetic algorithms, fuzzy logic, etc. Let's try to explain the essence of some popular ones.

- **Statistics** is one of largest branches of mathematics which deals with the collection and analysis of numerical data by using various methods and techniques. Some of the statistical techniques that find its extensive usage in data mining are:
- **Point estimation**: a process of calculating a single value from a given sample data using statistical techniques such as mean, variance, media and so on.
- **Data summarization**: a process of providing summary information from a large data bank without studying and analyzing and every data elements in the data bank. Creating a histogram is one of the most useful ways to summarize data using various statistical techniques such as calculating the mean, median, mode, and variance.
- **Bayesian techniques**: a technique of classifying data items available in a data bank. The simplest one of all Bayesian techniques is the use of Bayes Theorem that has led to the development of various advanced data mining techniques.
- **Testing a hypothesis**: a technique of applying sample data to a hypothesis in order to prove or disprove the hypothesis.
- **Correlation**: a technique of determining the relationship between two or more different sets of data variables by measuring their values.
- **Regression:** a technique of estimating the value of a continuous output data variable from some input data variables.
- **Decision Trees:** a tree-shaped structure which represents a predictive model. In a decision tree each branch of the tree represents a classification question while the leaves of the tree represent the partition of the classified information. You need to follow the branches of a decision tree that reflect the data elements in such a way that when you reach the bottom leaf of the tree, you have the answer to the question in that leaf node. Decision trees are generally suitable for tasks related to clustering and classification. It helps to generate rules that can be used to explain the taken decision.
- **Machine Learning**: a process of generating a computer system that is capable to acquire data independently and integrate data to generate useful knowledge. The concept of machine learning is to make a computer system behave and act as a human being who learns from experience, analyzes the observation in such a way that system is developed for continuously self-improvement and provision of increased efficiency and effectiveness. Machine learning enables to discover new and interesting structures and formats about a set of data that are previously unknown.

- **Hidden Markov Models**: a model that enables to predict future actions taken in time series. The models provide the probability of a future event when provided with the present and previous events. Hidden Markov models are constructed using the data collected from a series of events in such way that the series of present and past events enable to determine future events in a certain degree. Simply, Hidden Markov models are a kind of time series model where the outcome is directly related to the time. One of the constraints of Hidden Markov models is that the future actions of the series of the events are totally calculated by the present and past events.
- **Artificial Neural Networks**: the non-linear predictive models which use the concept of learning and training and closely resemble the structure of the biological neural networks. In artificial neural network a large set of historical data is trained or analyzed in order to predict the output of a particular future situation or a problem. You can use artificial neural network in a wide variety of applications such as fraud detection in online credit card transactions, secret military operations, and for operations which require biological simulations.
- **Genetic Algorithms**: a search algorithm that enables to locate optimal binary strings by processing an initial random of population of binary strings by performing operations such as artificial mutation, crossover and selection. You can use genetic algorithms to perform such tasks as clustering and association rules. If you have a certain set of sample data then genetic algorithms enable to determine the best possible model out of a set of models in order to represent the sample data. While using the genetic algorithm technique, first, you arbitrarily select a model to represent the sample data. Then you perform a set of iterations on the selected model to generate new models. You select the most feasible model out of the many generated models to represent the sample data using the defined fitness function.
- **Meta Learning**: a concept of combining the predictions made from multiple models of data mining and analyzing these predictions to formulate new and previously unknown prediction. You can use the predictions made by different data mining techniques as input to a Meta learner which would combine each of the predictions in order to create the best-possible model or solution. For example, if you use the predictions of a decision tree, an artificial neural network, and a genetic algorithm as an input to a neural network Meta learner, it will try to implement the learning methodology to combine the input predictions to generate the maximum classification accuracy.

6.4 Data Mining Applications as tools for analysis and management

DM applications can be found in various fields in our life. It is useful for small, middle and large organizations that generate large amount of data per day.

We will list some examples of DM applications, main goal of which is **analysis and management** of correspondent activities.

- Business

Business analysis and management: data mining enables established business organizations to consolidate business setup by providing reduced cost of doing business, improvements of profit, and enhancement of the service quality to consumers.

- **Electronic (and traditional) commerce**

Multidimensional analysis of sales, customers, products, time, and region. DM provides various decision support systems for consumer acquisition, segmentation, retention, and cross-selling. Thus, it enables to classify and cluster customers for targeted marketing, better interact with consumers, improve the level of consumer services that you provide, and establish a long-lasting consumer relationship.

Analysis of the effectiveness of sales of CAMPAIGNS (careful analysis can help improve company profiles), purchase recommendation and cross-reference of items: (clusters of often purchased items)

- **Computer security**

Data mining enables network administrators and computer security experts to combine their analytical techniques with business knowledge to identify probable cases of fraud and abuse that compromise the security of a computer or a network.

- **Banking and financial processing**

Prediction of loan payment and customer credit, policy analysis are factors which can strongly or weakly influence loan payment performance and customer credit rating.

Detection of “money laundering” and other financial crimes (collection, integration and analysis of information from multiple databases about bank transactions, federal or state crime history of DB).

- **Bioinformatics, Medicine, Health care**

Molecular genetic and genetic engineering (genome researches, study of human DNA sequences. Linking genes to different diseases and treatment effectiveness). As a tool for creating medical expert systems: symptoms clustering, association rules, medical treatments patterns, etc. Health organizations and pharmaceutical organizations generate large amount of data in its clinical and diagnostic activities. Data mining enables such organizations to use the machine learning technique to analyze healthcare and pharmaceutical data and retrieve information that might be useful for developing new drugs.

- **News and entertainment data**

News and entertainment industry generates large volumes of data in the form of the text, graphics, audio, and video formats that are read and viewed by people demographically different from each other. Data mining enables to study and analyze such diverse collections of data and retrieve meaningful and useful statistics that can be implemented in future for better readership or viewership of these programs.

You can find in the Internet huge number of other examples of DM applications in such fields of human activity as Scientific and Engineering data, Telecommunications, Stocks and Investment, Insurance, Crime.

6.5. Process models of Data Mining

As a rule, researchers working in the field of DM practical applications for organizations and enterprises follow a systematic approach of investigations of meaningful retrieval of data from large data sets (e.g. large Databases). Let's see several popular process models of DM.

5A (process model proposed and used by SPSS Inc. in Chicago, the USA)

For the first time SPSS Inc. developed and used this model as a preparatory step towards DM. Then it used enhanced process model, known as CRISP_DM (discussed below), to analyze collected data. The 5A begins first by assessing the problem followed by access or accumulation of data related to the problem. Then, it analyses the data using various DM techniques, extracts neccessary information and implements (Act) the results of solving the problem. Eventually, it tries to automate the process of data mining by building proper software.

Steps of the 5A process model are presented in Figure 6.3.

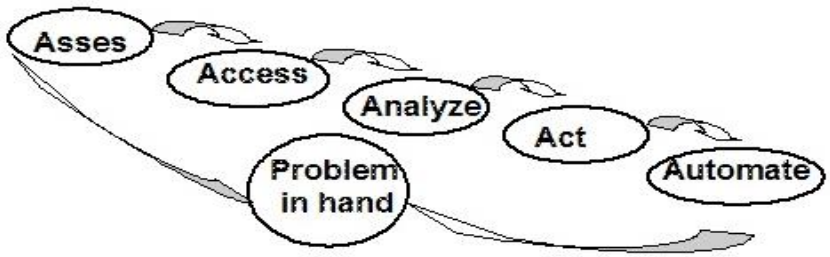


Figure 6.3 - The 5A process model.

CRISP-DM (Cross-Industry Standard Process model for Data Mining proposed by a multinational group of vendors (Denmark, Germany, UK, Netherlands):

The CRISP-DM process model consists of the following steps (Figure 6.4.):

- understand and collect the objectives and requirements to generate DM definition for the business problem.
- analyze the data collected in the first phase, matching patterns to propose a models for solving the problem.
- create final sets of needful data that are input for various modeling tools. The data are first transformed and cleaned to generate Database.
- select and apply different modeling techniques of DM using the Databases from the previous phase and analyze the generated output.

- evaluate models that you generate in the previous phase for better analysis of the refined data.
- deployment: organize and implement the gained knowledge for the end users.

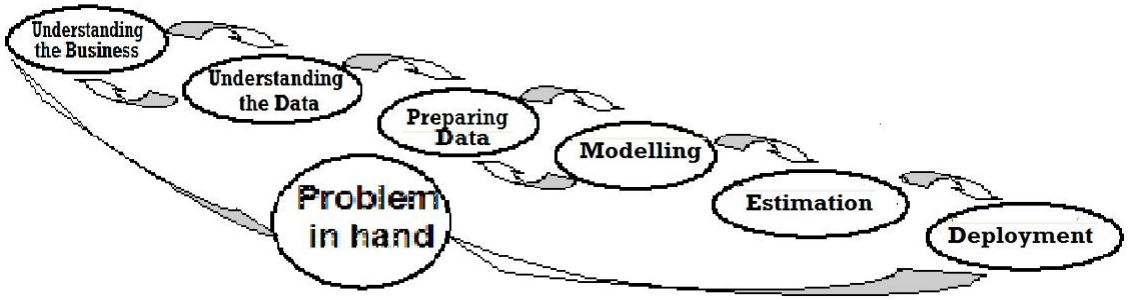


Figure 6.4 - The CRISP-DM process model.

We will list two other process models without detailed description of their items.

SEMMA (process model developed by Sas Institute Inc.) (Sample- Explore- Modify- Model- Analysis), includes the next steps:

- **Problem understanding**
- **Data sampling**
- **Exploration** (explore and refine the sample portion of data using various statistical techniques in order to search for unusual trends and other irregularities)
- **Modification** (clustering, association, visualization, transformation)
- **Modelling and assessment.**

SIX-SIGMA (6 – σ) (process model developed by MOTOROLLA, GE, the USA) includes the following steps

-Define main stages of the investigated process,
- Develop Measure quality methods ,
-Analyze technologies quality ,
- Improve of technologies,
- Control.

6.6 The basic Data mining tasks

More formal definitions of some DM tasks mentioned above, explanation of basic methods of solving tasks and examples will be given in this subchapter. The choice of the tasks and methods discussed here is intended primarily for initial acquaintance and understanding of the most popular applications of DM. This list does not claim to be in any degree a comprehensive summary of a large number of techniques and methods of research published in numerous books and journals, articles on theoretical and applied problems of DM.

1. Classification

Classification is, perhaps, the most familiar and popular data mining technique with big number of applications including image and pattern recognizing, medical diagnosis, loan approval, detecting crime patterns, financial tendencies. A lot of researches suppose that Estimation and Prediction may be considered as types of classification as well.

Before giving a formal definition of classification, let's look at the well-known table of the estimating knowledge of students (we can assume the table is as a small Database with correspondent columns and rows):

Table 6.1 - General Scale and criteria of an estimation of knowledge

% points (of 100)	**Letters grade**	**Traditional marks**
95-100	A	Excellent
90-94	A-	
85-89	B+	Good
80-84	B	
75-79	B-	
70-74	C+	Satisfactory
65-69	C	
60-64	C-	
55-59	D+	
50-54	D	
0-49	F	Unsatisfactory

Table 6.1 explains the way teachers classify students as A,B,…, F or (using traditional marks) as Excellent, Good, etc. based on their grades. This classification is possible by using simple boundaries (100, 95, …, 49, 0). So, Classification is a process and a method by which we divide data into categories, maps data into predefined groups or Classes.

It seems that the following formal definition will now be easier to understand.
Definition:

A given data base $D:\{t_1,t_2,\ldots,t_n\}$ of tuples (items, records) and a set of classes $C:\{C_1,C_2,\ldots,C_m\}$, the classification problem is to define a mapping $f: D \rightarrow C$ where each t_i is assigned to one class. A class, C_j, contains precisely tuples mapped to it; that is, $C_j = \{t_i \mid f(t_i) = C_j\}$, $1 \le i \le n$, and t_i belongs to D.

Classification algorithms require the classes to be defined based on data attribute values. The classification process is divided into two steps:

1. Developing model for evaluating and training data
2. Classifying tuples (rows) from target Database.

Note: training data consist of simple input data as well as corresponding classifications of data.

Figure 5 illustrates the classification problem: a) it shows the predefined classes dividing by the reference space (obtained using training data); b) it provides a sample input data; c) it shows the classification of the data based on the defined classes (i.e. each object/point belongs to one class)).

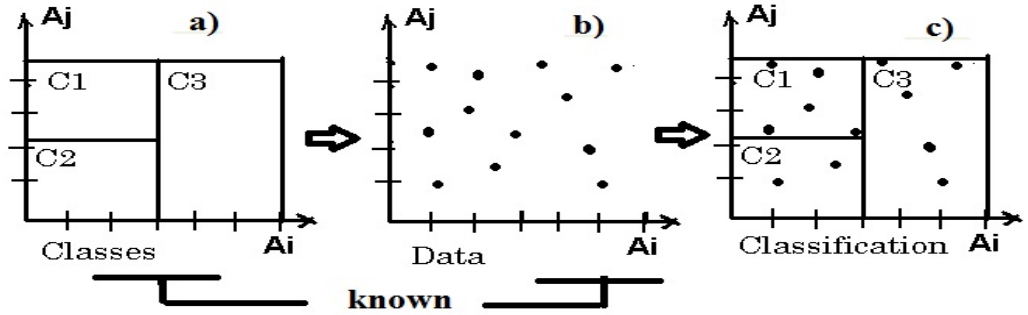


Figure 6.5 - Essence of classification problem

According to R.L. Kennedy, Yu. Lee, B.V. Roy (1998) there are three basic methods to solve the classification problem:

- Specifying boundaries: in this method classification is carried out by dividing input database into categories. Each of these categories is associated with one class.
- Using probability distribution: in this method, probability definition of a class at a particular point determined. Consider a class C_j, the probability definition at one point t_i is $P(t_i \mid C_j)$. Here each tuple is considered to have a single value and not multiple values. If the probability of the class is known to be as $P(C_j)$ then the probability that ti is in the class C_j is determined by the formula $P(C_j) * P(t_i \mid C_j)$:
- Using posterior probability: You would like to determine the probability that t_i is in a class C_j, where t_i is a data value. In this method for classification, the posterior probability for each class is computed and then ti is assigned to the class with highest probability. The formula for posterior probability is denoted as $P(C_j \mid t_i)$.

One can notice that example involves Table 6.1 is of the first group of methods, Neural network methods is of third group.

In general, we can classify algorithms or methods of solution as follows:

- Decision tree-based algorithms
- Rule-based algorithms
- Distance-based algorithms
- Statistic-based algorithms
- Neural Network-based algorithms.
- Combining algorithms.

In the following subchapters various approaches of classification are examined.

Decision tree (DT)-based algorithms:

The DT algorithms are the most useful in classification problems. Using this technique a tree is constructed to model the classification process. Once the tree is built it is applied to each tuple in the database and results in classifications for that tuple.

Definition: Decision Tree (DT) or Classification Tree is a tree associated with D *(D is data base contains tuples {t1,..., tn} and attributes {A1, ... , An})* that has the following properties:

- Each internal node (vertex) is labeled with A***i*** attribute;
- Each arc (edge) is labeled with a predicate that can be applied to the attribute associated with the parent node;
- Each leaf node is labeled with a C***j*** class.

Solving the classification problem using DT is a two steps process:

1. Decision tree induction: construction of DT and using training data
2. Application of DT for each t_i in D, to determinate its class.

Let's consider a simple DT to understand this definition. There is a known rule to determine body weight of adult person (at age after 20-25):

Firstly, let's determine parameter DW = 100*(W/(H-100) -1) ,% , where W is a weight of a person, kg; H is a height of a person, cm. Dimensionless values of these attributes are used to calculate DW. The following approximate information has been obtained using statistical data of medical observations (Table 6.2):

Table 6.2 - Data (Gender and Interval of DW) and classification of weight

Gender	***Interval of DW***	***Classification***
M	DW ≤ -20%	U (under weight)
M	-20% ≤DW ≤20%	N (normal weight)
M	20% ≤DW	O (over weight)
F	DW ≤ -15%	U (under weight)
F	-15% ≤DW ≤25%	N (normal weight)
F	25% ≤DW	O (over weight)

In accordance with the above definition of the structure of DT, we can create proper DT based on classification in this table.

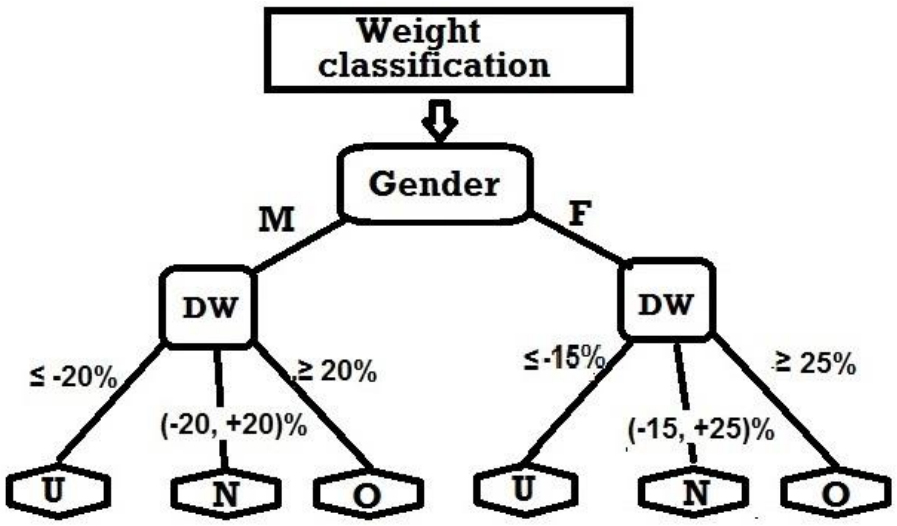


Figure 6.6 - Decision tree based on training data in Table 6.2.

Any person can determine his/her own weight using this DT (which is just graphical representation of data from Table 6.2.). For example: Woman's height is 160 cm and weight is 72 kg (i.e parameter of DW= 100*(72/(160-100) -1)= 20%), so, in accordance with DT she has normal weight. In accordance with the algorithm, after vertex 'Gender' we use edge F and then (after vertex 'DW') edge (-15 , +25)% which leads to leaf N (normal weight).

It is quite clear that similar DTs could be embedded, for example, in medical Decision Support Systems (DSS) which help doctor to take decision about diagnosis and type of cure for patient.

It is clear that the most important part in this classification approach is the creation of DT, and application part is standard. The basic method used to solve the classification problem involving DT is called "Specifying boundaries" (R.L. Kennedy, Y. Lee, B. van Roy, 1998): classification is performed by dividing the input space of potential database of tuples into regions where each region is associated with one class (Figure 6.5.).

We'll illustrate this approach using simple Database example and algorithm known as CLS (system ID3 –Interactive Dichotomizer). Let's suppose that we have an instance of training Database (Table 6.3) which contains binary values of attributes X1, X2, …, X8 of entity which has to be classified along with classification obtained on the base of experts opinion or by some other methods.

Table 6.3 - Training data along with classifications

No.	***X1***	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***Class***
1	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**I**
2	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**I**
3	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**I**
4	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**I**
5	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**II**

6	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**II**
7	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**II**
8	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**II**

On the each step of DT building it is necessary, in accordance with CLS algorithm, to define attribute which maximally separates (discriminates) tuples from different classes. It should be noted that there are a lot of researches and modifications of this algorithm which only differ in the methods of best choice of the separating attribute, but we'll apply the simplest one – just to calculate difference of amounts of '1' for the tuples of Class I and Class II in each column, to determine attribute closer connected to some class. We will obtain results shown in Table 6.4.

Table 6.4. Amount of '1' in columns of table 6.3:

X1	X2	X3	X4	X5	X6	X7	X8	Class
2	1	1	1	2	2	1	2	I
2	2	3	3	1	3	3	2	II

We can see that three attributes – X3, X4, X7 have the same maximal value of difference |1-3|=2, so we can arbitrarily take, for example, X4 as a discriminator for the first vertex of DT.

Then, split original database table 6.3 into two tables with values of attribute X4=1 (table 6.4(a)) and X4=0 (table 6.4.(b)):

Table 6.4 (a). Tuples with X4=1

No	***X1***	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***Class***
3	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**I**
5	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**II**
7	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**II**
8	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**II**

Table 6.4 (b). Tuples with X4=0

No	***X1***	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***Class***
1	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**I**
2	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**I**
4	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**I**
6	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**II**

As a result we obtain the first (top) level of DT:

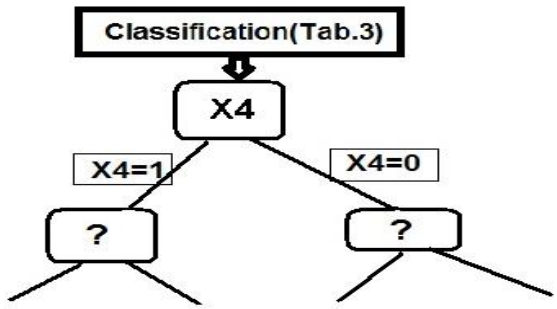


Figure 6.7a - Beginning of DT for database table 6.3.

In the same way we will define the next discriminator for the first edge from vertex X4 (X4=1):

Table 6.5 - Amount of '1' in columns of table 6.4(a)

X1	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*Class*
0	**0**	**0**	**X**	**1**	**1**	**1**	**0**	**I**
2	**2**	**3**	**X**	**1**	**3**	**2**	**1**	**II**

The maximally discriminate attribute, obviously is X3, and we repeat previous type of splitting.

Table 6.5 (a). Tuples with X3=1

No	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*Class*
5	**1**	**1**	**1**	**X**	**0**	**1**	**1**	**0**	**II**
7	**0**	**1**	**1**	**X**	**1**	**1**	**0**	**1**	**II**
8	**1**	**0**	**1**	**X**	**0**	**1**	**1**	**0**	**II**

Note!: ALL tuples in the Table 6.5 (a) belong Class II (i.e. it is the Leaf Node)

Table 6.5 (b). Tuples with X3=0.

No	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*Class*
3	**0**	**0**	**0**	**X**	**1**	**1**	**1**	**0**	**I**

Note!: ALL tuples in Table 6.5 (b) belong to Class I (i.e. it is also the Leaf Node)
Now, we update Decision tree:

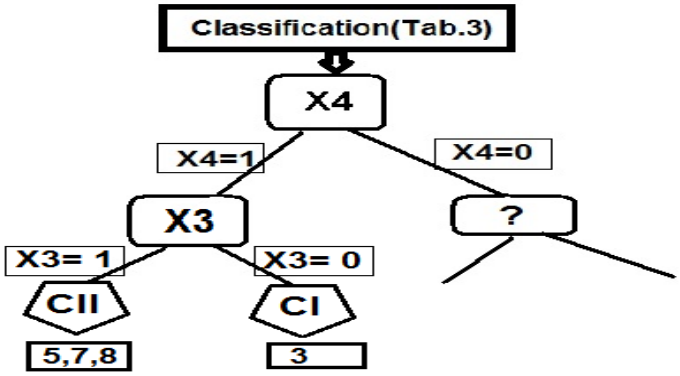


Figure 6.7b - Part of DT for database table 6.3

We classified tuples 3, 5, 7, 8 from Training Table 3 for arc X4=1. Try to perform similar steps for arc (X4=0) yourself. The result of initial step shows that solution of classification problem in general may be not unique; we can also check other variants with different discriminator, for example, X7. So, the last step is a choice of optimal DT (for example, with minimal length of all paths from root to leafs).

Rule-based algorithms

Another way to construct classification for tuples in Database (or for some interrelated objects in data set) is to create a set of logical rules which enable to put each tuple (or object) into one of predefined classes. There are several known techniques to provide these rules.

Generating rules from DT

For example, we can transform the result of DT solution into form of Rule-based algorithm describing each path from root to leaf of DT in the form of logical predicate:

IF (predicate 1) ∩(predicate 2) ∩....(predicate N) **THEN** B

For instance (tree in Figure 6.7b.):

IF (X4=1) ∩ (X3=1) **THEN** Class II;

IF (X4=1) ∩ (X3=0) **THEN** Class I.

Similar predicates could be constructed (try it yourself) for the rest part of Decision tree (beginning from edge 'X4=0').

Covering algorithms, another type of algorithms to generate rule for classification without DT, is described in the book of *I.H. Witten and E. Frank "Data mining Practical Mashine Learning Tools and Techniques", 2000.* Idea of this approach is to generate set of rules using all possible predicates which enable to classify all tuples in training table and then choose from it an optimal (minimal) set of logical rules. For above example we can start from simple rule:

IF (X4=1) THEN Class I; IF (X4=1) THEN Class II; IF (X4=0) THEN Class I;
IF (X4=0) THEN Class II;

After this, it is necessary to check the way each rule matches classifications in Table 6.3. Obviously, we count number of errors (mismatching), e.g. first rule

(with predicate ‘X4=1’) doesn’t match to the given class in tuples No 5, 7, 8. After, we check all possible single predicate rules (for X1, X2, …, X8). It becomes clear that one-predicate rules are not enough to classify all tuples correctly. Next step is to use all possible double-predicate rules, i.e. rules of type.

IF (Xi=K) ∩ (Xj = M) THEN Class N ,

where (i, j) take all possible values 1, …, 8, (i≠j) and K, M are equal to 0 or 1. After the same checking, we will find the number of rules which make correct classification (at least, for example, which we get using DT algorithm). The last step is to choose optimal (minimal) set of such rules. Of course this description is just Idea of Covering algorithm and you can find a lot of published modifications and optimizations. We should also mention A**lgorithms generating rules using Neural Networks** but details of these algorithms are beyond the frame of this chapter.

Distance-based algorithms of classification

Distance measures

It’s quite naturally to assume that classified objects (e.g. tuples of Database) mapped to the same class must be more similar to each other than to objects from other class. Each object which is defined by its attributes, let it be K, can be considered as a point in K-dimensional space E_K, that is why instead of ‘similarity’ in DM the term ‘distance’ is often used.

So, we need a distance measure $\boldsymbol{d}(x; y)$ that tells how ‘dissimilar’ or ‘far’ points $\boldsymbol{x}$ and $\boldsymbol{y}$ are. The usual axioms for a distance measure $\boldsymbol{d}$ in mathematics are:

1. $\boldsymbol{d}$ (x; x) = 0. - A point is distance 0 from itself.
2. $\boldsymbol{d}$ (x; y) = $\boldsymbol{d}$ (y; x). - Distance is symmetric.
3. $\boldsymbol{d}$ (x; y) ≤ $\boldsymbol{d}$ (x; z) + $\boldsymbol{d}$ (z; y). - The “triangle inequality” – the sum of lengths of any two sides of triangle isn’t less than length of the third side.

Often, our objects (points, tuples) may be thought to belong to a K-dimensional Euclidean space E_k, and the distance between any two points, let it be $\boldsymbol{t_i} = \{t_{i,1}; t_{i,2}; ...; t_{i,k}\}$ and $\boldsymbol{t_j} = \{t_{j,1}; t_{j,2}; : : :; t_{j,k}\}$, is given in one of the usual manners:

Common (Euclidean) distance:

$$\boldsymbol{d(t_i, t_j)} = \sqrt{\sum_{h=1}^{k} (t_{i,h} - t_{j,h})^2} \qquad (6.1)$$

Manhattan distance is also known as "city block" or “taxicab” distance between vectors *ti* and *tj*. (Manhattan is one of New York City’s 5 boroughs in which streets map looks like rectangular grid):

$$\boldsymbol{d(t_i, t_j)} = \sum_{h=1}^{k} |t_{i,h} - t_{j,h}| \qquad (6.2)$$

Max of dimensions:

$$d(t_i, t_j) = \max_{\forall h} |t_{i,h} - t_{j,h}| \quad (6.3)$$

It's not too difficult (at least in 2-dimensional space) to prove that all these distances satisfy the above axioms.

You may note that all these distance definitions can use only numeric attributes. However, the attributes may not be numerical, such as names of colors - red, green, etc. or logical expressions - yes, no, or traditional evaluation (Table 1) - excellent, good, etc. In such cases descriptions are usually converted into numerical determinations using different types of numeric variables. Below we'll consider the commonly used types of numeric variables and associated methods for calculating distance.

Types of data in Classification and Cluster Analysis

I. Interval-Scaled Variables

Interval-Scaled variables are continuous measurements of a linear scale, e.g. weight, height, temperature and etc. To avoid the dependency of the measurement units (e.g. Celsius or Fahrenheit temperature) often a standard data that is unit-less are used (e.g. in %% of means, ratio of Standard deviation, etc.), for example:

$$t^*_{i,j} = \frac{t_{i,j} - t^{MIN}_{i,j}}{t^{MAX}_{i,j} - t^{MIN}_{i,j}} \ , \quad (6.3)$$

where $t^{MIN,(MAX)}_{i,j} = \min_{\forall i},(\max)(t_{i,j})$, therefore normalized variable $t^*_{i,j} \in [0,1]$.

Dissimilarity can be defined as Euclidean metric (α=2), Manhattan metric (α=1), etc.

$$d(t_i, t_j) = \left(\sum_{h=1}^{k} |t_{i,h} - t_{j,h}|^{\alpha} \right)^{1/\alpha} \quad (6.4)$$

II. Binary Variables

Binary variables (BV) are understood by two states **0** and **1.** When state is 0, variable is absent (in tuple) and when state is 1, variable is present.

BV is *symmetric* if both states are equal valuable and weights (Color = Red|Blue can be denoted as 0|1 or 1|0), while *asymmetric* variables are variables that have not the same state values (Medical test = Positive| Negative, often denoted as +|- or 1|0).

Dissimilarity (or distance) between the same type two binary variables can be calculated using a **Contingency table** (where A, F – amount of matching; B, C - amount of mismatching values of correspondent attributes):

	Object 1			*Sum*
		1	***0***	
Object	***1***	A	B	A+B

2	***0***	C	F	C+F
Sum		A+C	B+F	

Calculation of the dissimilarity between pairs of the objects (tuples) using:

a) Simple matching coefficient (for symmetric BV)

$$d(i,j) = (B+C) / (A+B+C+F)$$

b) Jaccard coefficient (for asymmetric BV):

$$d(i,j) = (B+C) / (A+B+C)$$

Example: let *t1*, *t2* are two tuples with binary variables from Database

t1	1	0	1	1	0	1
t2	0	0	0	1	1	1

Contingency table is as following:

	O b j e c t *t1*			*Sum*
		1	***0***	
Object	***1***	2	1	3
t2	***0***	2	1	3
Sum		4	2	

Simple matching coefficient (for symmetric BV):

$d(1,2) = (1+2) / (2+1+2+1) = ½$;

Jaccard coefficient (for asymmetric BV):

$d(1,2) = (1+2) / (2+1+1) = ¾$.

For ***n*** tuples we should construct the dissimilarity ***n*** *x* ***n*** matrix { ***d*** *(i,j)* } based on Data matrix (or object by object structure)

X = { *Xi,j* } , (*i*= 1,..., n; *j*=1, ..., p).

(Consider example: Objects - members of team: AA, BB, CC; with binary attributes (yes – 1, no – 0): Gender, Graduate, Experience, Mobile, Car, Home)

III. Nominal Variables

Nominal Variables are a generalization of the BV, NV has more than two states (Color = Green, Red, Yellow,...). The dissimilarity between two objects can be calculated by using simple matching approach:

$$d(i,j) = (t - m) / t ,$$

where ***m*** is the number of matches, ***t*** – total number of variables.

IV. Ordinal Variables

Ordinal Variables are similar to Nominal Variables but all states are ordered in a meaningful sequence (excellent, good, satisfactory, unsatisfactory). The dissimilarity between two objects can be calculated by using the following approach:

a) Replace each state of Xi by its corresponding rank : Ri ; $Ri = \{1, ..., Ni\}$, (e.g. excellent – 5, good – 4, etc.)

b) Equalize/normalize (if neccessary) the weight of variable, for instance, use instead of R***i***:

$$Zi = (Ri - 1)/(Ni - 1)$$

c) ***d*** *(i,j)* can be computed by any of the distance measure approaches such as Euclidean or Manhattan distances.

V. Ratio-Scaled Variables

A ratio-scaled variable makes measurements on a non linear scale such as exponential scale, e.g. $A^{*}\exp(Bt)$, or $A^{*}\exp(-Bt)$, where A and B are constants.

d *(i,j)* can be computed by any of the distance measure approaches such as Euclidean or Manhattan distances for Ratio-scaled variables, directly using values of V or after logarithmic transformation: *Yi* = **Log** *(Xi*) (e.g. *pH, dB* – decibel).

VI. Mixed Type Variables

1) Group the same types of V in a particular cluster and perform separate dissimilarity computing method for each variable type cluster.

2) If the scale set consists of N mixed types, the dissimilarity can be calculated as:

$$d_N(i,j) = (\sum \delta_{i,j} d_{i,j}) / (\sum \delta_{i,j}) \ ,$$

where:

$\delta_{i,j} = 0$, ***if*** **either *Xi* or *Xj* is missing, or *Xi* = *Xj* = 0.**

$\delta_{i,j} = 1$, **otherwise**,

that is, $\delta_{i,j}$ is a contribution of variable (*Xi* and *Xj*) to the dissimilarity between tuples ***ti, tj*** depends on variable types. We can use also the weight coefficients for $\delta i,j$

E.g.: *If Xi | Xj is binary (or nominal):* $\delta_{i,j} = 0$ if *Xi=Xj*, otherwise $\delta_{i,j} = 1$ **;**

If Xi | Xj is interval scaled: $\delta i,j = |Xi - Xj| / (\max X - \min X)$,

where max*X* and min*X* are defined over all non-missed attributes *Xi* (normalized distance**).**

(Consider an example about cars grouping and comparison using attributes: color, type of body, class, engine power, maximal speed, fuel consumption on 100km).

Similarity:

Think of a tuple as a set of columns which has binary values 1 or 0. Then, **Similarity** of two tuples *t1* and *t2* can be defined as:

Sim (t1,t2) **=** $|t1 \cap t2| / |t1 \cup t2|$

E.g.: Let's consider the following tuples *t1,t2:*

t1	1	0	1	1	0	1
t2	0	0	0	1	1	1

Simple matching: Sim (*t1,t2*)= **A/(A+B+C+F)** = 2 / 6 =0.33 (33%), or

Jaccard coefficient: Sim (*t1,t2*) **= A/(A+B+C)** = 2 / 5 = 0.40 (40%)

Remark: we also can define distance as ***d****(i,j)* = ***d****(ti,tj)* = ***1 – Sim(ti,tj)***

Now let's return to distance-based methods of classifications.

Definition: Given Database $D:\{t_{1,}; t_{2,}; ...; t_k\}$ of tuples , where each tuple $\boldsymbol{ti} = \{t_{i,1}; t_{i,2}; ...; t_{i,k}\}$ contains numerical values and belong to some C_i from a set of classes C. Classification problem is to assign new tuple $\boldsymbol{t}_x = \{t_{x,1}; t_{x,2}; : : :; t_{x,k}\}$ to the one of C_i which tuples are similar to $\boldsymbol{t}_x$.

Simple Approach: (Simple Distance Algorithm)

Algorithm of Simple approach: Assign $\boldsymbol{t}_x$ to class C_i which contains the tuple(s) with the smallest distance to $\boldsymbol{t}_x$..

We can also determine a representative for each class by calculating the **center** of each region – e.g. tuple with average coordinates and then compares distances between $\boldsymbol{t}_x$ and centers of classes.

K Nearest Neighbors (KNN) algorithm:

The *k*-nearest-neighbor method was first described in the early 1950s. The method is labor intensive when given large training sets. It did not gain popularity until the 1960s when increased computing power became available. It has since been widely used in the area of pattern recognition.

When a classification is made for a new $\boldsymbol{t}_x$, its distance to each item in a set with known classification must be determined. Only the *K* closest (with shortest distances) entries are considered further. The new $\boldsymbol{t}_x$ is then placed in the class that contains the most items from this set of *K* closest items.

Example.

Task : Use training table 6.3 to classify new tuple t_9 ={1,0,1,0,0,0,1,1}.

Solution:

1) Simple approach algorithm. Firstly, calculate all $\boldsymbol{d(ti,tx)}$ using, for example,Manhattan distance (because it is simple, ☺). It is easy to check that distance

$\boldsymbol{d\ (t_1, t_9)}$ = | 1-1 | + | 0-0 | + | 1-1 | + | 0-0 | + | 0-0 | + | 0-0 | + | 0-1 | + | 1-1 |= 1 is the smallest. Hence, $\boldsymbol{t_9}$ belongs to Class I, because closest classified $\boldsymbol{t_1}$ belongs to Class I.

2) K Nearest Neighbors (KNN) algorithm. Let's take K=3. Using calculated distances from previous example we find three smallest distances which are: $\boldsymbol{d(t_1, t_9)}$=**1 ;** $\boldsymbol{d(t_6, t_9)}$=**2 ;** $\boldsymbol{d(t_4, t_9)}$=3; Major number of these tuples i.e.($\boldsymbol{t_1}$, $\boldsymbol{t_4}$) belongs to Class I, therefore $\boldsymbol{t_9}$ belongs to Class I as well.

From these examples we can notice that the Simple approach method is just particular case of KNN method with K=1, and then - it is better take K as odd number to avoid possible uncertainness when equal numbers of the smallest distances belong to different classes (fifty-fifty result).

Fuzzy Sets and Fuzzy Logic

In described methods of classification above we have supposed that each given object belongs exactly to one class. Nevertheless there are situations when this constraint doesn't hold. You can see in the Figure 6.8. one simple example of such situation. Income which is "low" in some cities (or even in one region of city)

is rather "medium" in other places. So, it is impossible to provide exact boundary between Low, Medium and High classes of income. To describe these overlapping classes so-called Fuzzy set can be used.

Definition 1: A Fuzzy Set (Class) is a set, let it be *F*, in which a **set (**or **class) membership function** ***f(X)***, is a real valued (as opposite to Boolean for conventional classification) function with output in the range [0,1].

Definition 2: An element *X* belongs to *F* with probability *f(X)* and simultaneously is in ⌐*F* (NOT *F*) with probability 1- *f(X)*.

Actually, *f(X*) is not true probability, but rather degree of truth associated with the statement: "*X* **belongs to** *F***".**

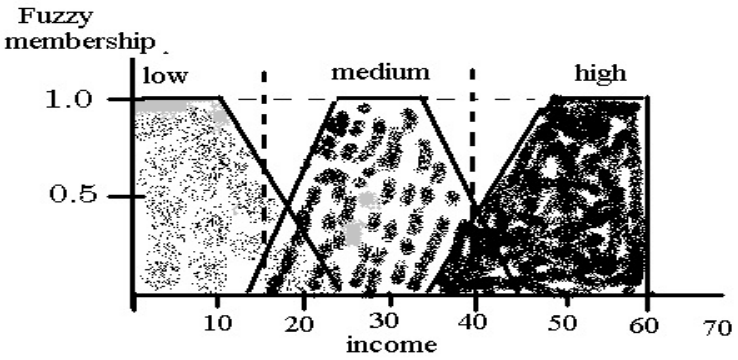


Figure 6.8 - An example of fuzzy membership classification.
(dashed lines – traditional set (Class) of membership)

Analysing the graph of membership in the Figure 6.8, we can see that the membership = 0.5 for the income corresponding to graphs intersection point (income = 20 or 40), there is no preference in the choice of class. In such cases, for classifying is possible either arbitrarily to choose one of the adjacent classes or use additional information or attributes for classification refinement.

The following values are commonly used to define the results of **fuzzy logic operations:**

Mem (-*X*) = 1 – mem(*X*)

Mem (*X* ∩ *Y)* = **min**(mem(*X*), mem(*Y*))

(e.g. reliability of a set of serial parts is usually determined using minimal class of reliability)

Mem (*X* U *Y*) = **max**(mem(*X*), mem(*Y*))

(e.g. benchmark class of a company is defined by maximal class of its departments)

Actually, these formulas are the same which used for definition logical functions AND, OR in math logic with binary values (0,1).

Regression analysis (Prediction)

Numeric prediction is a task of predicting continuous (or ordered) values for the given input. For example, we want to predict the salary of college graduates with 10 years work experience or the potential sales of a new product. By far, the

most widely used approach for numeric prediction (hereinafter referred to as prediction) is regression, a statistical methodology developed by Sir Frances Galton (1822–1911). In fact, many texts use the terms ‘regression’ and ‘numeric prediction’ synonymously. However, as we have seen, some classification techniques (such as support vector machines and k-nearest-neighbor classifiers KNN) can be adapted for prediction. In this subchapter the use of regression techniques for prediction is described. Regression analysis can be used to model the relationship between one or more independent or predictor variables (attributes) and a dependent or response variable, which is continuous-valued. In the context of Data Mining, the predictor variables are the attributes of interest describing the tuple (i.e. making up the attribute vector).

Linear regression

Regression assumes that there is functional dependence (FD) between values of two attributes, let them be *X* and *Y* :

Y = F(X); FD Y->X allows to predict (determine) the value of Y at the given value of X .

Initially, regression was investigated as statistical approach connected with correlation of random variables, but then it was proved (Legendre in 1805, Gauss in 1809) that the same results can be obtained using methods of minimization, in particular, Least Squares Method (LSM). This technique became more popular due to uniform approach to constructing regression equations for multivariate regression, and it is implemented in the numbers of statistics softwares. Now, the idea of this approach will be described.

Assume that the data model is $\boldsymbol{Y = K f(X) + C;}$ (***K, C*** are some constants)
In accordance with LSM the best fit of FD is when:

$$\boldsymbol{S(K,C) = \sum_i (Yi - K\, f(Xi) - C)^2 -> \min}$$

So, in accordance with theorem of extremum (this case –minimum) of differentiable functions we get the system of ‘normal equations’ for determination of ***K, C*:**

$$\left(\frac{\partial S(K,C)}{\partial C} = 0\right) \Rightarrow K\sum_i f(Xi) + nC = \sum_i Yi$$

$$\left(\frac{\partial S(K,C)}{\partial K} = 0\right) \Rightarrow K\sum_i (f(Xi))^2 + C\sum_i f(Xi) = \sum_i Yi\, f(Xi) \qquad (*)$$

The system has a unique solution (i.e. ***K,C***).
Example. Suppose we get the following empirical date (*X*,*Y*) as a result of some observations:

X	***0***	***1***	***3***	***3***	***5***	***5***	***7***
Y	***5***	***4***	***3.7***	***3.3***	***3.3***	***3.1***	***3***

Then we are going to describe dependence of *Y* on *X* using above regression model.

First of all we check ***f(x) = x*** ; i.e. regression equation in the form ***Y = Kx +C.***

From formulas (*) we obtain system of normal equations for ***K, C***:

$$24\boldsymbol{K} + 7\boldsymbol{C} = 25.4,$$

$$118\boldsymbol{K} + 24\boldsymbol{C} = 78.$$

Using any known method, we can find solution: $\boldsymbol{K} = -0.254$; $\boldsymbol{C} = 4.5$.

Therefore, regression equation is ***Y1 = -0.254X +4,5*** (we use notation ***Y1*** instead of ***Y*** to avoid collision between given *Y* and approximate values *Y1*). Line in Figure 6.9. represents this result.

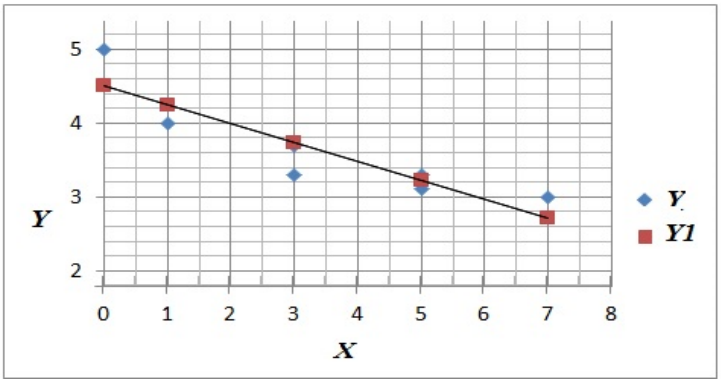


Figure 6.9. Comparison of the given values – ***Y*** with calculated by regression equation - ***Y1***

If we decide that accuracy of regression is not satisfactory, then we can try another type of dependence, i.e. another *f(X)*.

For example, we can use for regression the following function: $\boldsymbol{f(X)} = 1/\sqrt{\boldsymbol{1+X}}$, so regression equation is in the form:

$$\boldsymbol{Y}2 = \boldsymbol{K}\frac{1}{\sqrt{\boldsymbol{1+X}}} + \boldsymbol{C};$$

Using again formulas (*), we obtain system of normal equations for ***K, C***:

$$3.877\boldsymbol{K} + 7\boldsymbol{C} = 25.4,$$

$$2.458\boldsymbol{K} + 3.877\boldsymbol{C} = 15.0$$

Solution is $\boldsymbol{K} = 3.002$; $\boldsymbol{C} = 1.966$, so, we obtain the following regression equation:

$$\boldsymbol{Y}2 = \frac{3.002}{\sqrt{\boldsymbol{1+X}}} + 1.966;$$

Line in Figure 6.10. represents this result.

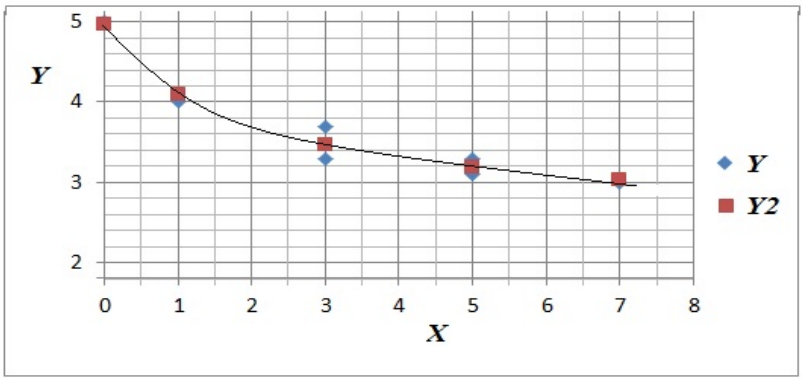


Figure 6.10 - Comparison of the given values - ***Y*** with calculated by regression equation – ***Y2***

There is no exact recommendations which function we have to use to obtain best fit to the given data. It's a matter of researcher's experience. But we can use as a criteria of accuracy, for example, the sum of squares of differences (**SSD**) between the given and calculated (using regression equation) values, or use so called **Std**.= $\sqrt{\mathbf{SSD/n}}$, where ***n*** is a number of given pairs (Xi,Yi).

Results of comparison of accuracy of regression models *Y1* and *Y2* are represented in Table 6.6

Table 6.6 - Given X,Y and calculated Y1,Y2 values using linear regression equation

Given data		*Approx. data (regression equation)*			
X	*Y*	*Y1*	*(Y-Y1)^2*	*Y2*	*(Y-Y2)^2*
0	5	4.50	0.250	4.968	0.001
1	4	4.25	0.060	4.089	0.008
3	3.7	3.74	0.001	3.467	0.054
3	3.3	3.74	0.191	3.467	0.028
5	3.3	3.23	0.005	3.192	0.012
5	3.1	3.23	0.016	3.192	0.008
7	3	2.72	0.079	3.027	0.001
		Sum=	0.603	**Sum=**	0.112
		Std=	0.293	**Std=**	0.126

Conclusion: Model *Y2* fits better to the given data than Model *Y1*, because **Std** for *Y2* is 0,126 whereas for *Y1* is 0,294, which also can be easily noticed from graphs in Figures 6.9, 6.10.

Using these regression equations we can evaluate (predict) unknown value of Y, for example, at *X=3.5; Y1 =3.61; Y2= 3.38.* So, if, for example, *Y* represents classes of some object, then different regression models can result in different classifications.

Multivariate Regression:

General form of multivariate linear regression is:

$$Y = K0 + K1*f1(X) + K2*f2(X) + \ldots + Kn*fn(X) \quad , \qquad (*)$$

where $f_i(X)$ is known (given) function depending on subset of arguments (*X1,X2,…).*

In particular, the simplest equation:

$$Y = K0 + K1*X1 + K2*X2 + \ldots + Kn*Xn \,,$$

where all $f_i(X) = Xi$.

If we have set of *M* tuples (*M > n+1*) then, according to LSM, the best fit of FD is when

$$S(K_0, K_1, \ldots Kn) = \sum_{i=1}^{M} (Yi - K_0 - K_1 f_1(X_{1,i}) - \ldots - K_n f_n(X_{ni}))^2 -> \min,$$

i.e. we obtain the system of normal equation for computation of ***Ki*** in the same manner as we did in the case of one independent variable ***X1***:

$$\frac{\partial S(K_0, K_1, \ldots K_n))}{\partial K_i} = 0; \quad (i=0,\ldots, n)$$

But there is more simple approach based on using of matrix algebra. If we write equations (*) for each of M tuples then we obtain system of M algebraic equations with unknown ***Ki (i=0,…,n)***, which can be represented in matrix form as $F * K = Y$,

where:

$$F = \begin{pmatrix} 1 & f_{1,1} & \ldots & f_{n,1} \\ 1 & f_{1,2} & \ldots & f_{n,2} \\ \ldots & \ldots & f_{i,k} & \ldots \\ 1 & f_{1,M} & & f_{n,M} \end{pmatrix}; \qquad K = \begin{pmatrix} K_0 \\ \ldots \\ K_n \end{pmatrix}; \quad Y = \begin{pmatrix} Y_1 \\ \ldots \\ Y_M \end{pmatrix};$$

$f_{i,k} = f_i(Xk)$; (i= 1 ,..., n; k = 1, ... , M) ; Xk is a subset of variables X_i having values from ***k***-th tuple.

It was proven that the system of normal equations can be written as:

$$F^T * F * K = F^T * Y \,,$$

where F^T denotes transposed matrix F. Obviously, this form is more convenient for computer algorithm and can be easier implemented as software product.

An example of the simple multivariate regression equation:

Let's construct the linear regression equation using data from the first three columns in Table 6.7.

Results of solution and evaluation of accuracy are put in the rest of the table. Solutions are obtained for different models of linear regression: *Y1* and *Y2* with one independent variable, *Y3* with two variables. After the determination of regression coefficients from correspondent systems of normal equations, we obtain the following regression equations:

Y1= -1.31*X1+ 8;

Y2= -0.39 *X2 + 7.69;

Yr = -0.41X1 - 0.28X2 + 7.86.

Evaluations of accuracy of these regression models using average of absolute relative deviations are shown in columns **Di,** (i=1, 2, r). We can notice from Table 6.7 that in some cases (particularly, in this instance) using simplest multivariate regression doesn't compulsorily lead to better accuracy, therefore to decrease deviations we have to examine different functions $f_i(X)$, e.g: $f_i(X) = X_m * X_j$ or $f_i(X) = X_k^2$, etc.

Table 6.7 - Example of regressions. Given *X1,X2,Y* and calculated *Y1,Y2,Yr* , using regression equations**;** Deviations: **D**i = *(Y- Yi) / Y, % , (i= 1, 2, r)*

X1	***X2***	***Y***	***Y1***	**D1=(Y-Y1)/Y, %**	***Y2***	**D2=(Y-Y2)/Y, %**	***Yr***	**Dr=(Y - Yr)/Y, %**
1	2	**7**	**6.69**	4.4	**6.91**	1.3	**6.90**	1.4
2	6	**5**	**5.38**	-7.6	**5.35**	-7.0	**5.39**	-7.9
3	10	**5**	**4.07**	18.6	**3.79**	24.2	**3.89**	22.3
3	11	**3**	**4.07**	-35.7	**3.40**	-13.3	**3.61**	-20.3
4	11	**3**	**2.76**	8.0	**3.40**	-13.3	**3.20**	-6.8
Average of **| Di |,** %				13.8		11.8		11.7

Thus, some popular "classical" methods of classifications are explained. There are other more complex techniques of classifications such as Discriminant Analyses, Genetic Algorithms, Information gain, Neural Network solutions and different hybrid approaches which are subjects of separate or advanced Data Mining courses.

2. Cluster Analysis

Clustering (Database segmentation)

The process of grouping a set of physical or abstract objects into classes of similar objects, *Clusters,* is called **Clustering.** Cluster is a collection of data that are similar to one another within the same cluster and dissimilar to the objects in other clusters.

Definition: In the given Database *D:{t1,t2,..., tn}* of tuples *ti*, a similarity measure ***Sim(****ti,tj)* (dissimilarity or distance) is defined between each pair of tuples . The clustering problem is to define a mapping ***f*** where each tuple *ti* is assigned to one cluster *Cj (j =1,...,k)* by condition: distances *D(ti,tj)* between tuples of one cluster are less than distances to any tuple of any other cluster (similarity definition is opposite to distance), where *k* (number of clusters) can be predefined or not.

Cluster analysis is an important human activity, it is used in data mining, statistics work, biological computations, marketing or machine learning. There are

various clustering techniques/algorithms which may be classified as it is shown on diagram in Figure 6.11.

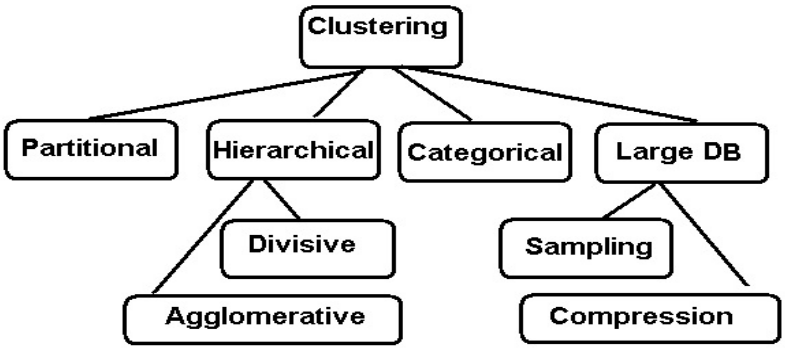


Figure 6.11 - Classification of clustering algorithms

Partitioning methods:

Idea of the partitioning methods is to arrange all objects into various partitions, where total number of partitions is less than the total number of objects, each partition represents a cluster. Here some algorithms are desribed.

K- means method

Algorithm of the *K*-means method (*K*- is defined as a number of cluster):

1. Select randomly *K* objects from *D* **(**each of them initially represents mean of some cluster**)**;

2. For each of the remaining objects each object is assigned to the cluster to which it is the most similar (min distance);

3. Calculate clusters mean ***Mj (j=1,…,K)*** and new distances between tuples and means.

4. Repeat from item 2, iteratively until the criterion function converges.

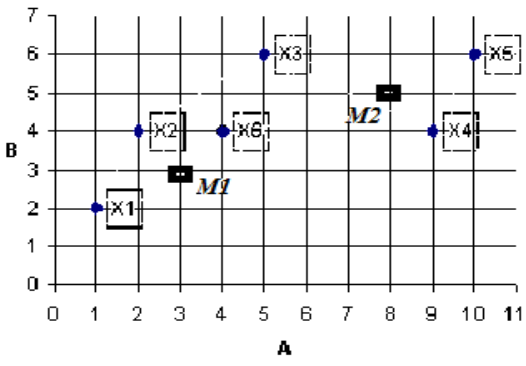
For example one may use Squared error criterion *F*:

$$F = \sum_{J=1}^{K} \sum_{\forall t \in C_J} |t - Mj|^2$$

Example: Table 6.8 and picture below describe values of attributes of a given set of objects (*X1,…, X6*) which have to be distributed in two clusters (i.e. *K*=2).

Table 6.8. Example of data base (and graphic)
for K-means method

Object / Attr	***A***	***B***
X1	**1**	**2**
X2	**2**	**4**
X3	**5**	**6**
X4	**9**	**4**
X5	**10**	**6**
X6	**4**	**4**



Clustering using K-means method:
Firstly, select two objects from *D* randomly, for example, *X1*, *X5* as the initial mean representatives of two clusters C1 and C2.

1 step: Calculate the table (Table 9.) of distances between all objects (e.g. using Manhattan distance)

Table 6.9 - Manhattan distances between objects (X1,…, X6)

	X1	*X2*	*X3*	*X4*	*X5*	*X6*
X1	0					
X2	3	0				
X3	8	5	0			
X4	10	7	6	0		
X5	13	10	5	3	0	
X6	5	2	3	5	8	0

2 step: Attach other objects *X2, X3, X4, X6* to one of the clusters using minimum distance.

In accordance with values in the table of distances *X2* and *X6* belong to cluster with *X1*, but *X3* and *X4* to cluster with X5. So, two clusters are obtained: C1{ *X1,X2,X6*}, C2{ *X3,X4,X5*}

3 step: Calculate mean of each cluster (we round results to integer values):

For C1: $M1 = M1((1+2+4)/3, (2+4+4)/3) \approx M1(2, 3)$ – it's the first center of new cluster

For C2: $M2 = M2((5+9+10)/3, (6+4+6)/3) \approx M2(8, 5)$ – it's the second center of new cluster

(see locations of *M1* and *M2* in the picture).

Repeat **1 step**: calculate distances between *M1,M2* and all other *Xi*, then repeat **2 step** using *M1,M2* instead of *X1, X5* (i.e. attach all objects *X1, X2,…, X6* to one of the clusters with representatives *M1* and *M2* using minimum distance.

After repeated steps the same clusters C1 and C2 are obtained, hence, we stop process of clustering with final clusters C1{ *X1,X2,X6*} , C2{ *X3,X4,X5*}.

K-medoids algorithm, PAM algorithm (Partition Around Medoids)

Idea of this method is much similar to K-means method but instead of means of calculation existing tuples (medoids) are used.

Algorithm:

1. Select arbitrarily K medoids from D**;** (e.g. X1, X2 from above *K*-means example). Calculate the distance matrix (between all objects in D);

2. Construct set of clusters (join each non-medoid object to some cluster in accordance with minimal distance or similarity/dissimilarity metric);

3. Choose one new medoid instead of previous one (see table below);

4. Calculate increment of total cost function (*F*) after this replacement of medoid (Save *F* value and set of medoids)

5. Repeat from item 3 for each objects.

6. Choose a set of clusters with the most negative (if any!) increment *F*, - it is optimal solution

E.g. We have 6 possible scenarios of medoids for our previous instance (*K*-means method)

Instead of	X1	X1	X1	X5	X5	X5
New medoid	X2	X3	X4	X2	X3	X4

Solution is a scenario with the minimal value of cost function *F*, for example, above defined Squared error criterion *F*:

CLARA (*Clustering LARge Applications*), **CLARANS** (.+R*andomize search*) are variants of PAM for large database.

The basic idea is that it applies PAM to a sample of database and then uses centers (medoids) of found clusters as medoids for the complete clustering. Each tuple from the database is then assigned to the cluster with the medoid which it is closest to.

Hierarchical Methods of clustering. Divisive and Agglomerative clustering.

Idea of divisive approach:

Given: Data base D =$\{ t_i \}$, $i= 1,...,n;$ and number of clusters - *K*.

1. Calculate distances matrix d =d$\{ d_{i,j} \}$;

2. Choose two objects t_k and t_l with maximal distance $d_{k,l}$ as centers (or medoids) of two clusters;

3. Join each of rest objects t_i ($i \neq k, i \neq l$) to some cluster in accordance with similarity/dissimilarity/minimal distance metric;

4. Choose cluster C_{mx} with the most distance between its objects;

5. Repeat the same with C_{mx} from item 2 until number of clusters less than *K* .

Example (using data from *K*-means method):

Step 1. Calculate the same table of Manhattan distances (Table 9.) .

Step 2. The objects (tuples) with maximal distances are *X1* and *X5*, therefore we chose them as medoids of two clusters C1 and C2.

Step 3. Attach the rest of objects (i.e. X2,X3,X4,X6) to closest of medoids. As a result we obtain two clusters: C1{ *X1, X2, X6*} , C2{ *X3, X4, X5*}. It is a solution.

If we need, for example, 3 clusters (*K*=3) then we have to continue step 2 with cluster C2 because it has maximal distance 6 between objects X3, X4, whereas in C1 maximal distance is 5. We repeat step 3 for cluster C2 and finally obtain three clusters: C1 {X1, X2, X6}, C2{X3}, C3{X4, X5}.

Now it is neccessary to explain the way we measure the distance between two sets to better understand some other clustering techniques.

Measures for distance between clasters (or between point and clusters): Ci and Cj

a)**Single link (minimum distance)**: ***dmin*** (t_{Ci}, t_{Cj})

(i.e. min d(t***hi***,t***mj***) for all *n* and *m*, where t*ni* belongs to C*i*, t*mj* belongs to C*j*)

b) **Complete link (maximum distance)**: ***dmax***(t_{Ci}, t_{Cj})

c) **Centroid (mean distance)**: ***d***(M***i***, M***j***) , where M***i*** – mean center (C***i***), M***j*** – mean center (C***j***). Some authors recommend to use medoids instead of centers.

d) **Average distance: Mean (**d(t_{hi},t_{mj}) for all *n* and *m*, where t*ni* belongs to C*i*, t_{mj} belongs to C*j*).

$$d_{avg}(C_i, C_j) = \frac{1}{N_i N_j} \sum_{t_{ni} \in C_i} \sum_{t_{mj} \in C_j} \left| t_{ni} - t_{mj} \right|$$

It should be noted that there are other methods such as Mahalanobis distance, D^2-Similarity (dependences) etc.

Agglomerative algorithms

The Nearest Neighbor Algorithm.

With this serial algorithm items are iteratively merged into the existing clusters that are closest. In this algorithm a threshold T is used to determine if items are added to the existing clusters or if new clusters are created.

Note: different modifications of the algorithm are based on different types of distance measures.

Given set of tuples *D{ tm}*; (*m=1,2,...,M*); threshold =*T* ,

1. Create cluster C1 C1={*t1*},

m=2

2. Check:

if *D(tm, Kj) <=T* **then** $t_m \in K_{j0}$ (existing clusters with minimal distance)

else create new cluster K_{j+1}={tm};

3. m=m+1; **If** m>M **then** END **else** go to 2.

Agglomerative algorithms. Dendrogram.

A tree structure called ‘dendrogram’ is commonly used to represent the process of hierarchical clustering. It shows how objects are grouped together step by step.

Algorithm:

Given: data base D ={ t_i }, *i= 1,...,n;* Nc – number of clusters.

1. Calculate distances matrix d =d { ***di,j*** };

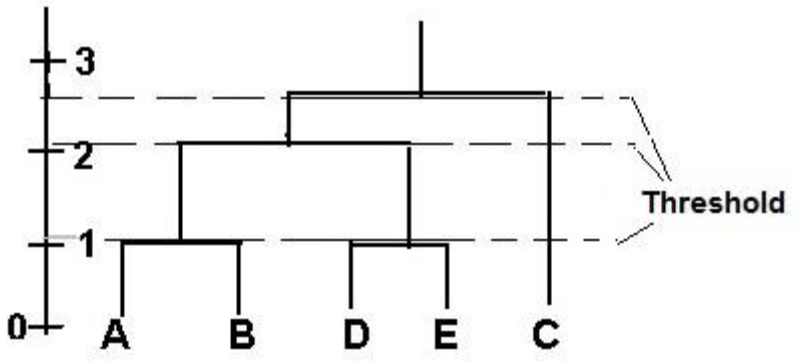
2. First, each element ***ti*** **is its OWN cluster C*i*** (See picture below);

3. **If** there are more than one cluster **then** go to 4 **else** STOP.

4. Choose two clusters with minimal distance d (C*i*, C*j*) and join them into new cluster (let C*j*) as a tree-wise structure.

5. Repeat from item 3.

An example so called ‘dendrogram’ is obtained:

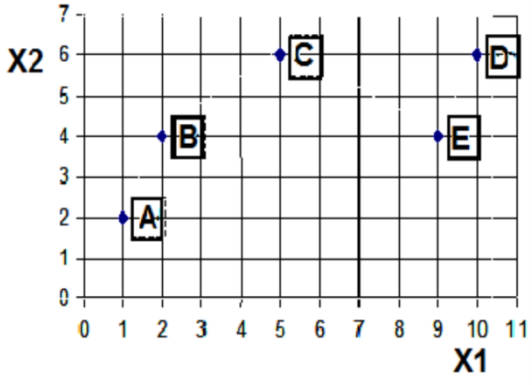


We can obtain different number of clusters which depend on **threshold distance** determination.

Example (dendrogram clustering)**:** Suppose, we have database (DB) Table 6.9. and we should construct dendrogram of clusters existing in this DB. Graphical representation of DB objects is shown in the picture below.

Table 6.10. Example of DB (and grapfik)
for Dendrogram algorithm

Object\ Attr.	***X1***	***X2***
A	***1***	***2***
B	***2***	***4***
C	***5***	***6***
D	***10***	***6***
E	***9***	***4***



Step 1. Construct distances matrix *d =d { d**i,j** }* using, for example, Manhattan distance:

Table D. Manhattan distances
between objects (X1, …, X5);

	A	**B**	**C**	**D**	**E**
A	*0*				
B	*3*	*0*			
C	*8*	*5*	*0*		
D	*13*	*10*	*5*	*0*	

E	*10*	*7*	*6*	*3*	*0*

$$d_{i,j} = D(t_i, t_j) = \sum_{h=1}^{k} |t_{i,h} - t_{j,h}|$$

Step 2. Assume objects **A, B, C, D, E** as 5 clusters C1, …, C5 respectively;
Step 3. Find min d(X,Y) in the table of distances. It is 3 for two pairs (A, B) and (D, E). Join them to two new clusters.

Result: a new set of clusters CI{A, B), CII{D, E}, CIII{C} with threshold *T*=3;

Remark: we also can split this step on 2 sequential steps and join only one pair of clusters per each step;

Step 4. Calculate distances between all new clusters using Table D and Average distance defined above:

d(C1, C2)= (1/4)*(*d*(A, D) +*d*(B, D)+*d*(A, E)+*d*(B, E))= (13+10+10+7)/4 =10;

d(C1, C3)=(1,2)*(*d*(A, C)+*d*(B, C))= (8+5)/2= 6.5 .

d(C2, C3)= (1/2)*(*d*(D, C)+*d*(E, C))= (6+5)/2=5.5 - minimal distance → joint C2 and C3 in cluster CIV.

Result: a new set of clusters CI{A, B}, CIV{E, D, C} with threshold *T* =5.5;

Step 5. Calculate distan*ce* *d*(CI, CIV) = (1/6)*(*d*(A, E) +*d*(A, D)+*d*(C, C) +*d*(B, E) + *d*(B,D) + *d*(B,C)) = 8.3.

Result: 1cluster CV(A, B, C, D, E) with threshold *T*=8.3.

STOP.

Graph of the dendrogram is shown in Figure 6.12.

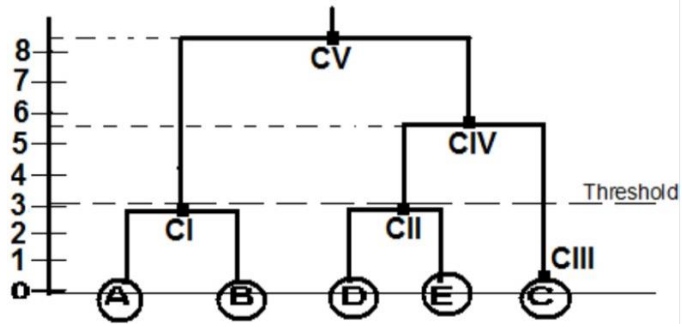


Figure 6.12 - Dendrogram of Agglomerative clustering for data in database table 6.10.

Density-Based Methods of clustering:

These methods deal with arbitrary shapes clusters. In the density-based clustering method, clusters are formed on the basis of the region where density (amount) of objects is high. Method is often used in geographical, soil science, agriculture, etc. mapping,

Idea:

The density function at an object X is defined as a sum of influence functions of all data points.

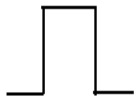
Given ***n*** data objects D={*X1, X2, ..., Xn*}, the density function is:

$$FD(x_k) = \sum_{i=1}^{n} f(x_k, x_i) ,$$

where $f(x_k, x_i)$ - influence function of any type:

E.g. ***Square wave influence function:***

$$f(x_k, x_i) = \begin{cases} 0 \ if \ \ d(x_k, x_i) > \sigma \\ 1 \quad otherwise \end{cases}$$



***Gaussian influence function*:**

$$f(x_k, x_i) = \exp\left(-\frac{d^2(x_k, x_i)}{\sigma^2}\right)$$

Potential influence function:

$$f(x_k, x_i) = \frac{1}{1 + \alpha d^p(x_k, x_i)}$$

Where ***σ, α, p*** are parameters which determine a threshold of the influence.

One of often used algorithms is described:

DENCLUE *(DENsity based CLUstEring)* algorithm:

- Choose the threshold value.
- Calculate *FD*(x_k) for all x_k from *D*.
- Local maximums of FD (*density attractors*) are centers of clusters.

We can also mention without details the **DBSCAN** (Density-Based Spatial Clustering of Applications with Noise) a density-based clustering algorithm. The algorithm grows regions with sufficiently high density into clusters and discovers clusters of arbitrary shape in spatial databases with noise. It defines a cluster as a maximal set of *density-connected* points. Method has numbers of modifications.

At the end of this subchapter we can say that a lot of techniques and computer algorithms have been developed last decades for solution of specific clustering problems but there is no room here even to mention all of them.

3. Association Rules:

Association rules(ARs) are the process to search relationships among data items in a given data set, so all the data items can be managed. Mainly association rules are used when a data set has large data items. It determines the sequential patterns that might exist in a large and unorganized data bank. These ideas have lots of application in medicine (diseases diagnostic), crime investigations, market-basket researches, etc.

The basic terminologies of the association rule are:

Definition: Let a data set S:{$I_1, I_2, I_3, \ldots, I_n$} and a database of transactions D:{$t_1, t_2, \ldots, t_n$} where t_i = {$I_{i1}, I_i, \ldots, I_{im}$} and $I_{iJ} \in$ S, then association rule is an implication of the form $\mathbf{X \Rightarrow Y}$, where X, Y $\subset$S are items of data called as item sets and X $\cap$ Y = $\varnothing$ ((i.e. trivial implications X$\rightarrow$ X are eliminated).

Example of Association Rules and Frequent Item Sets: the ***market-basket problem*** which assumes that we have some large number of items, e.g., "bread," "milk." Customers fill their market baskets with some subset of the items, and we have to know what items people buy together, even if we don't know who they are. Marketers use this information to position items and control the way a typical customer traverses the store. In addition to the marketing application, the similar question can be applied, for example, to the following areas of activity:

Baskets = documents; items = words. Words appearing frequently together in documents may represent phrases or linked concepts, and can be used for intelligence information gathering.

Baskets = sentences, items = documents. Documents with many similar sentences could represent plagiarism or mirror sites on the Web.

Support:

Support for an association rule $X \Rightarrow Y$ is a percentage of transaction in the database that consists of X U Y. It is represented by S.

Confidence:

Confidence for an association rule $X \Rightarrow Y$ is a ratio of the number of transactions that contains $X \cap Y$ to the number of transaction that contains X.

Large Item Set:

A large item set is an item set whose number of occurrences is above a threshold of support. ***L*** represents the complete set of large item sets and ***l*** represents an individual item set. These large item sets that are counted from data set are called as ‘candidates’ and the collection of all these counted large item sets are known as ‘candidate item set’.

Let’s discuss an example of Association Rules (ARs) applications. Suppose that each row in Table 6.11. contains list of goods purchased by one customer (each row is denoted as “transaction”).

Table 6.11 - Sample data of Association Rules

Transaction	*Items*
T1	Bread, Jelly, Butter
T2	Bread, Butter
T3	Bread, Milk, Butter
T4	Beer, Bread
T5	Beer, Milk

Firstly, we construct table of **supports:**

Table 6.12 - Support of all sets items found in Table 6.11

Set	*Support (s)*	*Set*	*Support (s)*
Beer	40	Beer, Bread, Jelly	0
Bread	80	Beer, Bread, Milk	0
Jelly	20	Beer, Bread, Butter	0
Milk	40		
Butter	60	Beer, Jelly, Milk	0
		Beer, Jelly, Butter	0
Beer, Bread	20		
Beer, Jelly	0	Beer, Milk, Butter	0
Beer, Milk	20		
Beer, Butter	0	Bread, Jelly, Milk	0
		Bread, Jelly, Butter	20
Bread, Jelly	20		
Bread, Milk	20	Bread, Milk, Butter	20
Bread, Butter	60	. . .	
		Beer, Bread, Jelly, Milk, Butter	0
Jelly, Milk	0		
Jelly, Butter	20		
Milk, Butter	20		

Gathering all data from Tables 6.11, 6.12. we obtain the final Table 6.13., which contains desirable information about ARs discovered in transactions (Table 6.11.). Each row in the table describes one association rule with support S and confidence α.

Table 6.13 - Support (S) and Confidence (α) for some ARs in Table 6.11.

X ⇒ Y	S	α
Bread ⇒ Butter	60%	75%
Butter ⇒Bread	60%	100%
Butter ⇒ Jelly	20%	33.3%
Jelly⇒ Milk	0%	0%

For example, rule in 2nd row means that 60% of customers purchased butter and 100% (i.e. all) of those customers purchased bread as well.

Below, the essence of quite popular A-priori algorithm of construction ARs in large Database is described.

The A-Priori Algorithm

This algorithm proceeds level-wise and has lots of implementations in parallel computing software products.

Considering the given support of threshold S, in the first pass we find the items that appear at least in fraction S of the baskets. This set is called **L**\, the frequent items. Presumably, there is enough main memory to count occurrences of each item since a typical store sells no more than 100,000 different items. Pairs of items in **L**\ become the candidate pairs C'2 for the second pass. We hope that the size of C'2 is not so large that there is no room for an integer count per candidate pair.

The pairs in C'2 whose count reaches S are the frequent pairs in **L2**\- the candidate triplets, C'3 are those sets {A, B, C'} that all of {A, B}, {A, C'} and {B, C'} are in **L2**\- on the third pass. Then we count the occurrences of triplets in C'3 and those with a count of at least **S** are the frequent triples **L3**\ , etc.

Proceed as far as you like (or the sets become empty). **Li**\ is the frequent sets of goups of size *i*; C*i+1* is the set of groups of size *i + 1* that each subset of size *i* is in **Li**\.

Thus, we have described essence of some core topics, methods and techniques of Data Mining and advanced topics titles such as Web Mining, Spatial mining, Temporal Mining which are subjects of separate or advance courses' books and researches.

Review questions

1. What is a Data Mining? What is the significance of DM application in some modern fields of science and business dealing with large Databases (Big Data).
2. Give the main differences between Date Warehouse and conventional Database System.
3. Define and explain the typical DM tasks.
4. Explain several often used DM techniques.
5. Explain the 5A process model.
6. Explain the CRISP-DM process model.
7. Describe some DM applications for customer services.
8. Describe DM application in computer security analysis and management.
9. How are classifications used and applied?
10. What is the Decision Tree? Give the example of how it can be embedded in Decision Support Systems.
11. What is the main difference between algorithms of building Decision Tree?

12. Classify tuple t_9 (0, 0, 1, 1, 1, 1, 1, 1) using DT in Figure 6.7.
13. How can set of logical rules for classification using Decision Tree be created?
14. Create Rule-based algorithm for "Traditional Marks" classes from Table 6.1 based on the values of attribute "%points".
15. What is an idea of KNN method of classifications?
16. What is the difference between KNN and Simple approach algorithm?
17. Why is it better to use odd number of neighbors in KNN method?
18. Give any example of Fuzzy Sets application of classifications problem.
19. Briefly describe the idea of using LSM for linear regression problems.
20. Give definition and describe some of the main applications of clustering.
21. Briefly describe various types of clustering techniques.
22. Calculate the distance between 2 objects A{12, 3, 40,10} and B{15, 7, 35, 12} using: a) Euclidean distance; b) Manhattan distance.
23. Give definitions of different types of Measures of distance between clasters.
24. Give explanation of K-means and K-medoids algorithm.
25. Give definition and explain some agglomerative clustering algorithms.
26. What is the essence of Density–based methods of clustering? Give example of influence function.
27. How does data mining help in market-basket analysis?
28. Describe possible analogy between market-basket problem and Web sites plagiarism.
29. What are Association rules, in which fields of human activities we can apply them?
30. Explain terms 'Support' and 'Confidence' for ARs applications, give an example.

References

Recommended textbooks and free software:

1. Jiawei Han and Micheline Kamber. Data Mining: Concepts and Techniques, Second Edition, Elsevier, 2006, Third edition, Elsevier, 2012. 743 pp.
2. Margaret H. Dunham. Data mining. Introductory and Advanced Topics. Pearson Education, Singapore 2003; Taj press, India 2005. , 314pp.
3. WEKA.Collection of machine learning algorithms and software for data mining tasks. Accessible Open source On-line and free downloads including several manuals PDF: www.cs.waikato.ac.nz/ml/weka/
4. Additional textbooks and huge numbers original researches in different aspects of Data Mining. you can find using Google™ searching machine.

CHAPTER 7. NETWORKS AND TELECOMMUNICATIONS

Communication network (generally) is a communication system to transmit information to the distance. Types of network are:

- tele- and radio broadcasting networks;
- telephone and cellular communication networks;
- cable television network;
- computer (computation) network.

Computer network is a distributed computing system, which includes set of:

- computer facilities and network devices;
- communication channels;
- software (it controls the information interaction of computers in the network).

Why are computers joined to a network? The network allows users of different computers to exchange information and access remote resources.

Therefore, the computer is joined to the network to exchange information and share computer resources (in the time-sharing mode). For example, together use one printer, plotter, fax-modem, disk storage, etc. Each year the list of new opportunities to use information resources is expanding.

7.1 Basic Definitions of Computer Network

Connecting two computers using a cable provides the simple network (network). The need in this kind of connection arises, if there is necessity of sharing some common resources and data. This is the basic principle of any network regardless of its complexity.

Thus, the practical need for sharing resources gives an impetus to the emergence of the network and its development.

Network is computers that are connected to a special network equipment to exchange data and share resources.

Traffic is data flow over a communication channel or through a network device, and the volume of this stream (in bytes).

Network bandwidth (the most important characteristic) is the amount of information that can be transmitted on the network per time unit. It is measured in bit/s (kbit/s, Mbit/s, Gb/s).

Network diameter is the shortest distance between the two most distant nodes in the network.

Networking hardware (network equipment or computer networking devices) is devices for connecting communication lines, amplifying the signal, forming the required network topology, data address forwarding, and information security, etc.

Local network is a network in which the computers are located within a room, building or nearby building.

Global network is a network on which computers are at a great distance from each other within another city or another country.

Local Area Network (LAN) includes multiple computers and peripherals connected by a cable within a limited area, for example, in the same building.

The advantages of using the computer networks are the following:

- quick and timely exchange of the data;
- sharing the peripherals reduces costs;
- possibility of using standard applications;
- effective planning and use of time while working on a common project.

Modern computer networks are not always LAN, and by the use of data and resources they grow into global computer network and spread over countries and continents.

7.1.1 Types of Network

Territorial feature will be taken as basic classifications. From this point, computer networks are divided into:

– LAN (LocalAreaNetwork – local CN) combines multiple computers within the building;

– CAN (CampusAreaNetwork – campus (coorporate) CN) brings together a group of closely located buildings;

– MAN (MetropolitanAreaNetwork – metropolitan (district, region) CN) provides information exchange within the city (district, region);

– WAN (WideAreaNetwork – large-scale CN) combines administrative units within the state or several neighboring states;

– GAN (GlobalAreaNetwork – global CN) brings together the continents.

A special place in this classification is taken by IntraNet and ExtraNet. They may be concurrently assigned to CAN and MAN (WAN, GAN).

Computer network is conventionally divided into two broad classes:

– the first class unites LAN and CAN;

– the second class unites MAN, WAN and GAN.

In the first class network, host computers are located at small distances and connected with the common bus of a particular type.

In the second class network, host computers are located at a considerable distance from each other. Territorial communication networks are used for the organization of their interaction, which are based on the main channel of primary networks. Main nodes of the second class may belong to one or more organizations, but are commonly used by many organizations.

Networks based on servers are widespread.

Server – a computer which controls the network and gives users access to their network resources.

Client – a computer in the network which is able to work with the data and the network resource.

Transmission media – method of computer connection.

According to the types of resources used in web, servers are divided into:

a) **file server** contains files and programs that are shared in the network. This system is a thin client, when a user's computer has software giving access to a server while using limited resources;

b) **print server** cannot be sufficiently powerful unless it is connected to the network printer, which prints from different network nodes. The installed software allows managing the printing queue;

c) **data server** stores a database that is edited from multiple computers on the network and can serve for different needs in different modes. It means the server can send data to the client computer and then there occurs data processing (thick client) or the server itself handles the client request and sends only the result (thin client). The last mode is more efficient and applicable in today's online databases;

d) **application server** is a centralized repository of application software. The application server stores the executable application software. To run this application, the client should be connected to the server over the network. The application runs on the server instead of the client computer;

e) **mail server** is involved in the exchange of information through messages. The data are stored on the mail server and are available to the user at any convenient time.

7.1.2 Basic Topology

All computers of LAN have to be connected with signal carrier such as a cable. This creates the cable system, which determines the physical topology of the network. Also, the logical topology, which is characterized by areas of data streams between network nodes is considered. Physical and logical topologies are relatively independent from each other.

Network topology is a mutual arrangement of computers, physical media (cabling) and other network devices.

A physical topology defines not only the location of computers, cables and other networking devices, but a physical connection of nodes. The term may be replaced by a "physical location", "network layout", "network map" or "circuit".

Currently, the networks based on 3 types of physical topologies are used. They are:

- "bus" topology;
- "star" topology;
- "ring" topology.

«Bus» is a network topology in which nodes are directly connected to a common linear (or branched) half-duplex link called a bus (Fig. 7.1).

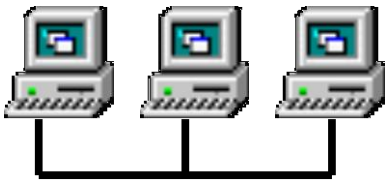


Figure 7.1 - Simple network with “bus” topology

The bus topology provides a linear diagram to connect computers to one cable. The terminal resistance - terminators are set at the end of the cable (Fig. 7.2). The signal passes through a cable through all the connected computers, bouncing off the terminator. The more connected computers to the cable via T-connector the slower the network would be. This is one of the factors affecting the performance of the network. Aside from this, there are many other factors:

- computer hardware operating in the network;
- data transmission frequency between computers;
- network applications used in the network;
- type of physical media (cable);
- distance between computers.

"Bus" carries signals from one end of the network to the other. In addition, each node checks the message address, and if it matches with the address of the node, the node receives the message. If the address does not match the address of the node, then it ignores the message.

The network of the bus topology is passive. This means that the nodes of the network only receive information and are not responsible for transmission. If one of the nodes does not work, then it does not affect the performance of the network. If the common cable or contact connector is broken, the entire network segment (the area between the two terminators) loses its integrity, and the network is inoperable. To determine the defect point, the cable is checked by the “halving" method.

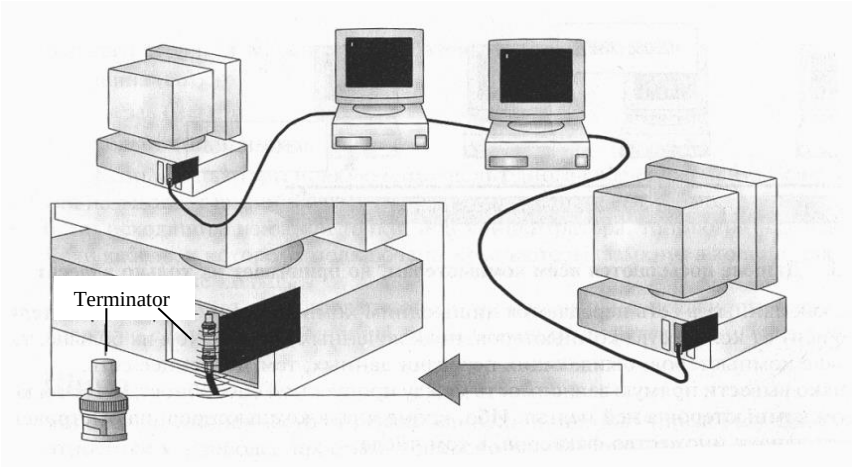


Figure 7.2 - Terminator absorbs the signal

Extension of the cable:

a) cable is connected via the Barrel connector (but in this method of connection the signal weakens, so it should not be abused)

b) cable is connected via Repeaters (device that amplifies the signal) (Fig. 7.3).

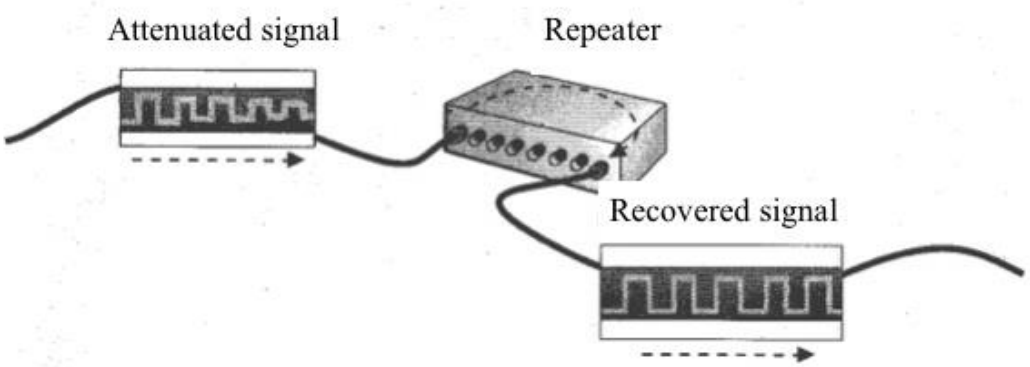


Figure 7.3 - Repeater connects cable segments and amplifies the signal

«Star» is a network topology in which computers are connected to cable segments from a single point (Fig. 7.4)

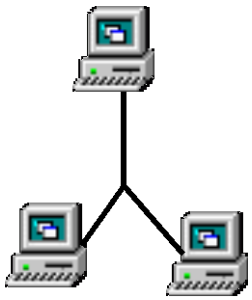


Figure 7.4 - Simple network with “star” topology

In the network of the star topology, each node is connected to a device called a Hub (Fig. 7.5) or Switch. The hub provides a common connection, when all nodes can communicate with each other. In the networks of this type, concentrator sends a signal from one node to the other nodes. Hubs can be both passive and active. Active hubs support a greater number of nodes and longer cables.

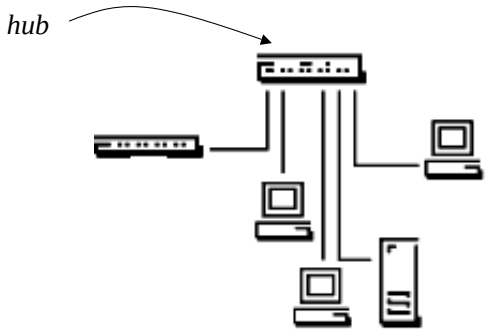


Figure 7.5 - Hub – a central node in the network of the "star" topology

Switches have more features than hubs, carrying, in particular, the role of routers within the network. Network topology containing switches are called switched topologies. Switch "learns" the MAC-address and stores them in an internal lookup table. The switch establishes a temporary connection between the sender and the recipient of the frame and the frame is transmitted on the temporary connection.

"Ring" is a cable with the connected computers closed to a ring (Fig. 7.6)

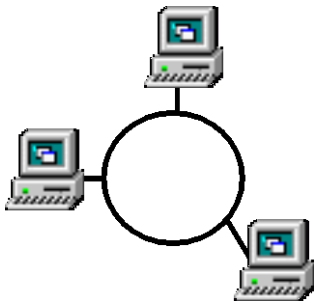


Figure 7.6 - Simple network with “ring” topology

The network with "ring" topology is characterized by the absence of endpoint connections: a network is closed, forming an indissoluble ring. Starting the movement from one point of the ring, the data are eventually coming back to the starting point. Because of such features of the "ring" topology, the data move in one direction only. Damage of a cable segment (length of cable connecting two adjacent computer) leads to failure of the entire network. Another weak point of "ring" is that the data pass through each node, allowing the interception not intended to outsiders. Typically, such topology is not used in a "pure" form because of its unreliability.

The data in the "ring" topology are transmitted by a token. The token is passed successively until the address matches with the destination address. Once the data are received by the destination computer and the acknowledgement is received by the sending computer, the source computer releases the token so that it can again start circulating in the network. The velocity of the token on the "ring" is almost like the speed of light.

Combined topology - "star-bus" - a combination of "bus" and “star" topologies, i.e. several networks with "star" topology are combined with linear backbone "bus" (Fig. 7.7).

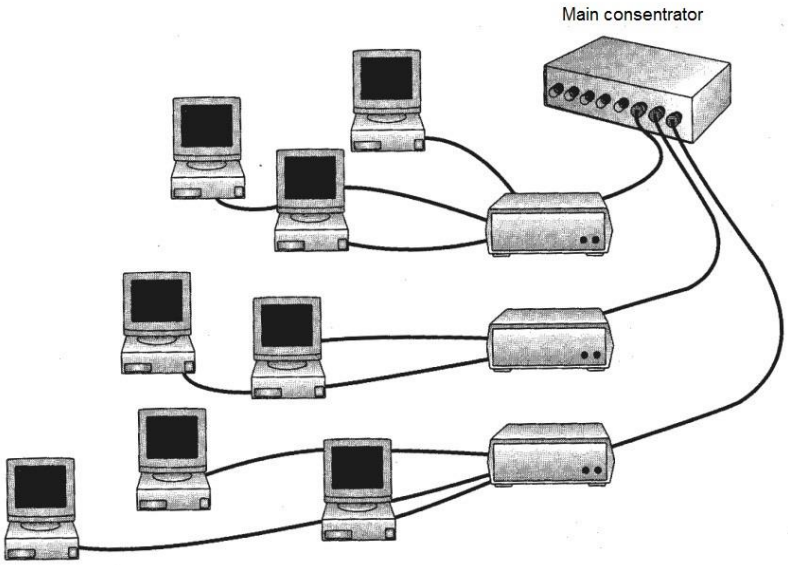


Figure 7.7 - An example of a network with “star-bus" topology

"Star-ring" in contrast to the “star-bus” hubs on the basis of the main hub forms a star (Fig, 7.8).

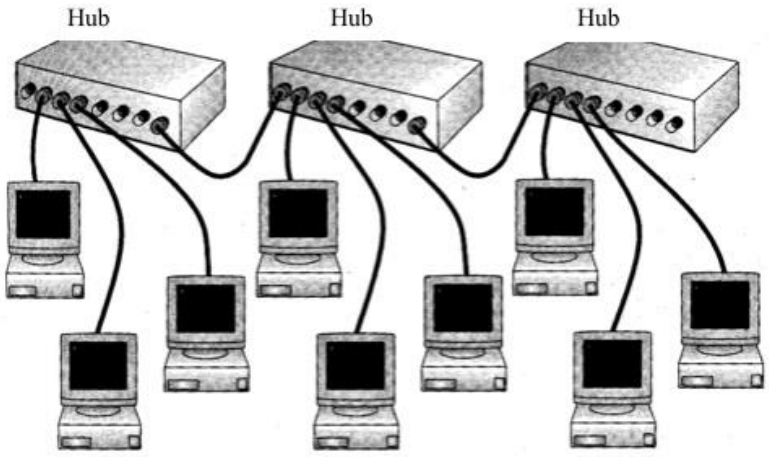


Figure 7.8 - Network with the “Star-ring" topology

Table 7.1 - Topology selection

Topology	Advantages	Disadvantages

Bus	• failure of the one of the nodes does not affect the operation of the network as a whole; • simplicity and flexibility of links; • inexpensive cables and connectors; • ease to expand network; • small amount of running meters of the cables; • ease of the cable routing (cross-connection), which increases the reliability of the network.	• cable break can affect the operation of a large number of nodes connected to the network; • cable length and the number of connected nodes limitation; • difficulty of detecting defects in the connections; • expansion of the network considerably reduces the performance of the network; • limited bandwidth of a cabling system.
Ring	• computers with equal access rights; • network performance is not dependent on the number of users.	• broken computer can disable the entire network; • difficult to identify the network problem; • making changes into the network design requires to stop the entire network.
Star	• ease to connect a new node; • possibility of centralized network control; • ease of changing the cabling scheme; • maximally simplified localization of defects of the connection.	• failure of the entire network segment due to failure of the hub (switch) on the basis of which this segment is built; • large consumption of cables used to create the network.

Summary:

Topology is understood as the specific physical location of the computers. There are three basic topologies: "bus", "star", "ring". Using these topologies is possible to build different combinations, such as "star-bus", "star-ring".

7.2 Network Cable - physical transmission medium

7.2.1 Cable Types

Modern computer networks are mostly connected via wires or cables. Cable network system is called a physical medium to transfer data between network nodes. There are various kinds of cables that are used for the construction of small and large networks.

The three cable groups listed below make up the foundation of the cable system:

а) coaxial cable;

б) twisted pair (can be unshielded and shielded)

в) fiber optic.

Coaxial Cable

Coaxial cable comprises of a copper wire (conducting core), an insulation layer, a metallic braid shielding and an outer sheath (Fig. 7.9).

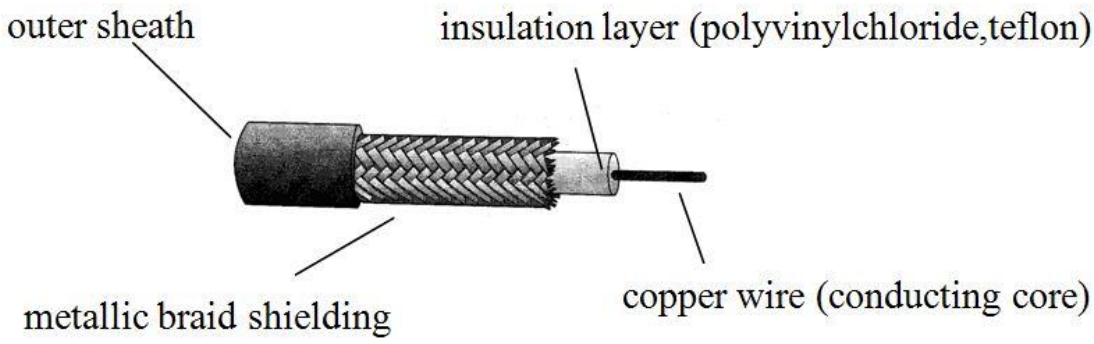


Figure 7.9 - The structure of the coaxial cable

Coaxial cable has high noise immunity and less signal attenuation compared with the twisted pair. Attenuation is a signal fading as it passes through a cable.

There are two types of coaxial cable:

- Thinnet coaxial;
- Thicknet coaxial.

Coaxial cables are chosen according to the needs of each network. The maximum length for a thinnet coaxial cable, to which it can transmit data without distortion is 185 m. Thicknet coaxial is characterized by its inflexibility. It is badly bent and its diameter is about 1 cm. It is also known as "standard Ethernet", as it was the first cable applied in the Ethernet. Thicknet coaxial cable can transmit a signal without distortion to a distance of 500 m. Thus, it can be paved as a backbone, which can be connected to the network using a thinnet coaxial cable.

Thinnet coaxial cable. Unlike the thicknet, it is easy to install, relatively inexpensive and flexible. Thus, the choice of a particular type of coaxial cable will depend on the specific network requirements (Table 7.2).

Table 7.2 - Comparison of cable types

Thinnet coaxial cable	**Thicknet coaxial cable**
Diameter – 0.5cm. Can be used in any type of network. Its installation is simple. It has connector on the network card to plug. It transmits a signal without distortion to a distance of 180 m. It belongs to the RG-58 family (with 50O m resistance). Distinctive feature is copper conductor.	Diameter – 1cm. Cable core in the section is thicker. Signal is transmitted to a distance of 500 m. It is used as a main backbone cable. Connection via a special device is called transceiver. The transceiver has a connector (vampire tooth) or DIX-connector. Installation difficulties. Expensive than thinnet.

The cables are connected by means of the following equipment (Figures 7.10, 7.11.):

a) BNC connector can be soldered or crimped to the end of the cable;

b) BNC E connector can attach the cable directly to the network adapter;

c) BNC barrel connectors are used to connect two segments of a thinnet coaxial cable;

g) terminator is a stub at the end of the network and serves to absorb reflected signals.

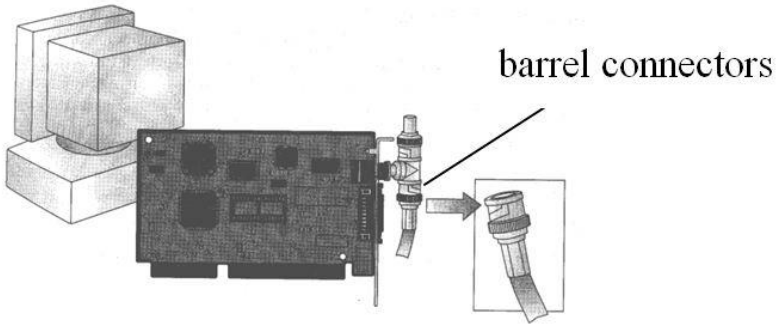


Figure 7.10 - Connection of the thinnet coaxial cable to the computer

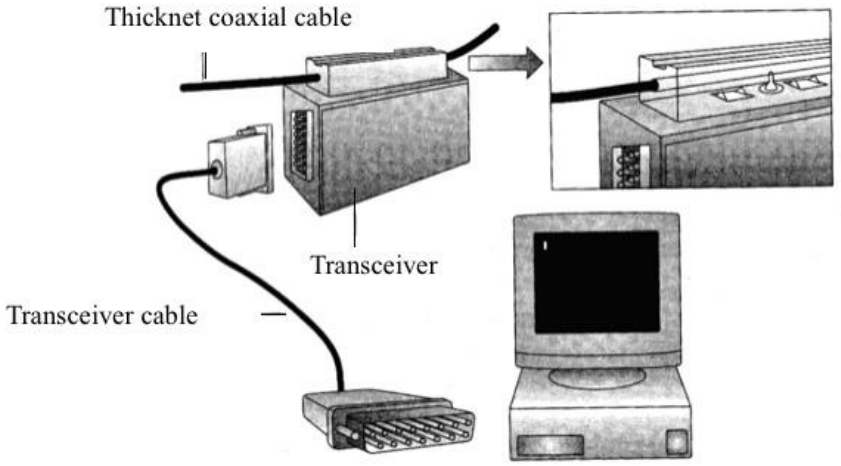


Figure 7.11 - Connection of transceiver to a thicknet coaxial cable

The Coaxial Cables Classes

PVC (polyvinylchloride) cable is a coaxial with a plastic insulating layer or with a plastic outer sheath. The advantage of these cables is flexibility, the disadvantage is emition of toxic fumes while burning.

Plenum cable is a cable that is laid in the small space between the false ceiling and chilling called plenum spaces of buildings. The insulating layer and the outer sheath are made of refractory materials. Disadvantages are expensiveness and inflexibility.

The coaxial cable is used when is required:

- transmition of audio, video and data;
- transmition of data over long distances (compared to less expensive cables);
- familiar technology, offering an adequate level of data protection.

Twisted Pair

Nowadays the coaxial cable is used reluctantly, because the twisted pair is preferable than it. Twisted pair cable consists of two wires twisted around each other and enclosed in a special plastic sheath. For example, home phone is connected to a telephone wall jack using a twisted pair.

Ordinary twisted pair is the two insulated copper wires twisted around each other. The twisted pair falls into two types:

- unshielded twisted pair - UTP;
- shielded twisted pair - STP.

UTP (specification 10BaseT) is widely used in LAN. It consists of two insulated copper wires. The maximum segment length is 100 m. The cables capable of transmitting data at a rate of 4 Mbit/s to 100 Mbit/s consist of four twisted pairs. Many phone systems use unshielded twisted pair.

STP has a copper braided shield as a protective screen against harmful interference. In addition, each pair of STP wires is wrapped in foil. Thus, STP is well protected from external interference (figure 7.12).

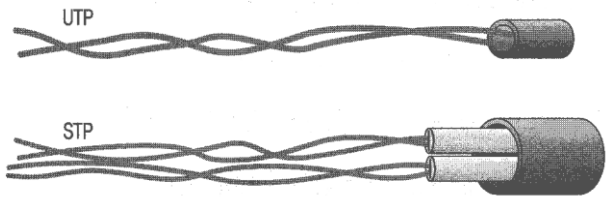


Figure 7.12 - Unshielded and shielded twisted pair

Twisted pair can be used, if:

- there is a financial limitations;
- simple installation is needed;

Do not install these types of cables if you want to be absolutely sure of the integrity of data transmitted over long distances at high speed.

The advantage of the twisted pair is that it is cheaper than other cables, such as coaxial. Furthermore, it is convenient to work during installation and maintenance the network, and it is readily available. Often, these types of cables are laid in a building during its construction. Their connectors are very similar to the phone connectors.

The disadvantages of the twisted pair are sensitivity to the interference and, as a consequence, the restriction on spacing gasket. However, their improvements will lead to the removal of these restrictions soon.

Fiber Optic

Fiber optic cable transmits digital data as a modulated light pulses in optical fiber. It is impossible to be connected to fiber optic cable from outside, without destroying it, so it is safe from interception. Fiber optic lines can transfer large amounts of data at a very high speed, because the signal does not decay in them and is not distorted.

The core in this type of cables is an optical fiber, a thin glass cylinder. It is covered with the glass, but with a different refractive index. The fiber signals are transmitted only in one direction, so two fibers are needed. One fiber to transmit data, and the second one is to receive data. The baud rate for fiber reaches the values of 100 Mbit/s - 1Gbit/s and above (Figure 7.13).

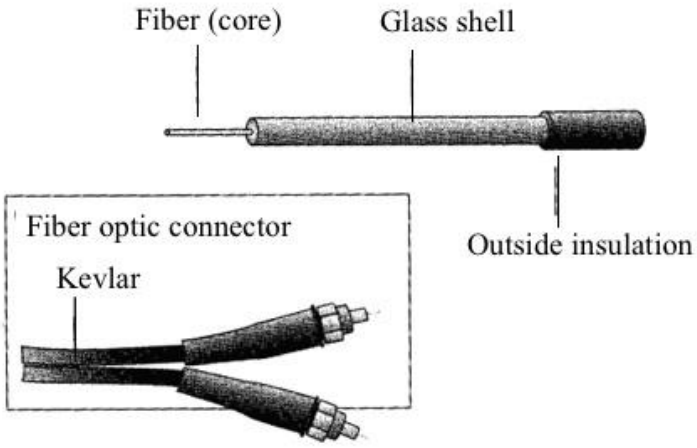


Figure 7.13 - Fiber optic cable

Fiber optic cable can be used, if:

- it is planned to send data at a high speed over long distances and with the use of reliable transmission medium;

Fiber optic cable should not be used, if:

- there is a financial limitations;
- you do not have skills to connect and install fiber optic network devices.

7.2.2 Transmitting the Signals

There are two existing technologies to transmit coded signals via cable:

- narrowband transmission;
- broadband transmission.

The narrowband transmission. In this case the transmission is carried out in the form of digital signals of one frequency. The signal is sent in both directions, and some network devices can simultaneously transmit data and receive them (Fig. 7.14).

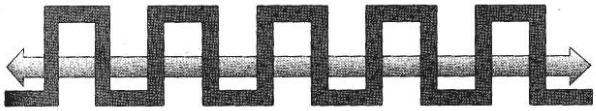


Figure 7.14 - The narrowband transmission. Bidirectional digital wave

The broadband transmission. In these systems the transmission is carried out in the form of analog signals with a certain frequency interval. The signal is sent in one direction only (Fig. 7.15).

Figure 7.15 - The broadband transmission. Unidirectional analogue wave

7.2.3 Wireless Network

Modern network technologies are increasingly using wireless data transmission, which eliminates the problems of the physical connection. Manufacturers offer a wide range of products at the normal price, which has led to increase of the demand for wireless communication.

The wireless environment is a mixed medium of components, as wireless components interact with the network, which use a transmission cable as a medium.

The advantages of a wireless environment are in the fact that its components:

- perform temporary connection to an existing cable network;
- enable mobility;
- can execute a back up in the existing cable system;
- disable restrictions on the length of the network;
- useful, if there is a cable installation problems.
- the wireless network works like a regular network externally, the only difference in the data transmission medium.

Transmission Methods

The most common data transmission methods in wireless local area networks are the following:

- infrared radiation;
- laser;
- broadcast in a narrow range (single-frequency transmission);
- broadcast in the scattered spectrum;
- mobile networks.

Infrared radiation. These networks use infrared rays. There is a network of direct visibility, when the transmitter and receiver are tuned to each other and network is in scattered radiation. In this case, the signal is reflected off the walls and ceiling before reaching the receiver.

Laser. Laser requires a direct sight between transmitter and receiver. Any interference to beam interrupts the transmission.

Broadcast in a narrow range. In this case, users can configure transmitters and receivers as an ordinary radio to a particular frequency.

Broadcast in the scattered spectrum. The basic difference of it is that the signals are transmitted in a frequency band, and it gives the opportunity to have a truly wireless network.

Mobile networks. In this case telephone lines, cellular networks, satellite connection are used.

7.3 Functioning of the Network

7.3.1 OSI Network Model

In 1983 after the practical testing of the experimental set of specifications the International Organization for Standartization (ISO) released a version of a set of specifications describing them as a reference model for Open Systems Interconnection Model or Open System Interconnect (OSI). The model is based on the principle of splitting the network into a separate functional levels. The model was based on the following assumptions:

a) each layer performs a particular function;

b) model and its levels must be compatible with an international scale;

c) number of levels should be sufficient, but not excessive.

The proposed model has set the global standards for determining functional levels necessary to support connections between network nodes.

OSI divides the various processes that occur during the communication session into the seven levels of functionality as shown in Figure 7.16.

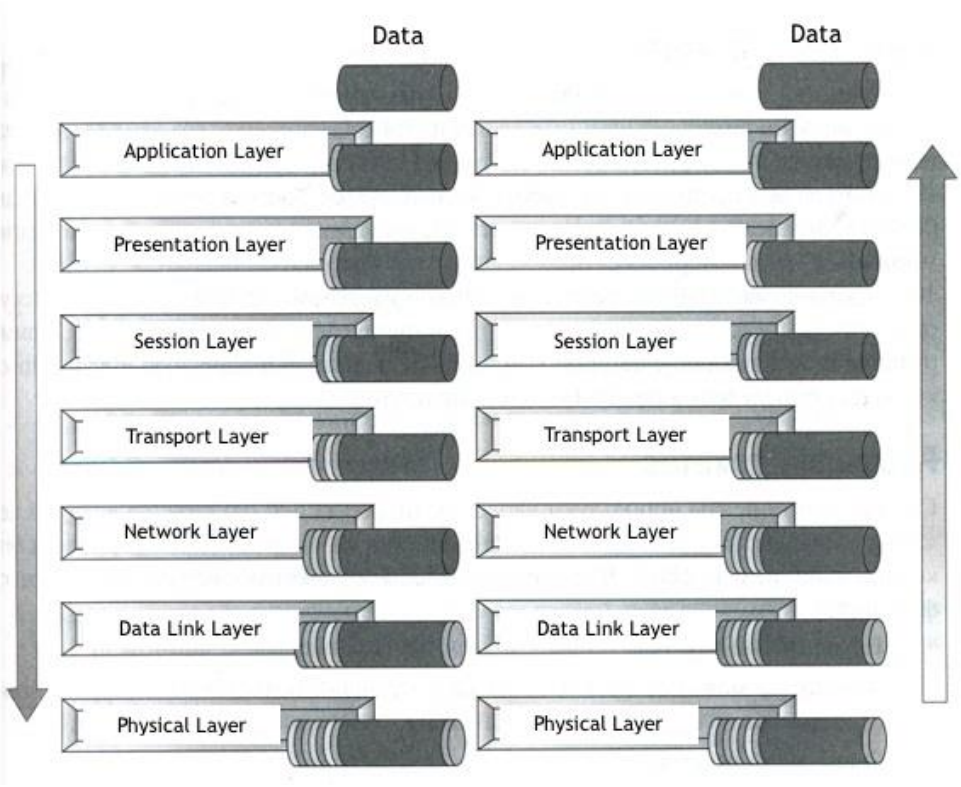


Figure 7.16 - Formation of the packet.

Functional layers of OSI are organized in accordance with the natural sequence of events of session connection (see Figure 7.16). Levels 1-3 are provided for physical access to the network. Levels 4-7 are designed to support a logical connection.

Part of the open system that performs some functions and which is a part of a certain level is called the subsystem.

Physical layer sends the bits into the communication channel and receives incoming bitstream. It understands only ones and zeros, but does not understand the semantics of the bitstream that it is transmitting or receiving. It is interested only in physical properties of the electrical, electromagnetic or optical communications channel, in particular:

– type of physical transmission media;
– active and reactive resistance of the physical transmission medium;
– levels of electric voltage, current and power;
– intensity of the optical signal;
– form of connectors, etc.

Procedures performed by physical level can be summarized as follows:

– connection with the communication channel;
– control of the channel during the communication session;
– disconnection of the channel at the end of the session.

It also determines the data transmission rate and the topology of the network (this applies to LANs).

Physical layer does not include the transmission medium. Its lower border is a physical jack connected to the transmission medium. Sometimes the physical environment is called zero level, but this is outside the scope of OSI.

The data link layer is responsible for ensuring the integrity of the transmitted data. On the transmitting side, it packs the data into frames.

Frame - a data link layer structure that contains enough data to ensure successful transmission of information via the local computer network of the recipient. Along with the actual user's data, the frame must contain: source address and the address of the data receiver, as well as the means to verify its integrity after delivery - a checksum.

To ensure the successful delivery of data, the following two steps should be taken:

- transmitting unit should receive the notification of successful reception of each frame by the receiving node;

- receiving node before acknowledging the frame must check its integrity.

If a frame has not reached the destination, or was damaged during the transmission, the data link layer should identify and correct these errors.

Link layer operates with such concepts as data flow control, identification and correction of errors, the transfer of frames. But it does not set the transmission and reception route.

The link layer provides the assembly of the frame from the bit stream received from the physical layer, but it does not create a new frame. It collects the incoming bits into the buffer until they compose a full frame.

Summary: Levels one and two are needed to establish connections of any type, both in local and global computer networks.

Network layer (Figure 7.17) is responsible for determining the route between the transmitting and receiving open systems. It does not have any mechanisms for detecting and correcting transmission errors and simply hopes for reliable transmission service of the link level.

The network layer is used to establish connections between open systems in the different LAN segments or in different local networks. A special device, Router, determines to which network segment (for which network) the message is intended, and directs it to that segment (to that network). For this purpose, it uses its own routing addressing architecture, which is fundamentally different from the physical addressing of the second level network nodes.

RoutingTables are built in the routers to determine the path of the data between the segments (networks), which reflect the sequence of data transmission through routers. Each route contains the address of the destination network. The address of the next router is the data transfer cost on this route.

To transmit the packet at the network layer, one may use one of the following methods:

– datagram method, when part of the message or the packet is delivered to the addressee on a random route determined by the current dynamics of the network;

– virtual connections method, when a single route for the transmission of the whole message is established.

The network layer can not be used if the components are located in the same network segment (or in the one unsegmented network).

Internet Protocol (IP) is an example of a network layer interface.

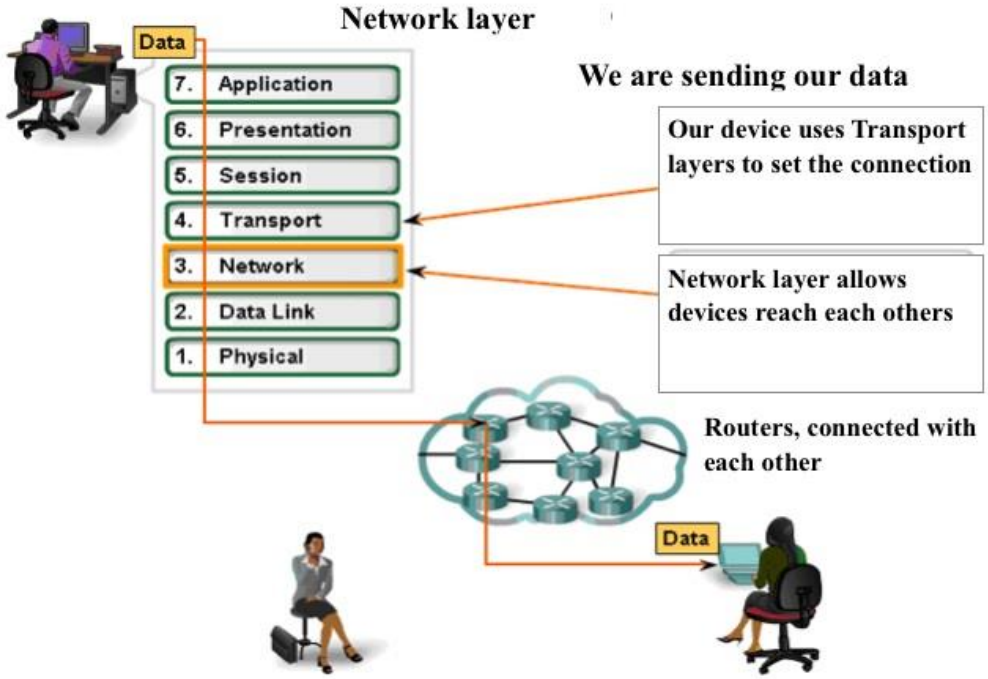


Figure 7.17 - Data transfer at the network level.

Transport layer as a link layer provides functions responsible for integrity of transmitting data. But in contrast to the data link layer, the authority of level extends beyond the current segment of the local network. It can detect packets that have not been correctly recognized by the router and automatically generate a request for their retransmission.

Another function of the transport layer is ordering the packets that come in a random order. If necessary, the datagrams of the higher levels can be divided into the network datagram size and then processed at the transport layer. Depending on the conditions, the transport layer sets the one or more network connections. Except that, this level makes the decision on the type of connection (Fig. 7.18).

The two main transport protocols are TCP (Transmission Control Protocol) and UDP (User Datagram Protocol).

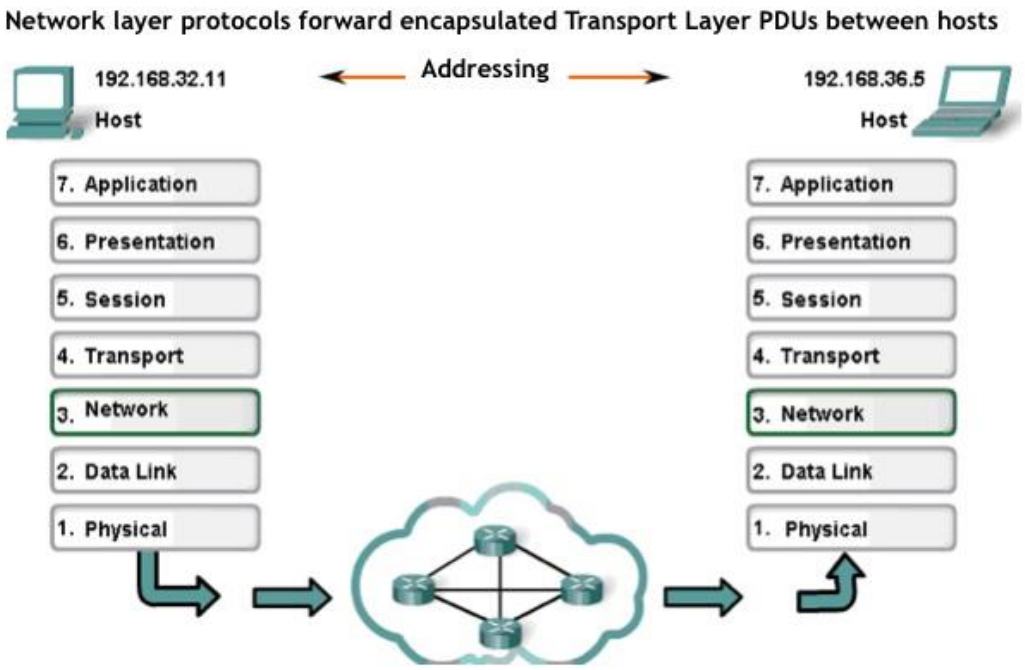


Figure 7.18 - Data encapsulation at the transport layer

Session layer is hardly involved as many protocols transmit its function to the transport layer. Managing the flow of proprietary information during the "dialogue" between the two open systems is the duty of the session layer. This flow is called the session, which:

– determines whether the connection is single or bi-directional;

– determines the start and end of the dialogue;

– determines the time and duration of the dialogue;

– defines the synchronization point for the intermediate control and recovery point when it detects errors in the data transmission;

– restores the connection without data loss after the error during the dialogue.

This level controls communication between the session connection. For example, it can include token control in the networks with logical topology “ring" (the responsibility of the session layer is to define the token owner), and network time synchronization.

Presentation layer is responsible for data coding method and controls the presentation of information in the network. The main function of the level is syntactic and semantic analysis of the transmitted data. At this level, the data presented in the format of an open system is converted to the required standard format for transmission. On the recipient side, the standard formatted data are converted into the appropriate format of the open system. Thus, it helps to create possibility to exchange data between open systems, in which different operating systems are installed. Formats of data presentation may vary according to the following criteria:

– sequence of bits and the dimension of the symbol (in bits);

– sequence of bytes;
– structure and syntax of the files;
– format of floating point numbers.

Data presentation layer also solves the encryption and decryption tasks, providing protection against eavesdropping.

Application layer provides the interface between the user applications and network programs (protocols). The scope of this level does not apply to the applications themselves. Examples are:

– FTP – file transfer protocol;
– DNS – domain name system;
– Telnet – virtual terminal;
– Simple Mail Transfer Protocol.

Application layer is conventionally called the initiator of the connection session.

7.3.2 Data Transfer over the Network and Cable

OSI model is the basis of network operation. Therefore, if you understand how different levels of OSI model interacts in the network connections, you will be able to understand the principles of the actions of the real network functions. Let’s start with drivers that ensure the functioning of the hardware components of the network.

Drivers - software that allows the computer to work with a variety of devices.

Drivers exist for almost every type of computer devices and peripherals. Printer driver can serve as a good example of the use of drivers. Printers are produced by many companies and have different functions and characteristics. Computer manufacturers are simply unable to equip their computer software to work with each type of printer. Instead, the printer manufacturers create drivers for their printers. When your computer can send documents to a printer, you first need to download the driver for this printer, which provides computer interaction with the device.

Drivers of network adapter card are located on the sub-layer of the Media Access Control (Data Link Layer of the OSI model). Access Control sublayer is responsible for access of network card to the physical layer, i.e. drivers provide a direct connection between the computer and the board. This, in turn, connects the computer to the network.

Now, when your computer and peripherals can communicate with each other, the network is ready to transfer data between computers. However, most of the files are too large for transmission via cable in its entirety. Firstly, this kind of block is filling the cable and the cable "binds" the entire network. Secondly, the occurrence of errors leads to the retransmission of the block. To quickly and easily transfer data over the network, it is necessary to divide them into manageable small blocks.

The packets are manageable blocks of data into which the file is divided.

The packet defines the unit of information in computer networks. When the data are broken into packets, the transfer rate is increased substantially, so that each computer in the network is able to receive and transmit data simultaneously with the other computers.

The components of the packets are the following: title, data, and trailer. Title includes:

- signal, "saying" that the packet is transmitted;
- source address;
- destination address;
- information synchronizing the transfer.

Trailer often contains information for errors checking called Cyclical Redundancy Check (CRC). CRC is a number obtained as a result of mathematical transformations on the packet and the initial information. When the packet reaches its destination, these transformations are repeated. If the result is the same as the CRC, then the packet is received without error.

Computers between which the connection is set, somewhat is similar to international organizations. There are many languages and modes of communication that these organizations can take advantage of. It is important to remember that all participants of communication must speak the same language and follow common rules or protocols in order to achieve mutual understanding.

Protocols are a set of rules and procedures governing the implementation of a communication.

Please, remember the three main things relating to the protocols:

There are many protocols. Each of them has a different purpose. It performs various tasks and has its own advantages and limitations.

Protocols operate at different levels of OSI model. Protocol functions are determined by the level at which it operates.

Several protocols can work together. This is so-called stack (or set) of protocols.

Protocols in a networked environment define the rules and data transfer procedures. Data transmission in the network consists of a series of steps that must be performed in a constant manner. The sending and receiving computers use protocols to perform the following procedures:

- partitioning data into packets;
- adding the address information to the packet;
- preparation of packets to the transfer;
- receiving packets transmitted by cable;
- copying the data from a packet to build the original data blocks;
- transmission of these reconstructed blocks to the computer.

Setting the correct protocol does not guarantee the correct operation of the network. To transmit data via cable computers use different access methods.

Access method is a collection of computer instructions on how it should send and receive data over a transmission medium.

The network should have multiple computers sharing a cable. However, if two computers try to transmit data at the same time, their packets "encounter" with each other and will be broken, this is called a collision (Fig. 7.19).

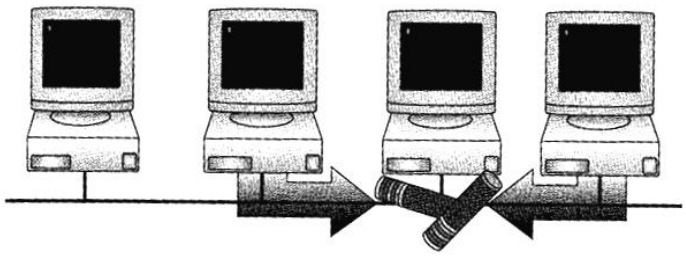


Figure 7.19 - Two computers trying to transmit data at the same time. It leads to the conflict.

Access methods are used to prevent simultaneous access to the cable by multiple computers. The main access methods are:

- multiple access with carrier and collision detection;
- multiple access with carrier and collision avoidance;
- access by token-passing;
- priority request access.

1. Carrier-Sense Multiple Access with Collision Detection (CSMA/CD) is used in the "bus" and “star" topology. The method is implemented in hardware (firmware) level in the network adapter, which has a transceiver connected to a shared data environment.

Host’s network adapter "listens" the channel before sending the data. It is needed to determine the presence or absence of an outside signal in the channel. If node "hears" that another node is transmitting the data, the first node should wait for the end of this transmission and take another try. After that, the node generates a Frame starting with the preamble. A binary data stream is followed after preamble. The remaining nodes are taking this frame, sync on the preamble and put the frame in their receive buffer. Completion of the frame is determined by the dropouts of carrier, and by this event, receivers of nodes’s network adapter analyze the received frame. Analysis of the received frame is done by an error check using the CRC and its length. Then, the address information is checked in an undistorted frame. Each frame has a header with a MAC address of a source node and a destination node. If the destination address of the frame matches with the MAC address of the node, then the frame is supplied for further processing with the higher-level protocols. If frames are not addressed to this node, they are ignored in hardware level of the network adapter.

It may happen that two nodes start transmitting the data almost simultaneously: both wait for the "silence" and begin to transmit a preamble (in such cases, there is a method that involves listening channel simultaneously with

the transfer). The clash of two signals - a collision - will lead to their distortion, which is detected by the network adapter transceivers. Transmitting nodes stop transmitting frames, if the collision is found. Retransmission attempts will be made in a random time interval (every node has its own interval) after the release of the line. 16 retries are acceptable and after each attempt the time interval duration increases.

2. Carrier-Sense Multiple Access with Collision Against (CSMA/CA) is multiple access with collision avoidance carrier control. Using the CSMA/CA method each computer before transmitting data to the network signals about its intention, so other computers "know" about the impending transfer and can avoid collisions.

However, broadcasting alert increases the overall network traffic and reduces its bandwidth, so network with CSMA/CA method is slower than with the CSMA/CD.

3. Access method with token passing. The node must obtain permission to transfer data. To do this, it must "catch" a special packet content - a token circulating on the network. Token moves in circles passing through each node sequentially.

After receiving the token, the transmitting node delays it by starting the transmission of the prepared message. The node releases the token after sending the message. While this message is transmitting to the addressee, any intermediate node can "catch" the token to send its message. Thus, the network may simultaneously transmit multiple messages.

The message passes through each node until it reaches the node, which address is the same as specified in the message. A destination node in the service field of the message records the fact of its reception and checks whether the result of the received message is correct. Onwards, this message continues to move around the ring to the sending node. It receives its message as a receipt if:

- there are no errors, and removes it from the ring;
- there are errors, and organizes the retransmission.

4. Priority request access is based on the fact that the network is constructed only from the hubs and nodes. Hubs control the access to the cable, sequentially interrogating all nodes in the network and identifying the transfer requests. The hub should know all the addresses, links and nodes and verify their operability. Having two simultaneous requests, the hub initially gives preference to the request with the higher priority. If the requests have the similar priority, they will be served in any order. Thus, the communication while priority request access is performed only between the sending computer, concentrator and the receiving computer. Data transmission is centrally controlled by hub, and it is not broadcasting to all the other computers in the network.

7.4 Network Technologies

7.4.1 Network Technology Ethernet

Network technology is a minimum set of standard protocols, network devices, software and hardware (such as network cards, drivers, cables and connectors), which can be used to build a functioning network. This network can be further improved by adding new protocols, communication devices for greater reliability and speed. But in any cases, network technology, which is a core, will be the basis of the network.

Ethernet technology was proposed in 1980 by the alliance of DEC, Intel, Xerox firms. IEEE 802.3 standard appeared some time later on its base. The word Ether (air) denotes the variety of transmission media: coaxial cable, twisted pair, fiber optic. Currently, the Ethernet is the IEEE 802.3 standard (data transmission speed of 10 Mbit/s). In 1995 the IEEE 802.3u standard was adopted - Fast Ethernet (data transmission speed of 100 Mbit/s), and the IEEE 802.3z standard was adopted in 1997 - Gigabit Ethernet on fiber optic (data transmission speed of 1 Gbit/s). IEEE 802.3ab - Gigabit Ethernet twisted-pair category 5 was adopted in autumn, 1999, as a standard (Fig. 7.20).

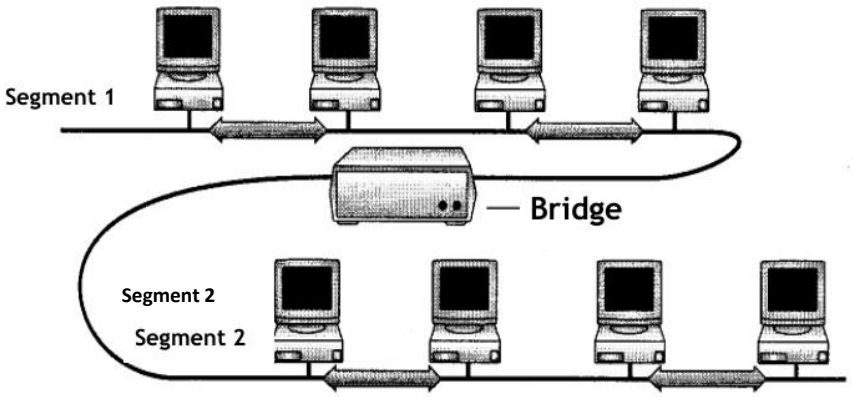


Figure 7.20 - Example of the Ethernet network

The main characteristics of an Ethernet network:

- traditional topology — linear bus
- other topologies — star-bus
- transmission type — narrowband
- access method — CSMA/CD
- data transmission speed — 10 and 100 Mbit/s
- cable system — thicknet and thinnet coaxial, UTP

Ethernet technology is based on the method of multiple access to a medium with listening carrier and collision detection - CSMA/CD.

The main advantage of Ethernet networks is their efficiency. To build a network, it is enough to have a network adapter for each computer, one physical segment of the coaxial cable of desired length. In addition, Ethernet networks are implemented in relatively simple algorithms for medium access, addressing and

data transfer. Easy logic of network operation leads to a simplification and therefore to reduction of cost of network adapters and their drivers. For the same reason, Ethernet network adapters have high reliability. And finally, another great feature of Ethernet networks is their good extensibility. It means that it is easy to connect new nodes.

Ethernet networks use different versions of the cables and topologies. We will consider four Ethernet topologies.

1. In 1990 the specification 802.3 was published to construct the Ethernet network based on twisted pair 10BaseT (10-transmission speed is10 Mbit/s, Base-narrowband, T - twisted pair). Most of these types of networks are built in the star topology, but the signaling system is represented as a bus. Usually 10BaseT network hub acts as a multiport repeater. Each computer is connected to the other end of the cable connected to the concentrator and uses two pairs of wires: one - for reception, another - for transmission. The maximum length of 10BaseT segment - 100 m. The minimum cable length - 2.5 m. LAN 10BaseT can serve up to 1,024 computers.

2.10Base2 (10-transmission speed is 10 Mbit/s, Base-narrowband 2 - transmission by a distance approximately two times greater than 100m). This type of network is focused on thinnet coaxial cable, the minimum length of which is 0.5m. Maximum number of computers is 30. The network on thinnet Ethernet is an economical way to implement networking for small offices and workgroups. The network may consist of a maximum of five cable segments connected by four repeaters, but only three segments can be connected to workstations at the same time. Thus, the two segments are reserved for repeaters. They are called as interrepeaters bonds. This configuration is known as the 5-4-3 rule.

3. 10Base5 (10-transmission speed is 10 Mbit/s, Base-narrowband 5 - five segments by 500m) - the so-called standard Ethernet. Networks on thicknet coaxial cable (thick Ethernet) commonly use “bus" topology. Thick Ethernet can support up to 100 nodes on the main segment. Mainline segment is the main cable, which is connected by transceivers attached with workstations and repeaters.

4. 100BaseX (100-transmission speed is 100 Mbit/s, Base-narrowband, X - extension) is an extension of the existing Ethernet standard. It is based on UTP Category 5 using the access method CSMA /CD and "star bus” topology, where all cables are connected to a hub.

7.4.2 Network Technology Token Ring

Token Ring network was originally developed by IBM in 1970. *Token Ring technology* standardized by the IEEE organization has many common properties with Ethernet and other network technologies, the specifications of which are described by a family of IEEE 802 standards. As a result the Token Ring networks can interact with other architectures using the transformative bridges.

Since its introduction, Token Ring technology has undergone several significant improvements. Having initially transmission speed 4 Mbit/s, the technology has been "upgraded" to 16 Mbit/s. To date, there are recommendations that assume increasing transmission speeds up to 100, 128 Mbit/s, and in the future up to 1Gbit/s.

Key features of Token ring network:

- conventional topology — ring
- other topologies — star-ring
- transmission type — narrowband
- access method — with token passing
- data transfer rate — 4 and 16 Mbit/s
- cable system — UTP and STP

When the first computer begins to work on the Token Ring network, the network generates a token. The token passes around the ring from one computer to another, until one of them does not report on the readiness to transmit data and take control of the token.

Token is a predefined sequence of bits (data stream) which allows the computer to send data via cable.

The computer sends a data frame to the network after capturing the token. The frame is held in the ring, until it reaches a node with the address corresponding to the address of the receiver in the frame. Computer-receiver copies the frame in the receive buffer, and makes a note on the status field of the frame about the reception of an information.

Frame continues transmitting through the ring, until it reaches the sender node, which certifies that the transfer is successful. Afterwards, the computer removes the frame from the ring and returns the token.

The network may transmit only one token at a time, wherein only in one direction. Token passing is deterministic process. This means that it is possible to calculate the maximum time that will pass before any end station will be able to transmit the data. This characteristic makes Token Ring network ideal for applications where a delay must be predictable and stability of network operability is essential. An automated stations environment in plants is one of the application examples of such networks.

IBM Token Ring network station is directly connected to the Multistation Access Unit (MAU) which can be joined with cables forming one large ring network (Fig. 7.21).

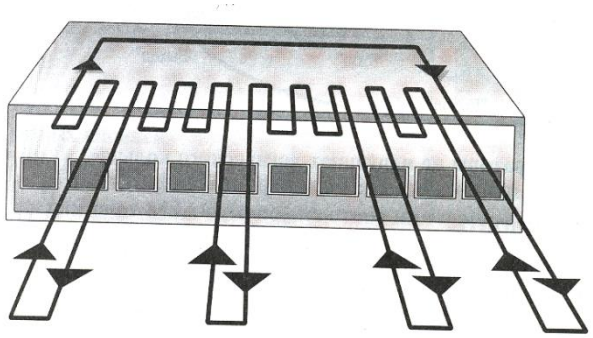


Figure 7.21 - Formation of the hub ring (the token motion is indicated).

The jumper cables are connected to MAU with the adjacent MAU. Petal cables are connected to MAU to the stations. To exclude stations from the ring, MAU has the bypass relays. Thus, the faulty computer (or connection) does not affect the operation of the entire Token Ring network. Up to eight computers can be connected to the Token Ring network. However, the Token Ring network is not limited to a single ring, each ring may have up to 33 concentrators.

When the ring is filled, i.e. the computer is connected to each MAU port, the network can be expanded by adding another ring. The only rule to be followed: each MAU must be connected so that it becomes part of the ring. Nests "entrance" and "exit" on MAU allow connecting up to 12 MAU (arranged in a stack) to a single ring with the use of cable.

7.4.3 Network Technologies Apple Talk and Arc Net

In 1983 Apple Computer Inc. introduced the Apple Talk as "proprietary" network architecture for small workgroups. Network functions are built into Macintosh computers which make implementation of Apple Talk network very simple compared to other networks.

Key features of Apple Talk network:

- conventional topology — bus or star
- transmission type — narrowband
- access method — CSMA/CA
- data transmission speed — 2 Kbit/s
- cable system — UTP, fiber optic

Apple Talk system has been developed as a distributed client-server network. In other words users can share network resources (such as files and printers). Computers that provide these resources are called service devices (*servers*); computers that use network resources of service devices are called clients (*clients*). Interaction with service devices is considerably transparent to the user, as the computer itself determines the location of the requested material, and refers to it without receiving the further information from the user. In addition to the ease of use, the distributed systems also have economic advantages over systems where all

are equal, since important material may be placed in a few, but not in many locations.

LocalTalk is an Apple's patented system of access to the media. It is based on access competition, combining topology via the bus and transmission of the baseband signals. It works on the carrier, which is a shielded twisted pair, at a rate of 230.4 Kbit/s. LocalTalk segments can be transported over a distance of 300 meters and provide up to 32 nodes.

Apple Talk identifies several network entities. The simplest is the *node*, which is simply any device connected to the Apple Talk network. The most common nodes are Macintosh computers and laser printers, but many other computers are also able to communicate with Apple Talk, including the IBM PC computers, Digital Equipment Corparation VAX and various APM. The next entity defined by Apple Talk is the network. Apple Talk network is simply a sing logical cable. Although this logical cable is often a separate physical cable, some data centers are using bridges to combine multiple physical cables. Finally, the *Apple Talk zone* is a logical group of multiple networks (possibly located far from each other (Fig. 7.22)).

Arc Net environment was developed by Datapoint Corporation in 1977. This is a simple, flexible, low-cost network architecture for workgroup-scale networks.

Key features of the Arc Net network:

- conventional topology — star-bus
- transmission type — narrowband
- access method — with token passing
- data transmission speed — 2,5 – 20 Mbit/s
- cable system — coaxial cable

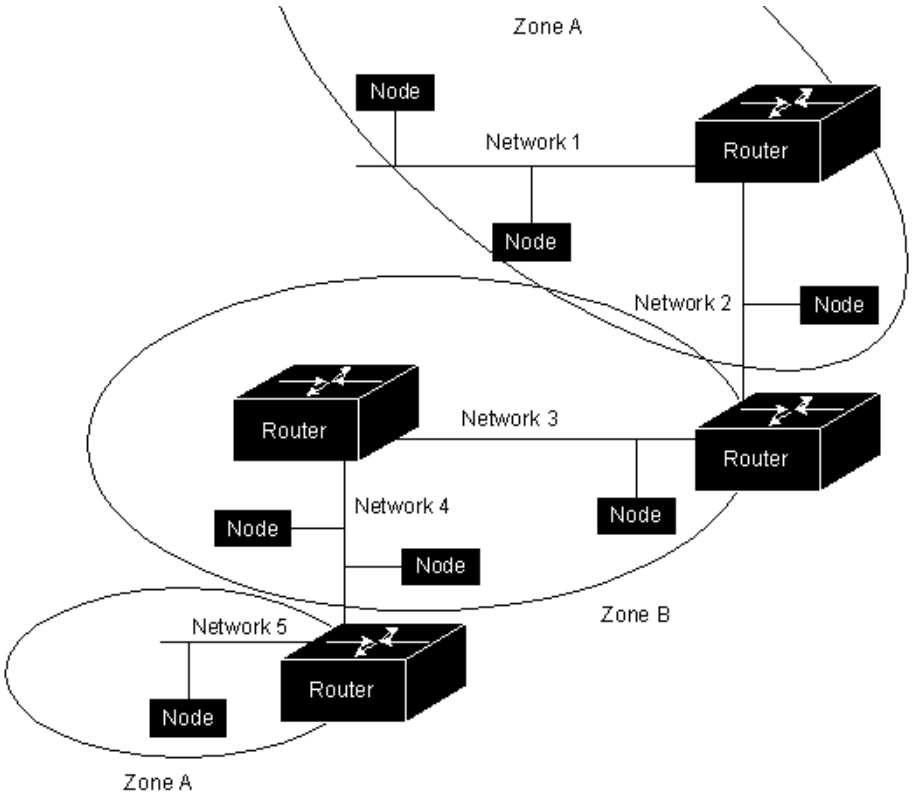


Figure 7.22 - AppleTalk entities

Since the Arc Net uses token passing, the computers in the Arc Net network should get token to transmit the data. Token moves from one computer to another in accordance with assigned sequence numbers regardless of their physical location (Fig. 7.23).

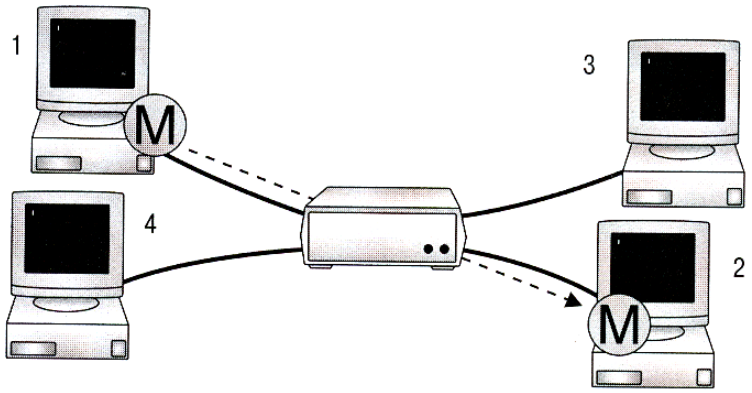


Figure 7.23 - The token is passed from computer to computer according to its sequence numbers.

7.4.4 Wide Area Networks Creation

When companies are growing, their network is expanding as well. In general LANs tend to grow to the initial projects. This becomes obvious when:

- network traffic has reached the bandwidth limit;
- waiting time has increased for processing tasks for printing;

- response time of intensive network applications, such as database, has increased.

Each network administrator sooner or later comes across with problem, when it is needed to expand the size of the network or to improve its performance. The network cannot be expanding by simply adding new computers and additional cabling. Any topology or architecture has its limitations. However, there are existing devices, which purpose is to expand the size of the network in the current environment.

1. **Modem** is a device that enables computers to exchange data over a telephone line.

The transmitting modem modulates the digital signal into analog, and receiving modem demodulates the receiving analog signal to digital (Fig. 7.24).

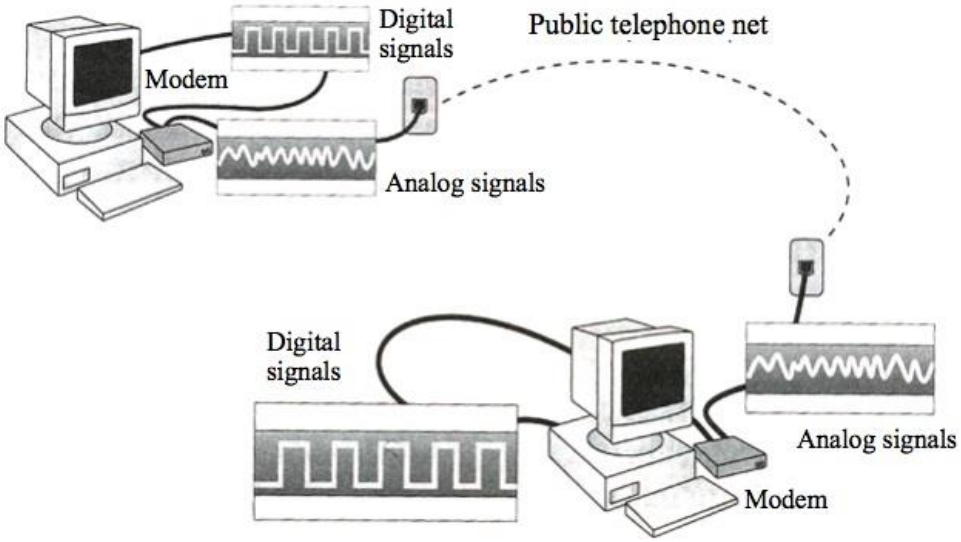


Figure 7.24 - Modems convert digital signals into analog and vice versa

Industry standards exist for almost each area of networking technologies, and the modem is not an exception. Standards enable communication of modems from different manufacturers. In the early 1980s Hayes Microcomputer Product, Inc. produced a modem called Hayes Smartmodem. It became a standard, that other modems were oriented. Initially, the modem speed was measured in bits per second, or in units called “baud” (Bd). Baud relates to the sound wave oscillation frequency, which transfers the bits of the data through the telephone line. The baud unit is named after Émile Baudot, the French officer-signalman, and an inventor of the Baudot code for telegraphy. In the early 80's baud rate was equal to the modem transmission rate. Then, communication engineers have developed methods of compression and encoding of the data. As a result, each modulation sound could carry more than one bit of information. This means that the bit rate per second may be greater than the baud rate.

There are different types of modems, since there are various types of transmission media which require different data transfer techniques. These environments can be roughly divided into two types, taking the communication synchronization as a criterion.

Asynchronous (sequential) modem supports asynchronous communication used in the standard telephone lines. Each character is decomposed into a sequence of bits. Each of these sequences is separated from the other by start bit and stop bit. The transmitting and receiving devices must agree on a combination of start and stop bits. Communication of this type of modems will not be synchronized, therefore, there is no special device for synchronization. The data are transmitted and received, the control information takes 25% of the traffic (Figure 7.25.).

The synchronous modem is based on the synchronization scheme agreed between the two devices. Its purpose is to allocate bits from the group while transmitting them with blocks called frames. Transfer is completed at the end of one frame and starts again at the next frame. This method is more effective than asynchronous transmission.

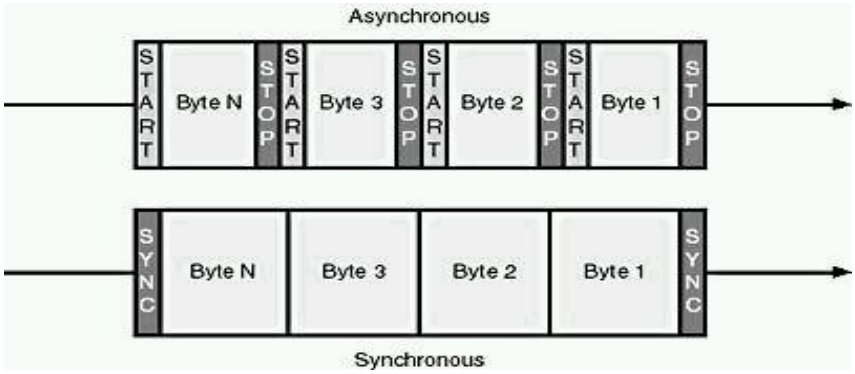


Figure 7.25 - Asynchronous and synchronous data streams.

Due to the high cost and complexity the synchronous modems are not offered for home use.

2. **Repeater** is a device that enhances the electric signal.

The repeater operates at the physical layer of OSI model restoring signal and transmitting it to the other segments. The repeater does not perform the function of transformation and filtering. It is required that both segments joined by repeater should have the same access method to proper work of the repeater. This is the cheapest way to the network expansion (Figure 7.26). The use of repeaters is justified in the case when to overcome the limitations on the length of the segment or the number of nodes is necessary while the expansion of the network and none of the segments generate traffic increase, and the cost is a major factor.

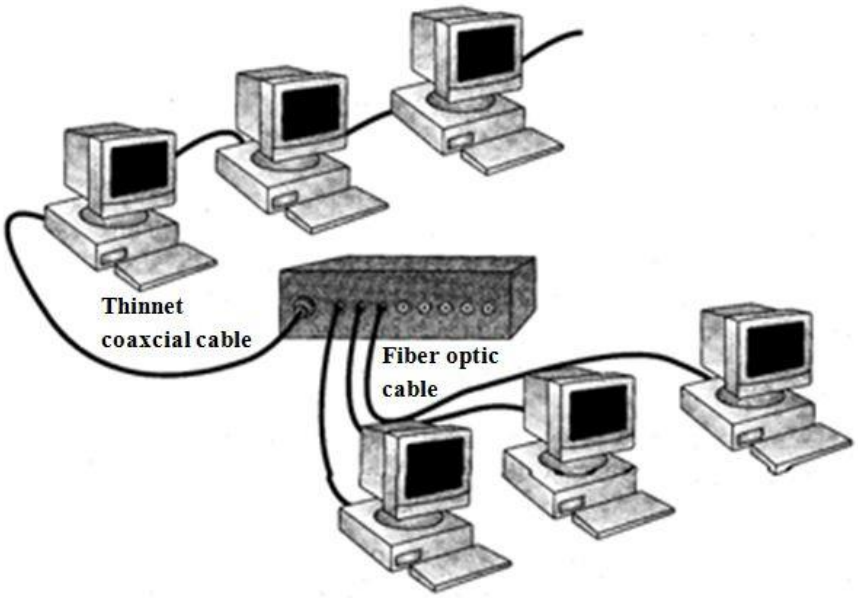


Figure 7.26 - Repeaters can connect different types of media.

3. **Bridge** is a device to connect segments or networks. Bridge tasks are to:

- increase the dimension of the network;
- increase the maximum number of computers in the network;
- eliminate bottlenecks in the network;
- connect disparate network segments;
- connect heterogeneous physical media.

Bridges operate at the data link layer of the OSI model, so they can not access to the information contained in the higher levels of the model. Bridges allow the use of all network protocols, not differing one protocol from the other. Since any protocols can run over bridges, each computer must determine the protocol it works. Bridges of the Media Access Control level perform the following actions:

- "listen" to all traffic;
- check the source and destination addresses of each packet;
- build a routing table;
- transmit packets.

The work of the bridge is based on the principle that each node of the network has its own address. At the beginning of the work bridge routing table is empty. Then, when nodes transmit packets, the source addresses are copied into the routing table. With the use of this information, the bridge examines the location of computers in the segments of a network.

Receiving the packet the bridge looks for a source address in the routing table. It copies address to the table if the source address is not found. Then the bridge compares the destination address with the routing table data. If the destination address is in the routing table and the destination is on the same segment with the

source, the packet is discarded. This filtering reduces network traffic and isolates network segments.

If the destination address is in the routing table, and the source and destination nodes are in different segments, the bridge forwards the packet to addressee through the appropriate port. If the destination address is not in the routing table, the bridge forwards the packet to all its ports, except the one through which the packet was received.

If you decide to expand network using bridges, you have to consider the following facts that bridges:

- have all the features of the repeaters;
- connect the two segments and restore signals on the packet level;
- operate at the link layer of OSI model;
- are not suitable for distributed networks at a transmission speed of 56 Kbit/s;
- cannot simultaneously use multiple routes;
- pass all broadcast messages allowing network congestion;
- read the source and destination address of each packet;
- allow packets with an unknown destination address.

The main purposes of the bridges are to:

- connect two network segments to increase the length or number of nodes in the network;
- reduce traffic by network segmentation;
- connect heterogeneous networks.

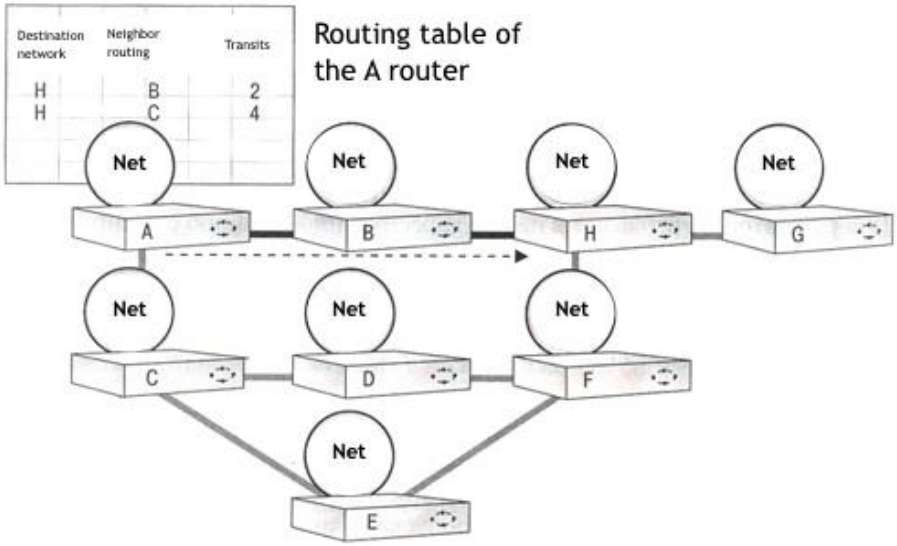
4. **Router** is a device that knows the address of each segment, determines the best route, and filters the broadcast messages. It works at the network layer of OSI model. This means that it can forward and route packets across multiple networks.

The routing table contains network addresses. For each protocol used on the network routing table is built. It includes the following information:

- all known network addresses;
- means of communication with other networks;
- possible paths between routers;
- data transfer costs to these routes.

The router chooses the best path for data comparing the cost and availability of various options (Fig. 7.27).

Not all protocols work with the router. Protocols working with a router are called routed protocols. These include: DECnet, IP, IPX, OSI, XNS. Non-routable protocols are: LAT, NetBEUI.



Figures 7.27 - Routers communicate with other routers but not with remote computers.

The routers are divided into two main types.

Table 7.3 – Comparison of types of routers

Static	**Dynamic**
Manual installation and configuration of all routes	Manual configuration of the first route. Automatic detection of additional networks and routes
Static router always uses the same route determined by the routing table	Dynamic router may choose a route based on such factors as the cost and size of the network traffic
The used route is strictly specified and not always is the best	Dynamic router may decide on the transfer of packets through an alternative route
Static router is considered safer as the administrator points each route by him/herself	Protection of the dynamic router can be improved by manually configuring it. The objective is filtering the detected network address and avoiding transmission through them

The router can "listen" to the network and determine which part of it is heavily loaded. It sets the number of transits between network segments. Using this information the router selects a data transmission route. If one path is overloaded, it will indicate an alternative one.

The difference between bridges and routers is that they operate at the different levels of OSI model. The router has more information. It recognizes not only the address, but also the type of protocol. Bridge can recognize only one path between networks. The router among several possible paths determines the best at the moment.

5. **Gateway** is a device integrating the information networks using different protocols. The gateways operate at the application layer of OSI model.

The gateways enable communication between different architectures and environments. They repackage and convert data transmitted from one medium to another medium, so that each media could understand the data from other media. In particular, the gateway repackages information in accordance with the requirements of the destination system; it changes the format of the message, so that the application on the receiving side can recognize the data. For example, e-mail gateways receive messages in one format and broadcast, and send it in different formats.

The gateway links two systems which use different:

- communication protocols;
- structure and data formats;
- languages;
- architecture.

The gateways are created for a particular type of problems, i.e. for a particular type of data conversion. The gateways perform the following operations while processing the data:

- extract data from incoming packets passing them through the entire protocol stack from the bottom to the up of the sending network;
- repackage the data passing them from the top to down through the protocol stack of the destination network.

Typically, the dedicated servers in the network take the role of gateways, so it is quite an expensive device to use it in network expansion.

The components discussed in this subchapter are used in local and wide area networks, and it is necessary to choose among them the most suitable one for increasing the size and performance of a particular network.

7.5 TCP/IP Protocols Stack

Internet Protocol

Transmission Control Protocol/Internet Protocol (TCP/IP) is an industrial set of protocols that enables communication in a heterogeneous (inhomogeneous) medium, i.e., ensures compatibility between different types of computers. Compatibility is one of the main advantages of TCP/IP, so most LANs supports it. In addition, TCP/IP provides access to Internet resources, as well as a routable protocol for enterprise networks. Because TCP/IP supports routing, it is generally used as a network protocol. Due to its popularity the TCP/IP became the de facto

standard for network interaction. TCP/IP is based on an open system, the system architecture corresponds to OSI model.

TCP/IP Implementation of Microsoft Company actually has a four-level model (Fig. 7.28).

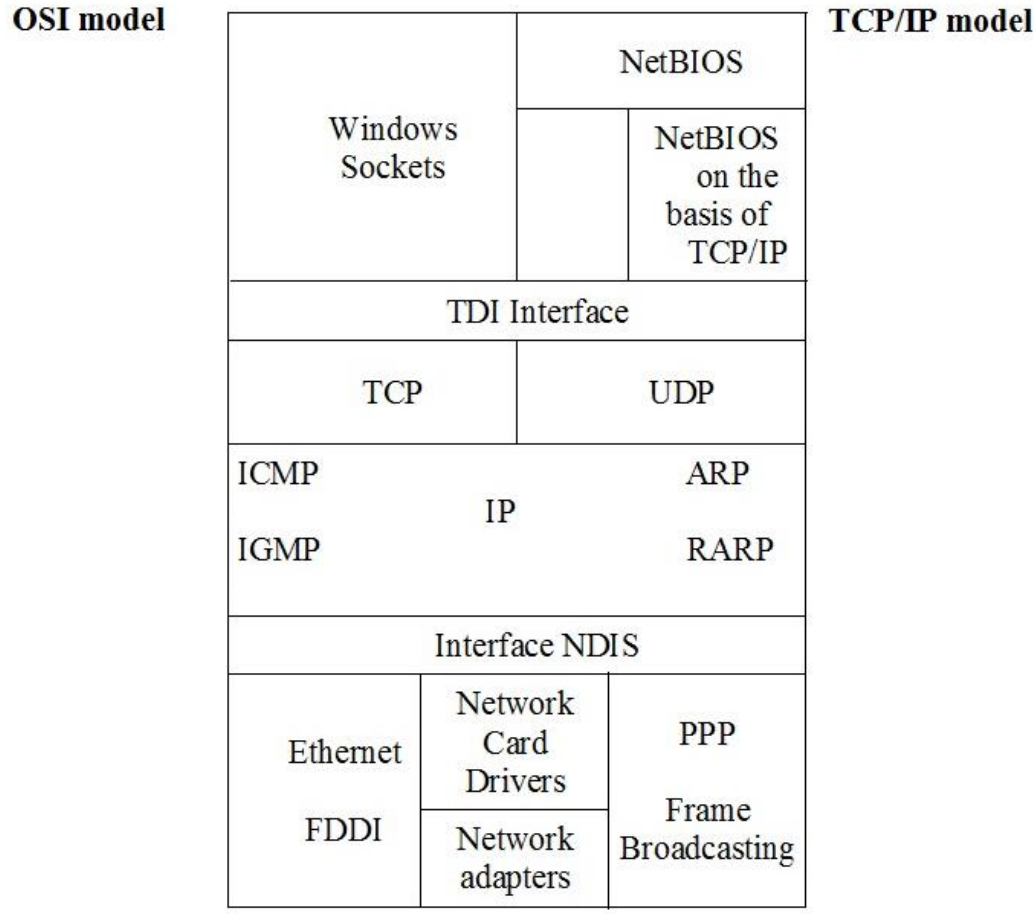


Figure 7.28- Correspondences of the OSI model and Microsoft's implementation of the TCP/I, a four-leveled TCP/IP model

The IP protocol is located at the network level and provides the transition of the data blocks called datagrams from the sender to the recipient. IP protocol is an unreliable protocol i.e. IP does not confirm delivery of data, does not control the integrity of the received data and is not proving the service information.

IP protocol treats each datagramm as an independent unit. The main objective of the IP is routing datatgramm (defyning the datagramms route from node to node).

Network node is a computer connected to the network and supporting the IP protocol. It has one or more IP-interfaces. Each interface has a unique IP-address.

IP-address is a unique 32-bit identifier of the IP interface on the Internet. IP-address is usually written, broken down into octets in decimal separated by a dot

IP address formats

Binary	Decimal
10100000.01010001.00000101.10000011	160.81.5.131

Each IP address in the Internet or Intranet should be unique regardless of the number of nodes in the network, weather 1000 or 1000 000 nodes. If your company network is configured to use TCP/IP and is not connected to the Internet, then assignment and the use of unduplicated address from the IP address space is not a big problem. You can choose from the entire address space those that meet your needs. However, if your organization's network must be connected to the Internet, it becomes much more difficult to make sure that the IP address is not used by anyone else. (Fig. 7.29)

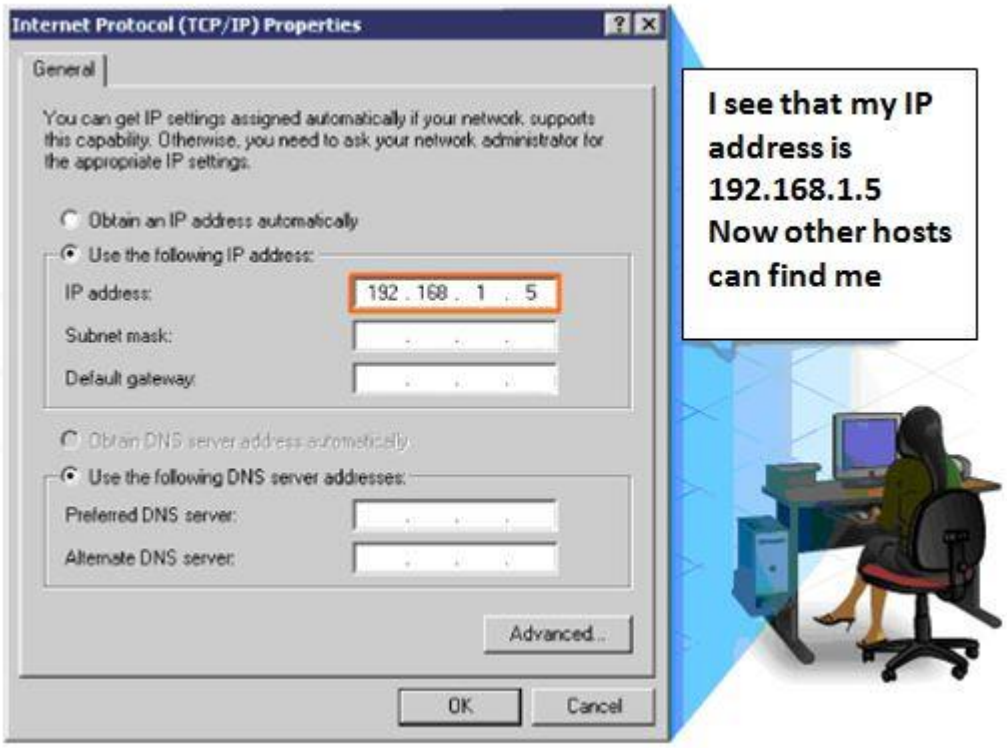


Figure 7.29 – Internet Protocol Properties

Internet Network Information Center (InterNIC) is responsible for the distribution and assignment of addresses in the Internet. Since only one group is responsible for the assignment of network addresses in the Internet, it is simple to ensure that the addresses are not repeated. However, the InterNIC does not keep track of every address in the Internet. Instead, it allocates network identifier to the organization, so that it can create a subnet with the required number of nodes. The organization can set node IDs in the same subnet as it is convenient for it.

IP Address Classes

1. A class

0			
0-127	X	X	X
network	Node		

A Class uses only the first octet as a network identifier and remaining three octets as the node ID. The most significant bit (MSB) of the first octet of this class addresses is always zero, which allows you to determine that the address belongs to A Class. The size of the network part is 8 bits, therefore, 2^7-1 can be addressed network of A class, and each network can have the address space 2^{24}-2. Because this class of addresses can be used to a large number of nodes in the network, these addresses are only given to organizations that need to provide access to an extremely large number of nodes. In fact, if it is not all, most of these addresses have already been allocated to any organizations, as a rule, military or universities, many years ago.

2. B class

10			
128-191	N	X	X
Network		Node	

B Class uses the first two octets for the network ID and the remaining two octets for the node identifier. Two bits of the first octet of the class address are always 10. It allows determining that it is a B Class address. The size of the network part is 14 bits, therefore, it can be addressed to 2^{14} of B Class network and each network can have the address space 2^{16}-2. These class addresses are intended to medium or large networks, and although they are not easy to get, some of the addresses are still available.

3. C class

110			
192-223	N	N	X

Network	node

C Class uses the first three octets for the network identifier and the remaining octet for the node ID. Three bits of the first octet of the class address are always 110. It allows determining that it is the address of a C Class. The size of the network part is 21 bits, therefore, it can be addressed to 2^{21} of C class network, and each network can have the address space of 2^8-2. This address class is designed for small networks, which may need to support a limited number of nodes.

4. D class

1110			
224>	X	X	X
network	logical group of the nodes		

D Class uses high-order bits of the first octet for broadcasting messages. Addresses in this class are always equal to 1110, which allow determining that the address is of D Class.

5. E class

1111			
240>	X	X	X
сеть			

E Class is an experimental class of the addresses reserved for future use. Addresses in this class are defined by the high bits set in 1111. The Table 7.4 illustrates the address classes, decimal value range of the first octet in this class, and available number of networks and nodes supported in this class. The ability to identify the class of the IP address, network ID and the node ID of network of a certain class is priceless.

Table 7.4 - IP address classes

Class	1st octet	1st octet bits	Network (N) and node (H) part of of the address	Default mask	The possible number of networks and nodes
A	1 – 127*	00000000 – 01111111	N.H.H.H	255.0.0.0	128 networks (2^7) 16,777,214 nodes (2^{24} -2)
B	128-191	10000000 – 10111111	N.N.H.H	255.255.0.0	16,384 networks (2^{14}) 65,534 nodes (2^{16} -2)
C	192-223	11000000 – 11011111	N.N.N.H	255.255.255.0	2,097,150 networks (2^{21}) 254 nodes (2^8 -2)
D	224-239	11100000 – 11101111	NA (multicast)		
E	240-255	11110000 – 11111111	NA (experimental)		

IP address selection rules:

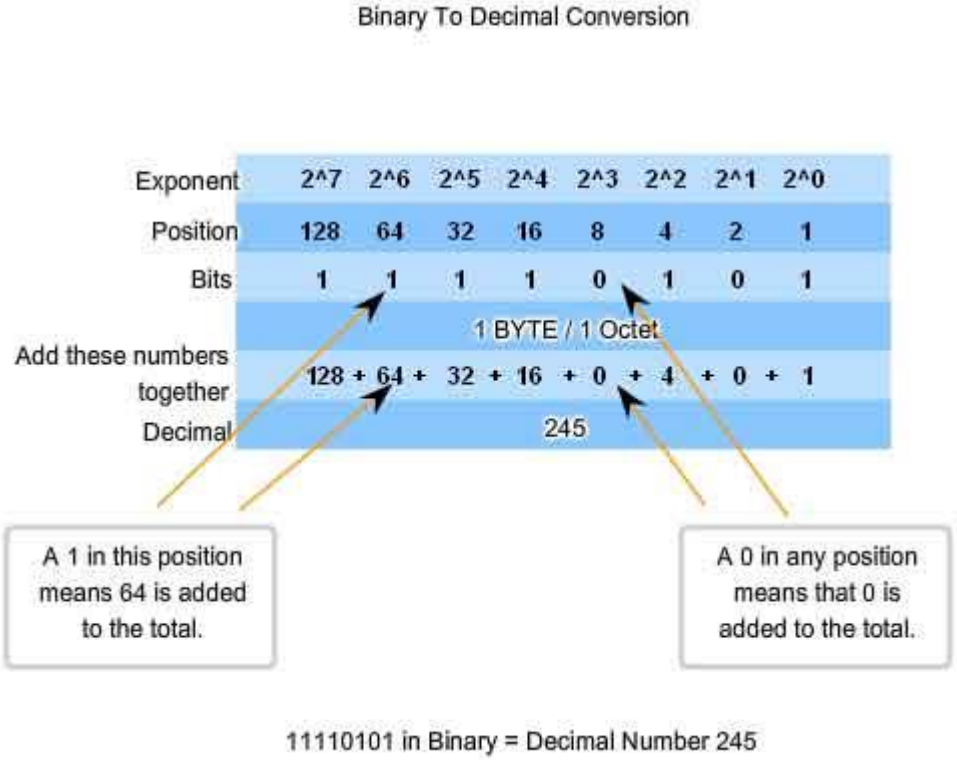
1. Plan the future. First and the most important: choose a class that allows further growth of your network.

2. Verify uniqueness of an IP address. Each segment of your network connected to the router must have a separate network ID.

3. Avoid using reserved addresses. Some addresses are normally not used the Internet as an IP address. For example, the network address of A class 127 is reserved for diagnostic purposes. The list of reserved addresses can be found on the Internic web-site at http // ds.internic.net.

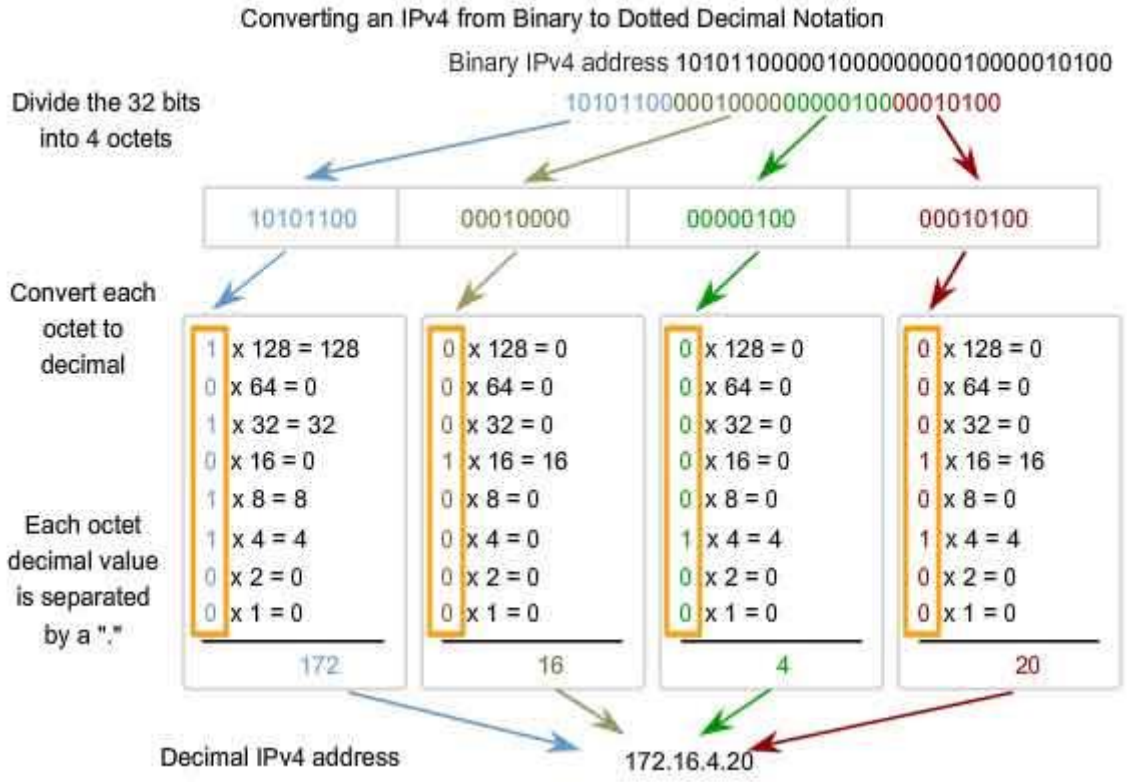
4. IP address of 0 (octet consists of all zeros) and 255 (octet consists of all ones) cannot be used as an IP address. The following are examples of calculations of IP addresses (Figure 7.30 (1-5)).

1.

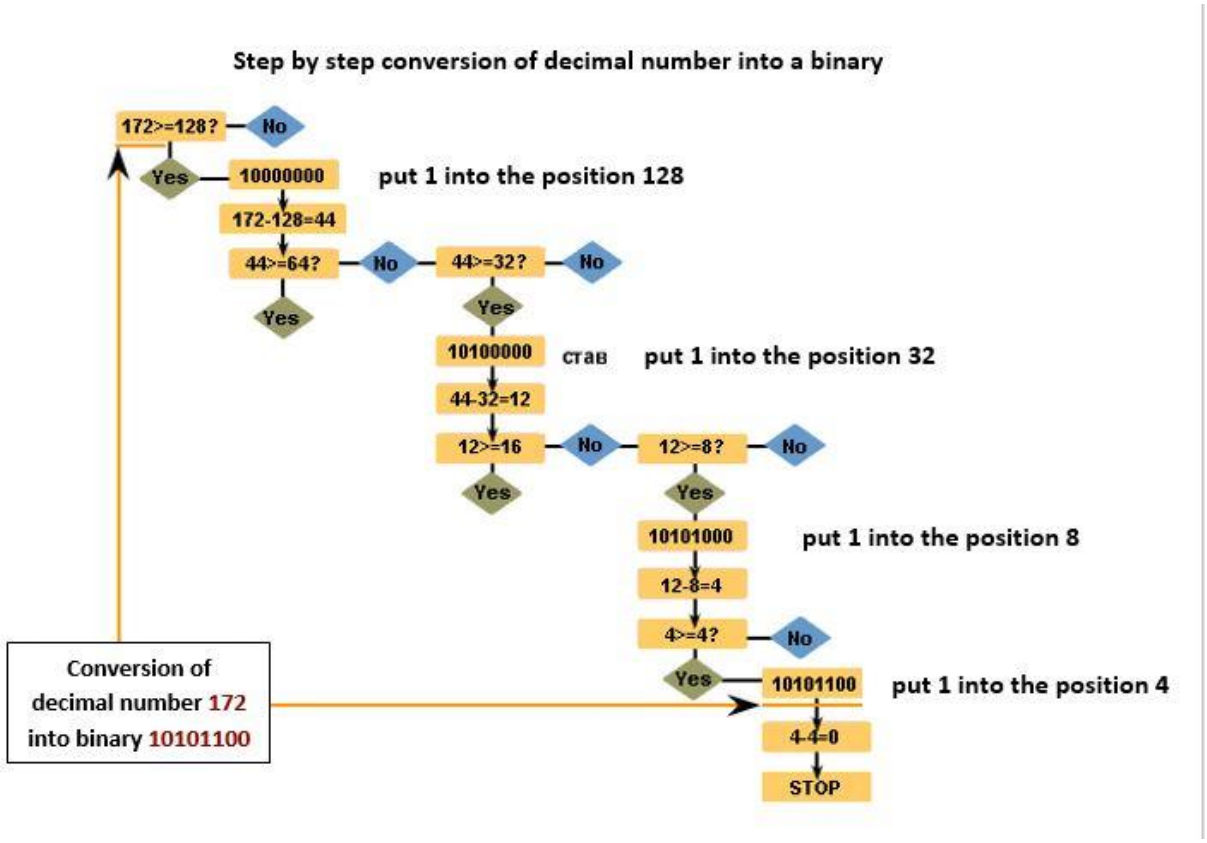


11110101 in Binary = Decimal Number 245

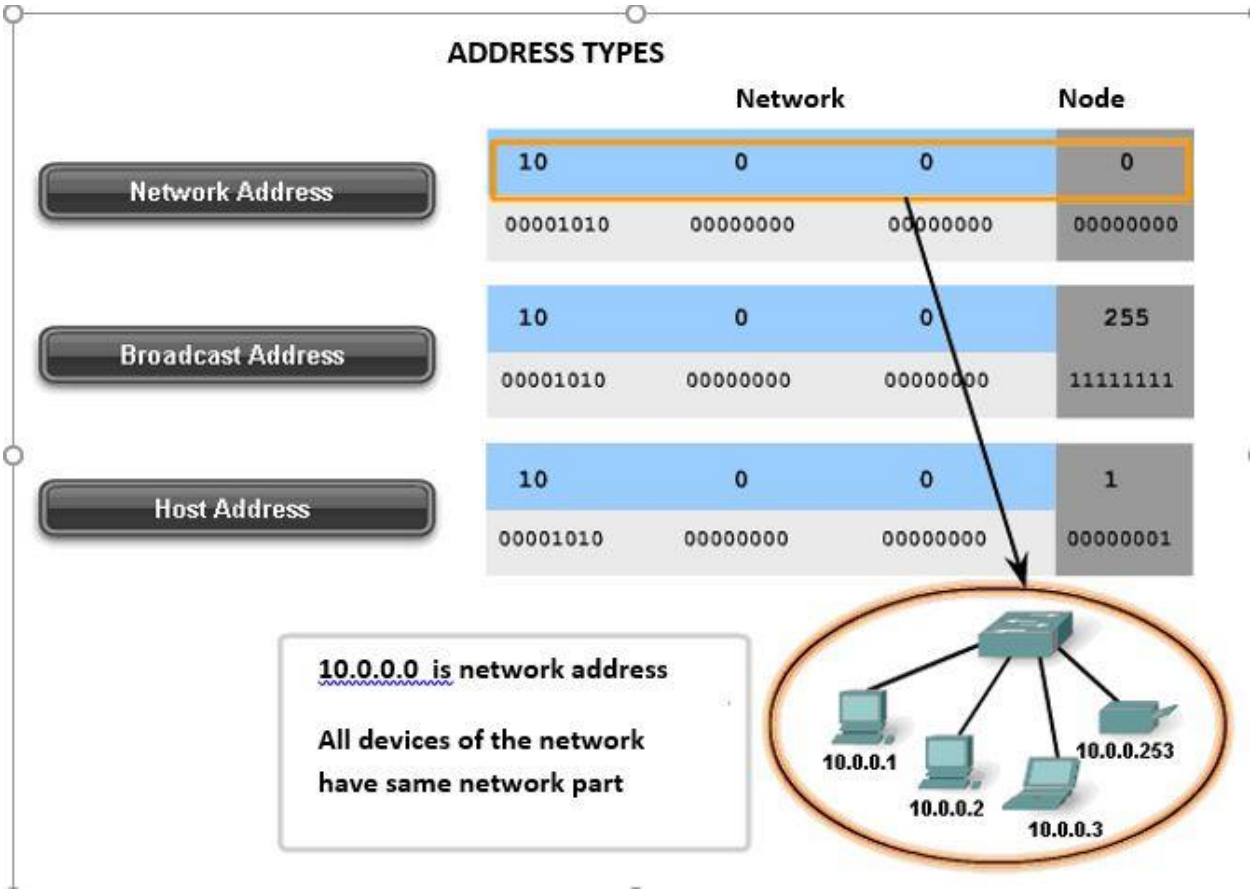
2.



3.


Step by step conversion of decimal number into a binary
172>=128?
No
Yes
10000000
put 1 into the position 128
172-128=44
44>=64?
No
44>=32?
No
Yes
Yes
10100000
став
put 1 into the position 32
44-32=12
12>=16
No
12>=8?
No
Yes
Yes
10101000
put 1 into the position 8
12-8=4
4>=4?
No
Yes
10101100
put 1 into the position 4
4-4=0
STOP
Conversion of decimal number 172 into binary 10101100

4.


ADDRESS TYPES
Network
Node
Network Address
10 0 0 0
00001010 00000000 00000000 00000000
Broadcast Address
10 0 0 255
00001010 00000000 00000000 11111111
Host Address
10 0 0 1
00001010 00000000 00000000 00000001
10.0.0.0 is network address
All devices of the network have same network part
10.0.0.1
10.0.0.2
10.0.0.3
10.0.0.253

5.

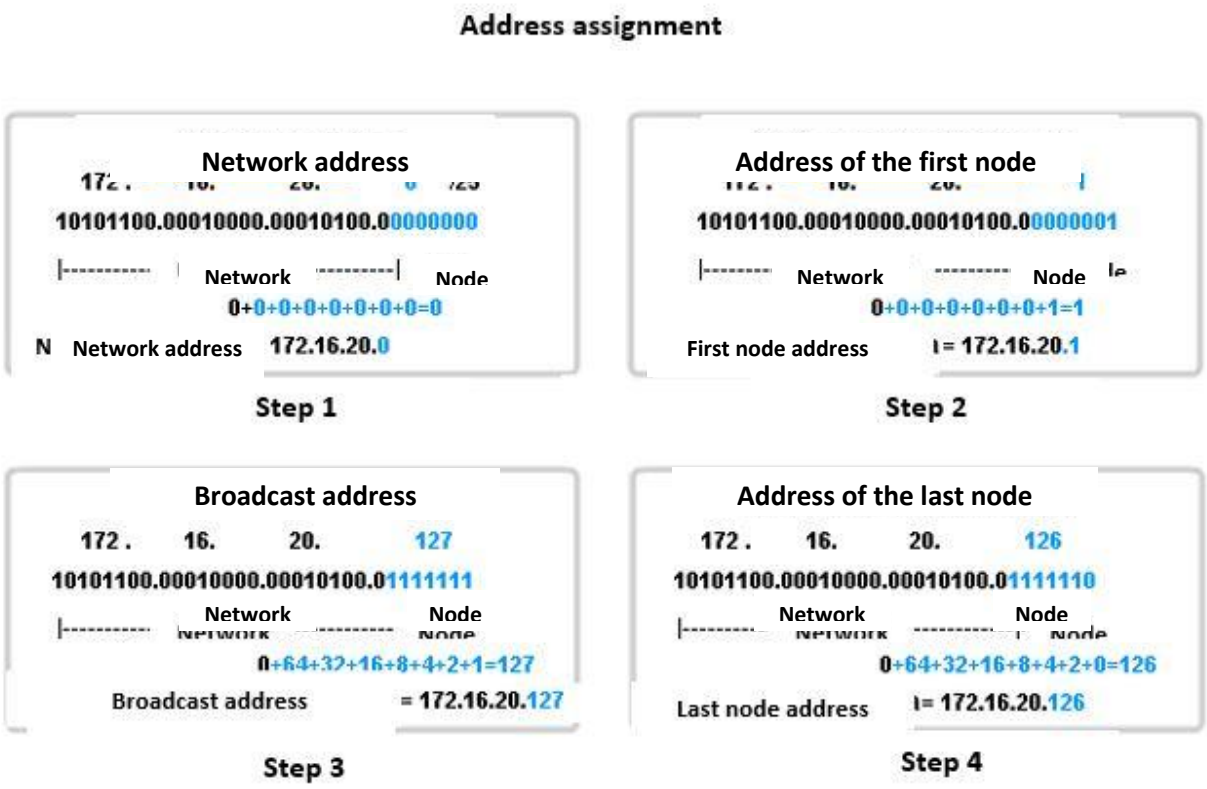


Figure 7.30 (1-5) – IP Address conversion examples

Classless Model

The need for efficient use of the available address space has stimulated the creation of a new IP addressing scheme Classless Inter-Domain Routing (CIDR).

Let's suppose that there are 2000 computers in the LAN connected to the Internet. To connect the address space you need eight addresses of C Class or one of B Class. But B Class has a capacity of 65534 nodes. This is much more than you need. However, if you use eight C Class addresses, the problem of traffic congestion with the service information arises while connecting to this network.

On the other hand, we can divide 32 as 21 and 11, as 2^{11}=2046 addresses, therefore, it will be one network with 21-bit address, and the only one entry will be required in the routing table for its maintenance. Subnet masks are used to facilitate the separation of the address space.

Subnet is a network or network identifier created by using a few bits transferred from the IP address that contains the node identifier, into the part that contains the network identifier.

Subnet musk is a 32-bit address that allows you to determine how many bits in the address are used as the network ID.

The network mask is constructed by the following rules:

1) at a position corresponding to the network ID, bits are set (1).
2) at a position corresponding to the node ID, the bits are released (0).

For convenience of recording the IP addresses in the CIDR model, it can be represented as: a.b.c.d./n, where a.b.c.d - IP address; n - number of bits in the network part. For example, the given IP address is 137.158.128.0/17, consequently, the subnet mask units 17 (network identifier), and 15 zeros (node ID) and it is equal to 255.255.128.0.

How to find the node ID in the subnet if you know the IP address? Let's consider that we are given an IP address of 205.37.193.134 C Class - node ID is 134. Let's divide the network into subnets as follows 205.37.193.134/26. What is the node address in this case?

Table 7.5 – IP address, Network ID and Node ID

	IP address	Network ID	Node ID
Source node IP address	205.37.193.134	11001101.00100101.11000111.	10000110
Subnet mask	255.255.255.192	11111111.11111111.11111111.11	000000
The result of the logical operation "AND"	205.37.193.128	11001101.00100101.11000111.10	000110

As a result, we have the IP address of the subnet which is equal to 205.37.193.128., and the node number in the subnet is 6.

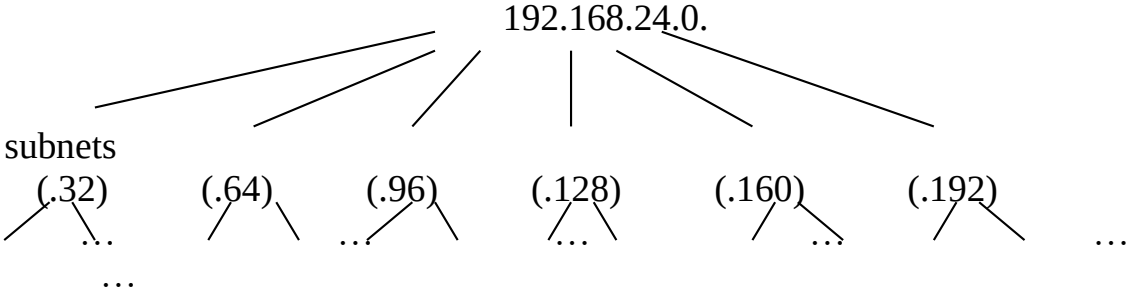
Default masks for:

- A class - 255.0.0.0;
- B class - 255.255.0.0;
- C class - 255.255.255.0.

Exercise 1. Indicate that the IP address 132.90.132.5 with mask 255.255.240.0 specifies the node number 4.5 in the network 132.90.128.0/20.

Subnet addressing example.

Let's consider that NIC assigned you the IP address 192.168.24.0. You have three networks. What mask do you have to apply to divide them into subnets? Proposed mask 255.255.255.224, because in this case at part of the network ID will be three units, therefore, 2^3-2=6 can be addressed to subnets and 2^5-2=30 nodes for subnet.



33…63 65 … 95 97…127 129…159 161…191 193…223
number of nodes

Thus, division into subnets is necessary to:

- overcome the physical limitations on the capacity of the network (network architectures have limitations on the number of nodes in the network);
- use various methods for nodes communicating (different network architectures can be connected with the use of a router).

Stages of division of the network into the subnets:

1) Determine the total number of required network IDs. Do not forget to think about the future development of the network.
2) Determine the total number of nodes IDs that each subnet should support. Again, be sure that in the future the new nodes can be connected to the network.
3) Determine the subnet mask which will maintain the necessary amount of network IDs and the nodes in the subnet.
4) Determine which network IDs will be used.
5) Assign the IDs to the nodes in the subnet.

Exercise 2. Node D has an IP address 202.12.74.37 and a subnet mask 255.255.255.224. Node D should transmit information to the node F, which has the IP address 202.121.74.66 and the mask 255.255.255.224. Determine whether the nodes D and F are on the same subnet and how the information is transmitted.

Exercise 3. You are working for a company that has received an IP address of B class 128.131.0.0. Currently it has 45 separate network segments. It is planned to introduce another 50 subnets. What mask should be used to maintain the maximum number of nodes?

Exercise 4. The company has nine divisions and received the IP address 130.121.0.0. It requires to support 3,000 nodes in the division. What mask should be chosen?

IP Routing

Routing is the process of data transfer to the destination node or an intermediate router.

Routing is based on tables, the route is just a database which stores the correspondence between the IP addresses of segments and IP address of the router interfaces. The router checks the routing table whenever the data come from any node. If the destination node (or its network segment) is not specified in the table, by default the data are sent to the gateway. If the destination node is found, the data are sent to the recipient. If the destination node is not found, then an error message is sent to the sending node.

Figure 7.31 demonstrates the routing process. There are two types of routing tables: static and dynamic. System administrators must create and maintain static routing tables manually, because the table cannot be changed without a specific intervention. Dynamic routing tables are created and maintained automatically by the routing protocol.

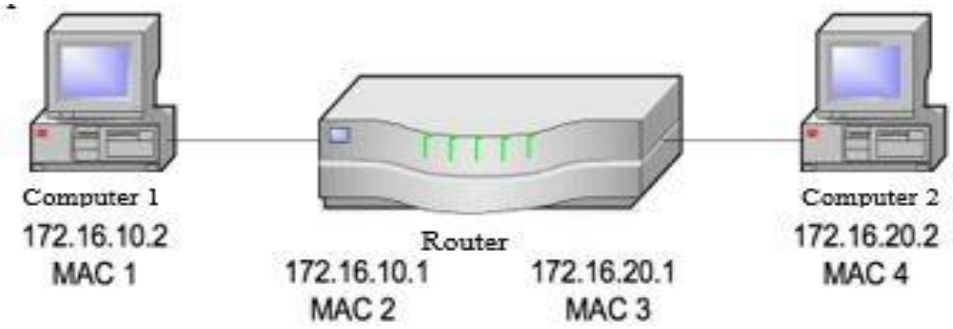


Figure 7.31 - Simple routing.

Static Routing

Static routing is a built-in function of IP which does not require any additional services for working. Static routing table must be created and maintained on each router manually. Static routing table defines the communication between the networks and the gateway or router interface to access them. Static Routing Table contains the following columns:

- Network address. Address of each known network including a local address (0.0.0.0) and the broadcast address (255.255.255.255).
- Network mask. The subnet mask used for each network.
- Gateway Address. IP-address of the entry point (router interface) for each network.
- Interface. IP assigned to the network interface.
- Metrics. The number of retransmissions ("hops") to reach the network.

The table 7.6 presents an example of the routing table.

Table 7.6 - Routing Table

Network	Mask	Metrics	Interface	Gateway
0.0.0.0	0.0.0.0	1	10.57.11.169	10.57.8.2
127.0.0.0	255.0.0.0	1	127.0.0.1	127.0.0.1
10.57.8.0	255.255.248.0	1	10.57.11.169	10.57.11.169
10.57.11.169	255.255.255.255	1	127.0.0.1	127.0.0.1
10.57.255.255	255.255.255.255	1	10.57.11.169	10.57.11.169
224.0.0.0	224.0.0.0	1	10.57.11.169	10.57.11.169

Static router can only communicate with the networks that are listed in the routing table.

Route command is a TCP/IP utility which is used to create and modify the static routing table. It has following syntax:

route [-f] [-p] [Command [Destination] [mask Netmask] [Gateway] [metric Metric]] [if Interface]]

Parameters have the following meanings:

- -f – removal of all entries for the getways. If this parameter is used in conjunction with others, you must first delete entries made to the gateway;
- -p – addition (using the add command) of permanent record. By default, add entries are not saved when the system is restarted. All permanent paths can be displayed using the print command.
- command – one of the four commands can be specified: print (print a list of paths), add (add the path), delete (delete the path), change (change the current path);
- destination – specifies the computer to which you want to send the specified command;
- mask – specifies the subnet mask for a given path. The default is 255.255.255.255;
- geteway – for the specified path;
- metrics – setting the metric field in the routing table with a specified value. It can be set to any value from 1 to 9999.

Tracert command is a TCP/IP utility used from the command line and is designed to test the route and measure packets transit time. Tracert syntax:
tracert [-d] [-h maximum_hops] [-j host-list] [-w timeout] target_name.

Parameters have the following meanings:

- -d – do not translate the IP- addresses into the host-names;
- -h – maximum_hops - the maximum number of retransmissions ("hops") when the system is searching;
- -j – host list - free choice of path among the systems in this list;
- -w – timeout - expect each answer in a specified number of milliseconds;
- target_name - the system name, the searching path to which is carried out.

Tracert is an excellent tool for checking the path. It is also can be used to determine the speed effects of paths.

Dynamic Routing

In large networks with complex architecture is optimal to use dynamic routing, because it can help to avoid the tedious manual configuration of a large number of routing tables. In this case the work load on the network management administrator will be minimal, because only the address of the default gateway will have to be specified for each router and all other settings and creation of the routing table will be held automatically.

Review questions

1. What is a computer network?
2. What are the structure and the purpose of a computer network?
3. What are the advantages of joining computers in a computer network?

4. How do you understand the principle of interaction between computers on a ‘client-server’ network? What are the differences between server computers and client computers?

5. What are the types of networks and data transmission methods?

6. What is the purpose of various levels of networking model?

7. Why are protocols necessary when transferring files over a network?

8. What is the network topology? How do the various topologies like “star”, “ring” and “bus” differ?

9. What is a Fast Ethernet?

10. What are the differences between the transmission media: twisted pair, coaxial cable and fiber optic cable?

11. What are the features of wireless data transmission technologies in computer networks?

12. What is the purpose of network cards? Why are repeaters necessary for data transmission?

13. What is the purpose of hubs and switches? What is the difference?

14. What is the purpose of network operating system?

15. What are the differences between basic approaches to network management organization: objects tables, domains and DNS service?

16. What is the IP address of a computer used for?

17. What classes of addresses are used in the TCP/IP protocol?

18. What is the purpose of a subnet mask?

19. In the networks of which classes the IP addresses have more than 1000 hosts? In the networks of which classes the IP addresses have only 254 hosts?

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CHAPTER 8. CYBERSECURITY

Rapid development of communication technology in Kazakhstan raises infrastructure protection issues, as its damage or destruction may have significant implications for the security of the country. According to experts, it is estimated that Kazakhstan takes the 18th place in the world in the amount of spam received and the 7th place in dangers of web surfing. The increase in the number of Internet users and the expansion of online services have escalated the cybercrime rate, mainly in the financial sector. Among their most important features are: the particular difficulty of detection and investigation; extremely high level of latency; transparency of national borders for criminals, and the absence of an integrated legal framework for dealing with them; enormous extent of the damage; a highly professional structure of perpetrators of such crimes. All of these do not only aggravate the problem of information security, but also make possible the usage of IT-communications in the organization of public protests or acts of terrorism, as well as in the management of possible conflicts. That is why the society needs solid guarantees of resistance to cyber-attacks and other emergencies, regardless of whether these attacks are directed against businesses or government agencies.

Cybersecurity is a set of tools, policies, security principles, security guarantees, risk management approaches, actions, training, insurance and technology, which are used to protect the cyber environment, resources, organizations and users. Cybersecurity means to achieve and maintain the security properties of the organization's resources or users against cyber threats. The primary goals of security are: availability, integrity including authenticity, and confidentiality. Cyber security is a prerequisite for the development of the information society. Usually, the concept of cyber security is considered as a synonym to safety.

The **information security** is the security of information and supporting infrastructure from accidental or intentional exposure of natural or artificial origin which could harm the subjects of information relations, including the owners and users of the information and supporting infrastructure.

Data Protection is a set of measures aimed at ensuring information security.

Information Security Problems

Information security is one of the most important aspects of integrated security. The following facts can serve as an example.

The protection against unauthorized access to information resources, and security of information and telecommunication systems are identified as important components of national interests in the concept of information security of Kazakhstan.

8.1 Information Security Threats

Information Security Risk (IS) is a potential event, action, process or phenomenon that can cause damage to anyone's interests.

An attempt of threatening activities **is** called an **attack.**

Classification of IS threats can be made according to several criteria:

- by the information security aspect (availability, integrity, confidentiality);

- by the IS components at which threats are aimed (data, software, equipment, supporting infrastructure);

- by the implementation method (accidental or intentional action of natural or artificial origin);

- by location of the threat source (inside or outside of the IS).

Regardless of the specific threat types, an information system must possess the basic properties of information and its processing systems:

- availability - the ability to get information or information services in a reasonable time;

- integrity - the relevance of the property and the consistency of the information, its protection from destruction and unauthorized changes;

- confidentiality - protection against unauthorized access to information.

Examples of Privacy Violation Threats

Some information stored and processed in the information systems (IS) must be hidden from outsiders. Transmission of this information may cause damage to both the organization and the information system itself.

Confidential information can be divided into **subject** and **official.** Official information (such as passwords) doesn’t belong in a specific subject area, but its disclosure may lead to unauthorized access to all information.

Subject information contains information the disclosure of which could cause damage (economic, moral) to an organization or a person.

Different technical means (eavesdropping conversations, network), and other methods (unauthorized transfer of access passwords, etc.) can serve as a means of attack.

The continuity of data protection throughout the cycle of its storage and processing is an important aspect. Accessible storage of data backup can be considered as an example of a violation.

Examples of Data Corruption Threats

One of the most frequently implemented information security threats is theft and forgery. Unauthorized modification of data in information system can lead to information loss.

Integrity of information can be divided into **static** and **dynamic.**

Examples of violations of the static integrity are:

– entering incorrect data;

– unauthorized modification of data;
– change of the program module by means of a virus;

Examples of violations of the dynamic integrity are:

– violation of transactional atomicity;
– data duplication;
– Entering of additional packets into the network traffic.

Malicious Software

One of the methods of attack is an introduction of malicious software into the system. This type of software is used by hackers for:

– introduction of malware;
– gaining control over the attacked system;
– aggressive resource consumption;
– alteration or destruction of programs and / or data.

According to the distribution mechanisms there are:

– Viruses - a code that has the ability to self-spread by its implementation in other programs;
– Worms - codes that can cause the spread of its own copies and their implementation.

The RK GOST (national standard) 51272-99 "Information Security. Object of informatization. Factors influencing information. General provisions" introduces the following concept of a virus:

Virus Software is an executable or interpretable code, which has the property of unauthorized dissemination and self-reproduction in automated systems or telecommunications networks in order to change or destroy the software and / or data stored in automated systems.

An example of the access denial threat is an access denial service. Regarding IS components, this class of threats can be divided into the following types:

– User failure (unwillingness, inability to work with an IS);
– Internal information system failure (errors during the reconfiguration of system software and hardware failure, data corruption);
– Failure of the supporting infrastructure (communication systems operating failure, power supply failure, destruction and damage of the room).

The Concept of an Attack on an Information System

Attack is an action or a sequence of actions, using the vulnerability of an information system and leading to a security policy breach.

Security Mechanism is a piece of software and / or hardware that identifies and/or prevents an attack.

Security Service is a service that ensures the security of the systems and/or transmitted data set by policy, or protects from attacks.

Complexity of Security Systems. In addressing the issues of information security, it is necessary to bear in mind all aspects - software, technical, legal, organizational, etc.

Protection Continuity. Protection continuity assumes that a set of measures to ensure information security must be continuous in time and space.

Protection of information objects should be provided during basic or repair work, and also during the setup and configuration of information systems and services.

Reasonable Sufficiency. The construction and maintenance of information security require sometimes certain considerable tools. However, it is impossible to establish a comprehensive security system. When choosing a protection system, one should look for a compromise between the expenses of the information security objects and possible losses that may be incurred in the breach of security.

Control and Management Flexibility. Threats to information security are multifaceted and not pre-determined. For a successful response, it is necessary to have the possibility of changing the currently used means of data security, the possibility of expeditious inclusion or exception of the used means of data security, and also adding new security mechanisms.

Openness of Algorithms and Security Mechanisms. Means of information security can become a threat to an information system or object itself. For prevention of such class of threats, the security algorithms and mechanisms must allow independent safety check and comply with the standards, and also the possibility of their application with other means of data protection as a whole.

Simplicity of Application of Security Measures and Means. During the information security system design, it is necessary to remember that implementation of proposed measures and means will be carried out by users (who are often not specialists in the field of IB).

It is necessary to increase the efficiency of security measures by ensuring that the algorithm of work with them is clear to the user. Besides, the used means and mechanisms of information security shouldn't break the normal work of the user with an automated system (sharply reduce performance, increase complexity of work, etc.).

8.2 Methods of Information Security

Here is the example of classification of methods used for information security:

- **an obstacle** – a method of physical blockage of a malefactor's way to the information;
- **management of access** – a security method by means of regulation using the information system resources ;
- **masking** – an information security method of its cryptographic transformation;

- **regimentation** – the information security method creating conditions of the automated handling under which possibilities of unauthorized access are minimized;
- **coercion** – a security method of forcing the personnel to follow the rules of information handling, transfer and use;
- **motivation** – a security method of inducing the user not to break the modes of information handling, transfer and use due to respect for ethical and moral standards.

Means of Information Systems Security

Security means can be classified into:

- **technical means** – various electric, electronic and computer devices;
- **physical means –** means, which are implemented in the form of self-contained units and systems;
- **software means –**software intended for accomplishment of information security functions;
- **cryptographic means** –mathematical algorithms providing transformation of data for the solution of information security issues;
- **organizational means –** a set of technical-organizational and legal-organizational measures;
- **moral and ethical means –** means, which are implemented in the form of the regulations developed in the process of distributing the COMPUTER and information technologies;
- **legislative means** – a set of the legal acts regulating the use of IS, handling and transfer of information.

8.3 Software and Technical Measures to Ensure Information Security

Program and technical measures are understood as a set of the information systems and technologies aimed at providing information security. These measures allow to automate many tasks to support information security.

By reviewing an information system at the initial detailed level, it can be considered as a set of information services providing execution of the main functional objectives of ICs.

It is possible to provide the following number of services for safety:

- identification and authentication;
- access control;
- recording and auditing;
- encoding;
- integrity monitoring;
- screening;
- security analysis;
- failover support;
- security restore support.

Classification of security measures on the basis of safety servicesand their place in the general architecture of the IC:

- preventive measures;
- measures for detection of violations;
- measures for localizing an influence zone;
- measures for detection of violations;
- measures for security mode restoring.

Features of Modern IS

From the point of view of information security, there are the most essential aspects:

Corporate network is distributed, communication between separate parts is provided with external providers;

- Corporate network has one or several connections to Internet;
- Crucial servers can be settled down on different platforms;
- Both computers and other mobile devices are used for users access;
- During one session, the user addresses several information services;
- There are severe accessibility requirements to information services;
- An information system is a network with the active agents, during the process of operation software modules are transferred from the server to the user's computers, etc.;
- Not all user systems are controlled by IS administrators;
- Software and modules received on a network can't be considered reliable;
- IS configuration is changed permanently at the levels of administration of data, programs and equipment.

Information Security Support

Safety information in ICC implies not merely the introduction of some kind of protection. Competent and consistent construction of the subsystems is included in the information security system (SOBI) and construction shall be in accordance with the results of the analysis of current threats to information security, integrated approach to SOBI design. This should take into account the need for centralized management of information security tools.

SOBI must be built as a hierarchical, multi-level system.

The integrated approach used in the construction of SOBI provides several levels of protection that define requirements for the security of information at all stages of its appeal to the ICC: technology, user, network and channel.

Subsystems of an Information Security System

- **The subsystem of the Entrusted Information Environment (EIE)** support is intended for maintenance of the integral CIS hardware-software environment, and also for support of guarantees of CIS users' confidence in the provided system

of information and services.

- **The subsystem of authentication and identification** is intended for holding procedures of authentication/identification of the network entities which form a part of CIS at all processing stages and the internal circulation of information in CIS. The subsystem tightly interacts with an access monitoring subsystem.

- **The subsystem of access monitoring** based on a multi-level security strategy is intended for control users' access to an automated worksite, servers, application-oriented systems, system and network services, and other parts of CIS .

- **The subsystem of stream protection** is intended for creation of the entrusted communication links between structural components of CIS.

- **The subsystem of audit and registration** deals with collection and information storage about shared state of the program and technical components which function separately or are a part of security subsystems. The subsystem is intended for the preliminary analysis of such information.

- **The control subsystem** – the key subsystem of SOBI intended for operational management by both separate SOBI component, and the system in general according to the security strategy.

The subsystem includes such mechanisms as analysis of information from consoles monitoring the security features, the support system of making decisions on operational gain / loosening of a security strategy in separate elements or the SOBI nodes and counteractions to the external and internal attacks, control of separate means and complexes of information security, etc.

Security Subsystem Sets

SOBI contains various set of subsystems (decisions) for each organization. This set isn't standard and varies depending on business challenges to be met by CIS. However, it is possible to allocate several basic subsystems constituting SOBI of a corporate information system practically for any organization:

- subsystem of secure connection of corporate network to the Internet;
- subsystem of corporate e-mail security;
- subsystem of protection against malicious applications and computer viruses;
- subsystem of security of internal and external information streams;
- subsystem of preventing invasions;
- subsystem providing information security of personal computers from unauthorized access;
- subsystem of the program environment integrity control;
- subsystem of data backup and its restoring (Fig. 8.1).

Functional Security Subsystem of Identification and Authentication

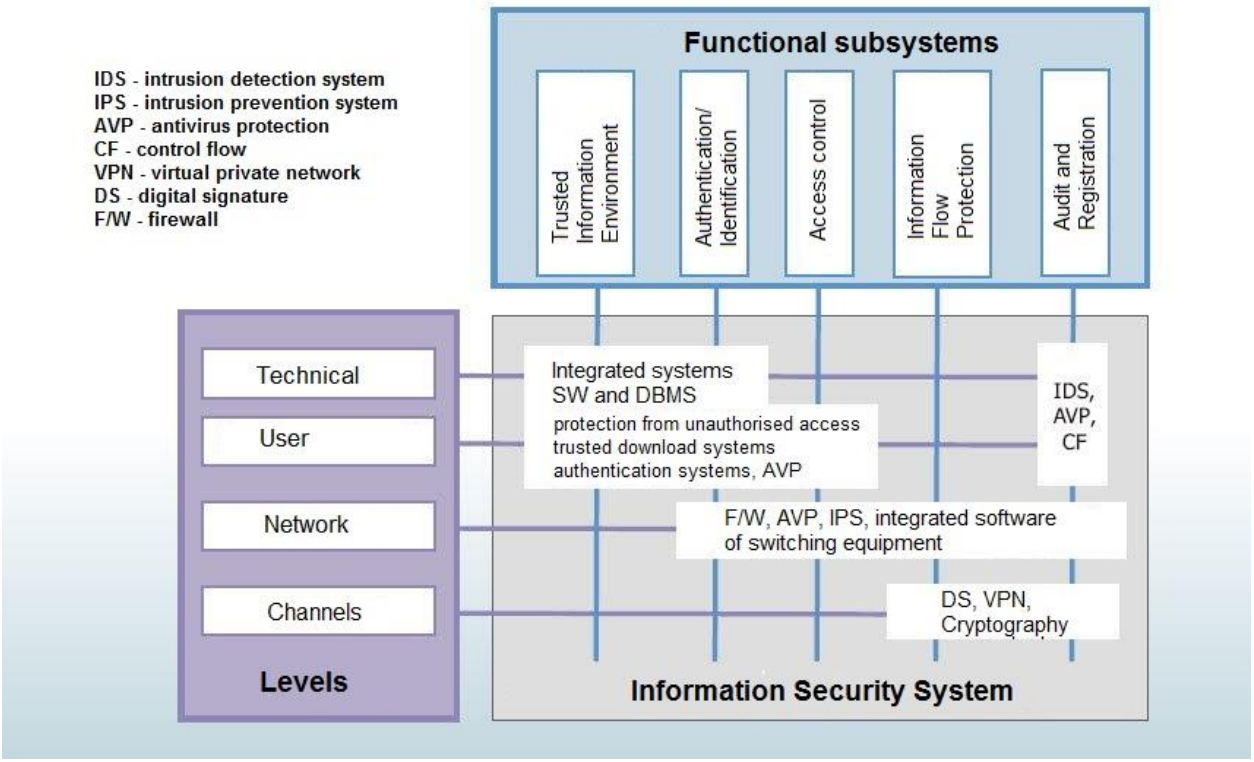

Figure 8.1- Functional Security Subsystem

Identification and authentication. Identification and authentication processes form the basis of software and hardware information security. Identification allows the subject to include their names in IP. Authentication is a measure which confirms the user identity. Authentication may be a one-way (client proves the authenticity of the server) or a bilateral (mutual) process.

Password Authentication. Using a password for the identification of the subject. Advantages: simplicity and convenience to humans. Disadvantages: weak protection.

Password Protection. Measures to ensure the reliability of password protection:

- Imposition of technical restrictions (password length, password alphabet);
- Password expiration management, its periodic change;
- Restricting access to the password file;
- Limitation of the number of failed login attempts;
- User Training;
- Software password generation.

One-time Passwords. Measures for support of reliability of password security:

- statement of technical constraints (password length, alphabet of the password);
- control of password aging, its periodic change;
- access restriction to the passwords' file;

- limitation of the number of failed login attempts;
- user training;
- use of the password generation software.

One-time Passwords. One of the methods of improving password plan reliability is the usage of one-time passwords (for example, the S/Key system):

- In the authentication process, one-sided f-function is used. This function is known to the authentication user and server.
- The given K-key is known only to the user.
- At the start of administration the f-function is applied to a K-key n-times, the result being saved on the server.
- During authentication, the server sends the number (n-1) to the user system.
- The user applies the f-function to the confidential number (n-1) and sends the result to the server.
- The server applies the f-function to the user's final value and compares it to the earlier saved value. In case of coincidence the authenticity is confirmed, and the server remembers the sent value and reduces the counter by unit.

Kerberos Authentication

The Kerberos diagram is intended for authentication of problem solving tasks in an open network with the use of the third entrusted party (Fig. 8.2).

To get access to the S-server, the C-client sends the request containing the information about the client and the required service to the Kerberos. The Kerberos returns the so-called ticket ciphered by secret key of the server and the copy of a part of information from the ticket ciphered by the client's secret key. The client decrypts the second portion of data and sends it with the ticket to the server. The server, having decrypted the ticket, compares the additional information sent by the client. Coincidence will demonstrate that the client could decrypt the data sent by Kerberos and confirms the information about the secret key and the authenticity.

In the Kerberos diagram, the secret keys aren't transferred through a network. They are used only in the course of encoding.

1. C-client -> Kerberos: c, s, … the client sends information about itself and the required server to the Kerberos

2. Kerberos -> The C-client: { d1 } Kc, { Tc.s } Ks Kerberos returns the ticket ciphered by a key of the server and the additional information ciphered by the client's key.

3. C-client->; the S-server : d2, { Tc.s }the Ks client sends the ticket and additional information to the server.

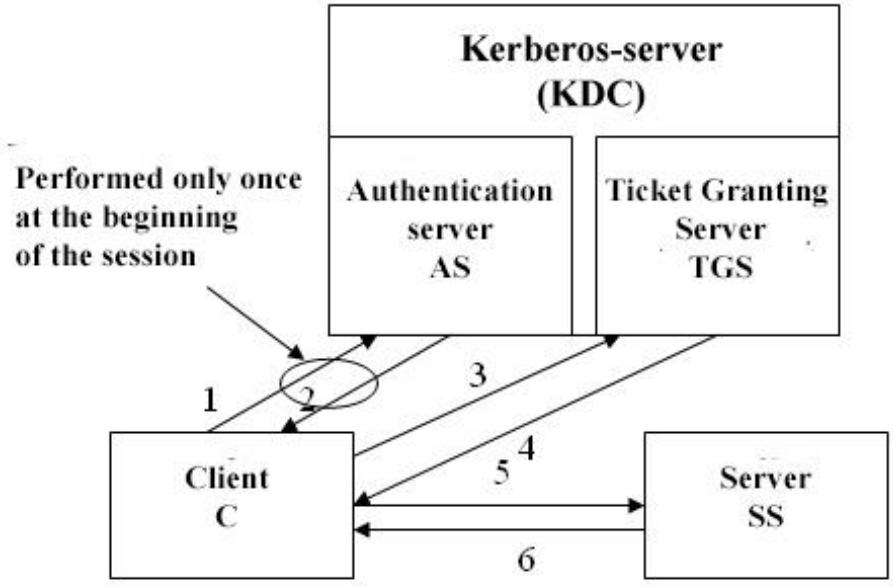

Figure 8.2 – Kerberos diagram

The Usage of Biometric Data

Biometric data used for execution of users' identification/authentication are (Fig. 8.3):

- fingerprints;
- eye retina and cornea;
- hand and person geometry;
- voice and voice recognition;
- signature and operation with the keypad.

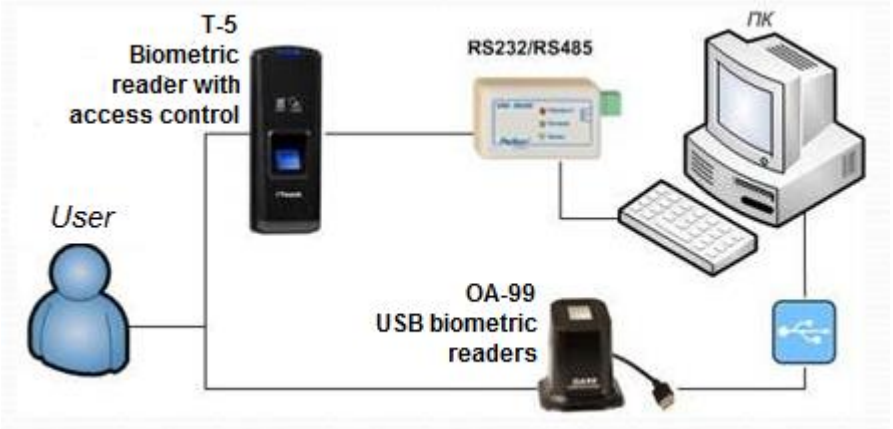

Figure 8.3 – Scheme of Biometric Information Protection

Today, biometric protection of your data solves a number of important tasks at the highest level (migration issues, work of special services). Biometrics is the best alternative to traditional methods; today in the world more than 300 companies are engaged in these development and production, the market capacity - tens of billions of dollars. That's impressive, but not all so rosy, there are problems in matters of protection of biometric information. Any scanners can be fooled, the

digitized biometric information can be lost. And it is the most vulnerable place of biometrics. Low reliability of scanners for reading the biological parameters of the person, their work may be influenced by dustiness, humidity premises. Dirty hands, poor lighting, bad exhibited to the lens face changed due to illness or stress voice - lead to a distortion of information. Fears and prejudices of people, who are not without foundation, can also be related to the disadvantages of biometric security systems.

Access Control

Access control allows controlling those actions which subjects have the right to execute over information objects.

Traditional problem definition is in existence of a set of Si-subjects and a set of Oj-objects.

The task of logical control is to define a set of admissible operations and to control execution of the established order for each couple (Si, Oj).

The "object-subject" relationship can be presented as a matrix in which access subjects are in lines, and access objects are in columns. Cells at the intersection of lines and columns set conditions and access rights.

As such matrix is often rarefied, access rights lists, i.e. columns of this matrix are used.

Monitoring of access rights is made by special components of the software environment – operating system kernel, security services, a database management system, software modules of the interfacial layer.

In case of access permit, the analysis of the following information is done:

- The subject's identifier – discretionary (arbitrary) access;
- Attributes of the subject (a security tag, a user group) – mandatory (forced) access.

Disadvantages of discretionary access:

- access control requires manipulations over objects that lead to division of functions of control between many users;
- access rights exist separately from data (it allows the malefactor having an information access to write the file available to all or to change information).

Role Control:

- There is an intermediate entity between users and their access rights – the user's role in the IS.
- For each user, there can be several roles, each of which grants certain rights.
- The role is neutral in relation to specific types of the rights and methods of their check. It realizes the object-oriented approach to control of users.

Role control is defined by concepts:

- User;
- Session of the user;
- Role (determined by an organization structure);
- Object (an entity, access to which is differentiated);

- Operation (executed over an object);
- Right of access.

Logging and audit

Logging is a process of collection and accumulation of information about IS events (external, internal, client). **Audit** is the analysis of accumulated information which is carried out quickly or periodically. It allows to solve the following problems:

- Ensuring accountability of users and IS administrators;
- Ensuring reconstruction of the sequence of events;
- Detection of IS violation attempts;
- Provision of information for identification and the analysis of problems.

The events recommended for recording in "The orange book":

- Login;
- Log-off;
- Appeal to a remote system;
- Transactions with files;
- Change of privileges or other security attributes.

During the logging process, it is recommended to write down the following information:

- Date and time of an event;
- Unique identifier of the subject who is the initiator of an event;
- Result of the event;
- Request source;
- Names of objects;
- Description of the changes made to the security database.

Active Audit

The aim of active audit is detection of suspicious activity and management of means of automatic response to it. The activity which contradicts the security policy is divided into:

- attacks directed at illegal authorization;
- operations performed under authority, but breaking the security policy (abuse of authority).

There are errors of active audit of the first and second sort:

- skipping attacks are considered as errors of the first sort;
- false operations are considered as errors of the second sort.

Methods of Active Audit:

- The signature method is based on determination of signature of the attack (set of conditions under which the attack is considered to have taken place). There is a great possibility of errors of the first sort (inability to detect unknown attacks);
- The statistical method is based on the analysis of the performed operations of subjects. There is a great possibility of errors of the second sort.

Encryption

Encryption is the usage of cryptographic security services. The procedure of encrypting means the transformation of the clear text of the message into a closed one.

Modern means of encryption is known as a crypto algorithm. There are special keys of the guarantee of confidentiality of the transformed message.

The encryption key - a secret information, cryptographic algorithm used to encrypt / decrypt messages, set and check the digital signature, calculate the authenticity of the code. By using the same encryption algorithm, the result depends on the key. Loss of key strong cryptography for modern algorithms leads to a practical impossibility to decipher the information.

Cryptographic transformations are used in case of implementation of the following security services:

- encryption per se;
- integrity control;
- authentication.

Encryption methods. There are two main methods of encoding:

- Symmetric encryption (with a closed key);
- Asymmetric encryption (with an open key).

Symmetric encryption. In the process of encrypting and decrypting of the same parameter, the used confidential key is known to both parties.

Examples of symmetric encryption:

- GOST 28147-89;
- DES;
- Blow Fish;
- IDEA.

Advantage of symmetric encryption: the speed of transformation accomplishment.

A negative attribute of symmetric encryption:

A key is known to the receiver and the sender, which creates problems in case of distribution and the proof of authenticity of the message.

Asymmetric encryption. In cryptographic transformations, two keys are used. One of them is an unclassified (open) key that is used for enciphering. The second is a confidential key for deciphering.

Examples of asymmetrical encryption:

- RSA;
- El-Gamal's algorithm.

A negative attribute of asymmetric encryption:

Low speed of algorithms (because of length of a key and complexity of transformations).

Advantages of asymmetric encryption

Application of asymmetric algorithms for the solution of tasks on checking authenticity of messages, integrity, etc.

Authentication. Cryptographic methods allow to control integrity of messages, define authenticity of data sources, and guarantee impossibility of perfect actions refusal.

Basically, there are two concepts of cryptographic control of integrity:

- hash function;
- digital signature.

Hash function is difficult transformation of data realized by means of symmetric encoding with binding of blocks. The result of encoding is the last block which also serves as a result of hashing.

To check the integrity of data, the hash function of controlled data and earlier calculated result of its use (digest) are compared.

Integrity control. The digital signature plays a role of the usual signature in electronic documents for confirmation of authenticity of messages. Data join is the transferred message, confirming authenticity of the sender of the message.

During the formation of the digital signature, according to the classical scheme the sender should:

- apply a hash function to the source text;
- supplement a hash image to the length demanded in an algorithm of EDS creation;
- calculate the EDS on a hash image with the use of a confidential key of signature creation.

The recipient separates the digital signature from the main text. It takes the following steps:

- applies a hash function to the text of the received message;
- supplements the compliance of a hash image to the required length;
- checks the aptness of the hash image of the message to the received digital signature with the use of an open key of the signature verification.

8.4 Features of Data Security Cryptography

Encryption is the usage of cryptography security services. The procedure of encoding is the conversion of a clear text of the message into a closed one. The modern means of encoding used are the known encryption algorithms. Special keys are used for support of confidentiality of the transformed message.

Cryptography conversions are used in case of implementation of the following security services:

- encoding per se (support of confidentiality of data);
- integrity monitoring;
- authentication.

DES encryption standard.

The encryption algorithm is a block cipher that uses substitution, permutation and addition by modulo 2. In DES the size of the block is 64 bits and a key size is 56 bits. Substitution and permutation used in DES are fixed.

DES encryption algorithm

The main stages of the encryption algorithm:

1 step. The block of the input text uses fixed IP permutation. For each cycle (total of 16) encryption is held.

Step 2. 64-bit block is divided into two halves (left "L" and right "R") by 32 bits. The right half "R" is divided into 8 tetrad of 4 bits. The last 2 bits of the adjacent tetrads are added to each tetrads to construct 6-bit word.

Step 3. The resulting 48-bit block is summed in modulo 2 with 48 subkey bits which are selected in each cycle in a special way from 56 bits, and then divided into eight blocks of six bits.

Step 4. Each of the blocks obtained in the previous step adds to the input function of the fixed S-box, which performs non-linear substitution sets of 6-bit blocks by tetrads.

Step 5. These 32 bits are subjected to a fixed permutation, the result of which is semiblock Fi (x ').

Step 6. Components of the right encrypted semiblock Fi (x ') are summed in modulo 2 with the components of the left semiblock x "and are reversed, i.e., block (x ", Fi (x ')) is converted into the block (x" + Fi (x'), x ").

Step 7. The block of text, obtained after 16 cycles is subject to inverse permutation.

Step 8. The result is an output ciphertext.

Detailed encryption scheme is shown below (Fig. 8.4)

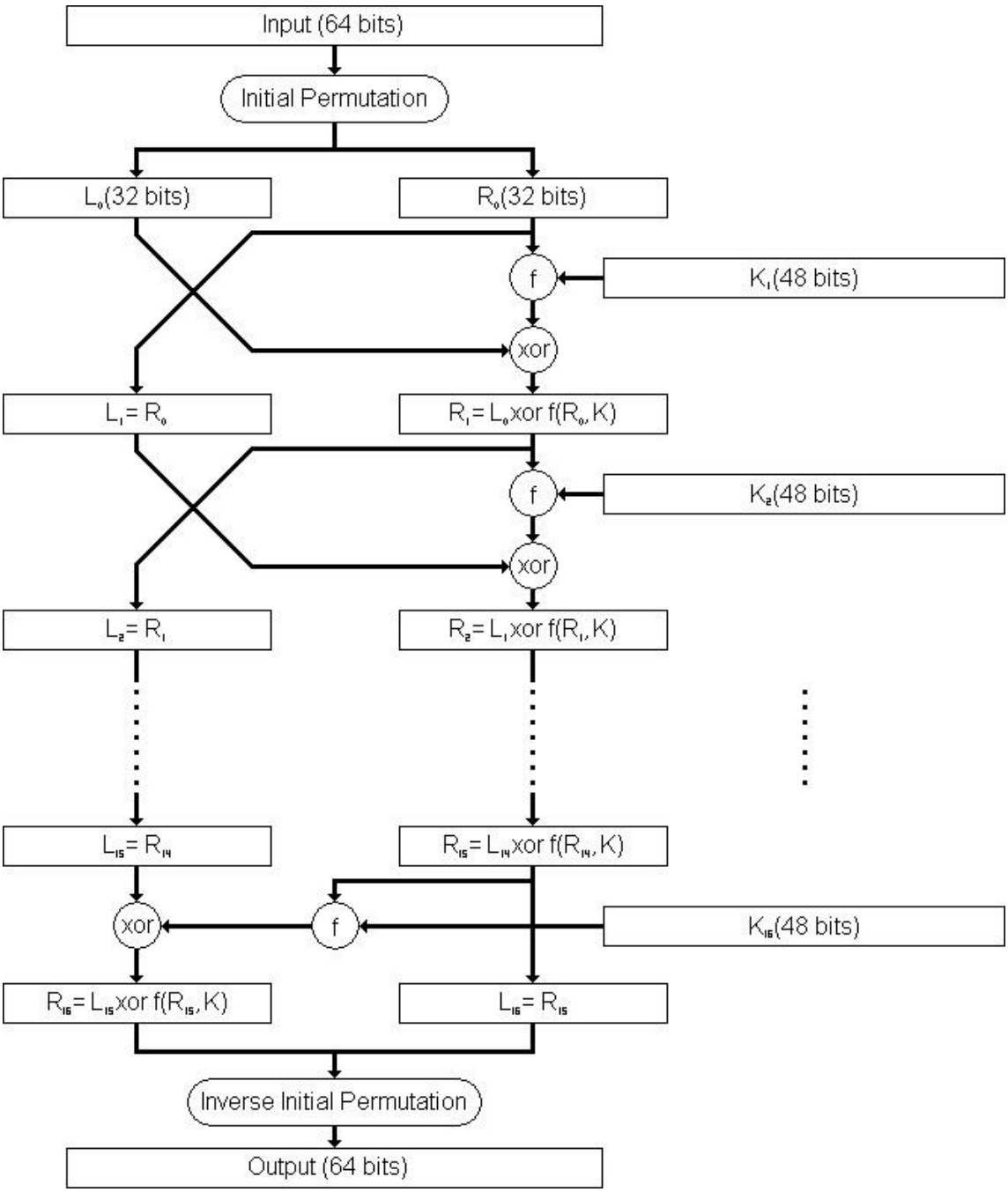

Figure 8.4 – DES encryption scheme

Decryption

The process of decryption is similar to the encryption process. At the entrance of the algorithm is used by the ciphertext, but Ki keys are used in the reverse order. K16 is used in the first round, K1 is used at the last round. Let the output of the i-th round of encryption is Li || Ri. Then the corresponding input (16-i) -th round of the decryption will be Ri || Li.

After the last round of the decryption process, the two halves of the output are reversed so that the input of the final permutation IP-1 is R16 || L16. The output of this stage is a plain text.

Table 8.1- Comparison of encryption algorithms

Algorithm	**Key Size**	**Unit length**	**Number of cycles**	**Basic operations**
DES	56	64	16	Permutation, substitution, **A**
FEAL	64, 128	64	<= 4	Modulo 28, cyclic shift, **A**
IDEA	128	64	8	Multiplication modulo 216 + 1, modulo 216, **A**
GOST 28147-89	256	64	32	Modulo 232, permutation, cyclic shift, **A**
RC5	8t, t <= 255	32, 64, 128	<= 255	Modulo 2W, (W = 1/2 block lengths), cyclic shift, **A**
Blowfish	<= 448	64	16	Modulo 232, substitution, **A**

Asymmetric Encoding

In asymmetrical encoding algorithms, the encoding and decryption keys are always different (though related to each other). The key to encrypt is unclassified (open), the decryption key is kept secret.

RSA encoding algorithm (proposed R. Rivestom, E. Shamirom and L. Adlmanom)

Two primes p and q and let n = pq Let a, **j** (n) = (p-1) (q-1). Let the number e be such that the numbers e and **j** (the n) are relatively prime, and d is multiplicatively inverse to it, that is ed ° mod **j** (the n). The numbers e and d are called open and closed figures, respectively. The public key is the pair (n, e) the private key is d. The factors p and q must be kept secret. Thus, the security of the RSA system is based on the difficulty of the task factorization.

In addition to the RSA algorithm, the commonly used asymmetric encoding algorithms are:

1. El-Gamal algorithm (using a prime number p, forming groups g and exponent y = gx (mod p)).
2. encoding algorithm of Massey-Omura (using such prime number p with which that p -1 has a large easy- divider at an open key, the secret key is determined in the process of a dialogue between the receiver and the source).

Systems of Information Security Cryptography

The aim of information security cryptography is the conversion of information objects by means of some reversible mathematical algorithm. The process of encoding uses the first (a clear text) and the second object (a key) as

input parameters. As a result of conversion an object turns into a ciphered text. During decoding an inverse process takes place. A cryptography method in IS corresponds to some special algorithm. In case of execution of this algorithm, a unique numerical value (a key) is used. Knowledge of a key allows to execute inverse transformation and to receive an open message. Firmness of the cryptography system is defined by the algorithms used and the key privacy level.

Cryptography means of information security are actively applied to support information security in the distributed information systems. The entity of cryptography methods may be presented in the following scheme (Fig. 8.5):

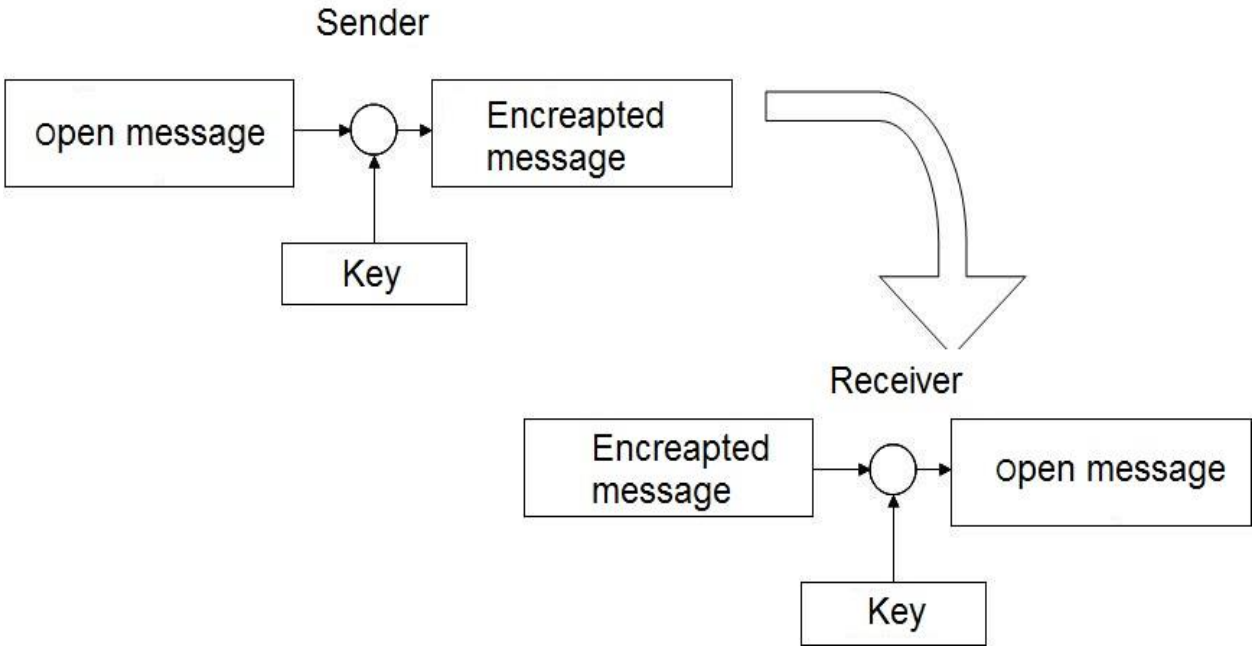

Figure 8.5 – The essence of cryptographic techniques

Support of Data Confidentiality. Use of cryptographic algorithms allows preventing the information leakage. Absence of a key at the "malefactor" doesn't allow opening the ciphered information.

Support of Data Integrity. Use of algorithms of the asymmetrical encoding and hashing helps to create a method of monitoring the information integrity.

Digital Signature. It allows to solve the problem of information denial.

Authentication Support. Cryptography methods are used in different authentication schemes in distributed systems (Kerberos, S/Key, etc.).

Requirements to the Security Systems Cryptography

Cryptography Requirements

Efficiency of a malefactor's actions is defined by an average share of the deciphered information, which is mean. The average value of the relation of deciphered information number to the total quantity of the encoded information

which is subject to decoding and labor input in decoding an information unit is measured by the Q-number of elementary approbations.

Elementary approbations are understood as an operation over two n-bit binary numbers. In case of implementing a decoding algorithm, the hypothetical calculator whose memory size doesn't exceed the M binary places can be used. For one memory access, it can be written to some address or retrieved from no more than n-bits of information. Memory access on labor input is equated to elementary approbation.

The total amount of information processed by one means of the cryptography protection is regarded as an information unit. A malefactor attack will be successful if the volume of the obtained open information exceeds some given V-volume.

Requirements of Reliability

Security features that provide the given level of reliability of the applied cryptography information transforms are determined by the value of admissible failure probability leading to the malefactor's obtaining additional information on cryptography conversions.

Scheduled works (repair and service) of means of security cryptography shouldn't deteriorate the properties of means in terms of reliability parameters.

The requirement for protection against illegal access to the cryptography means is a part of information systems

The following security mechanisms should be provided in automated information systems in which implemented program or information security cryptography hardware means are realized in case of information storage and processing:

- identification and authentication of users and subjects of access;
- access control;
- integrity support;
- registration and account.

Requirements to the development tools, manufacturing and functioning of information security cryptography means

Hardware and program facilities on which systems of information security cryptography are developed shouldn't contain any explicit or hidden functional capabilities which allow to:

- modify or change the algorithm of operation of information security means in the course of their development, manufacturing and operation;
- modify or change the information or control the flows connected to the functioning of such means;
- provide access for strangers to identification keys and authentication information;
- get access to confidential information of information security cryptography means.

8.5 Protection of Information in Computer Networks

Modern information system usually operates in a distributed data processing mode. It includes a variety of computer systems that are interconnected via a computer network.

Exchange of information in the network is between:

- users;
- processes of different network elements;
- users and processes.

Exchange of Information on the Web. When exchanging information on the network, comply with the following:

- Each user and process have their own level of authority;
- The subscriber information passing in transit through the switching unit, should be invisible to the staff of the unit;
- Transit subscriber information should not be subject to documentation in the node;
- when processed in the node the transit subscriber information should not be stored in non-volatile memory.

Features of Modern Information Systems.OSI Model

Interworking procedures are always considered on the basis of standards developed by the *International, of Standard Organization (the ISO)*. These standards are called "seven-layer network communications model" or the English version of *"the Reference Interconnection the Open the System the Model" (the OSI Ref.Model)*.

Use of OSI Model. This model is used to describe the rules and data transfer procedures, as well as the structure of open systems and the standards which the system must meet. The main elements of the model are the connection objects and physical means.

Physical Means of Connection are understood as the totality of the physical environment, hardware and software, which provides signal transmission.

The physical layer defines the mechanical, optical, electrical and procedural means of signaling through the physical connections. The main objective is the creation of physical interfaces for connecting to the physical means of connection.

The functions of the physical layer:

- Establishment and disconnection of physical connections;
- Sending a signal sequence;
- Listening to the channel;
- The channel identification;
- Notification of faults and failures;
- Data Link Layer;

- Channel (route) over which the data is transmitted.
- One physical channel serves for interaction between groups of pairs of systems.

The route by which data is transmitted from source to destination is called **a logical channel**. A channel extending through the communications network is called **a virtual channel**.

The link layer performs generating and transmitting data blocks between the systems.

Link layer functions:

- Organization of channel connections and identification of their ports;
- Organization of the sequence of data blocks;
- Detection and correction of errors;
- Transfer of data blocks;
- Data flow control;
- Ensuring transparency of logical channels.

The network layer provides a channel strip, connecting the subscriber and control systems through communication channels. The objective of this level is the creation of virtual channels. Data packets are transmitted in which pieces of data are placed.

Network layer functions:

- Creating a network connection and identification of their ports;
- Detection and correction of errors;
- Data flow control;
- Organization of the sequence of packets;
- Routing and Switching;
- Segmentation and integration of packets;
- Resetting.

The transport layer handles the addressing of subscriber information systems within the network. This provides the transmission of packets through a communications network using virtual channels.

Transport Layer Functions:

- Management of the transmission of data units and ensuring their integrity;
- Error detection of uncorrected error message;
- Recovery after transmission failure;
- Changing the size of the data blocks;
- Giving priority when transmitting data blocks;
- Confirmation of data transmission;
- Elimination of blocks at the deadlock in the network.

The session is a series of operations performed without interruption and providing interaction between the participants. Tasks for the session: session establishment, session authentication, session failover, failure or error, session termination.

Session layer functions:

- Establishing and ending the session layer connection;
- Implementation of a normal and urgent communication between application processes;
- Management of interaction during the application processes;
- Synchronization of the work session connections;
- Notifying application processes of the extraordinary situations;
- Establishment of tags in the application process;
- Interruption of the application process and resumption of its correct operation;
- Termination of session without losing data.

The presentation layer described in the required form the data transmitted during the application processes. This level is designed to work with the data syntax, determining the structure of commands, messages and replies.

Main functions:

- Generation of requests for establishing interaction between sessions during the application processes;
- Coordination of kinds of data representation during the application processes;
- Implementation of the forms of data presentation;
- Presentation of graphic materials;
- Ensuring the data confidentiality;
- Transmission of requests for the termination of the session.

The application process ensures processing of data for the needs of the user. The application layer provides application processes by means of access to the interaction region.

Application layer functions:

- Description of the forms and methods of interaction between application processes;
- Performing various types of data operations;
- Identification of users;
- Identification of operating subscribers;
- Announcement of the possibility of access to the application;
- Determination of the adequacy of resources;
- Sending queries for connection to other users;
- Queries to the level of representations for the appropriate methods of describing information;
- Synchronization of interaction between application processes;
- Determination of the quality of service;
- Agreement on the correction of errors and determining the data reliability.

Potential Threats to the Security of Information in a LAN:

– Access to the LAN side computer staff;

- Access by cable communication lines;
- Access on the part of the staff member -wrongdoer;
- Connection to the outside computer and other equipment;
- Incidental electromagnetic radiation and information route guidance;
- Emergency, hardware failure, human error, software developers' error, etc.

8.5.1 Classification of Network Attacks

In the description of network attacks, we generally use the representations showing a flow of information from the sender (file, user, computer) to the destination (file, user, PC):

Network Attacks

I. Passive Attack

In a Passive *attack the enemy* is not able to modify the messages and insert its messages into the information channel between the sender and the recipient. The purpose of *the passive attack* can only be listening to the transmitted messages and traffic analysis.

Modification of data flow, ***or*** *the "man in the middle" attack*

Data flow modification means any change in the contents of the forwarded message, or change in the order of messages.

Creating a false flow (falsification)

Falsification (inauthentic) means an attempt of one subject to impersonate another.

Recycling. Reuse is a passive data capture and their subsequent shipment to gain unauthorized access - the so-called *replay-attack*.

In fact, a *replay-attack* is one of the variants of falsification, but due to the fact that it is one of the most common variants of *attacks* to gain unauthorized access, it is often treated as a separate type of *attack*.

Functions of the Firewall. The firewall may be implemented in several types of protection.

These include:

- Filtering of network packets;
- Means of user identification and authentication;
- Means of warning and alarm about the revealed violations.

Filtering Network Traffic. Filtering of incoming and outgoing information is based on the rules at several levels. Filtering on the basis of the transport addresses of the sender and the recipient is performed on the network and transport layer. Simultaneously, the access is controlled in accordance with the established rules for restricting access to network resources and services.

The second filtration step is performed on the application level.

For this, there are special application layer filters, each of which is responsible for filtering information exchange on one particular protocol between applications of a specific type. At this level, the processed protocols are HTTP, FTP, SMTP, TELNET and SNMP.

In order to increase the capacity of the firewall, (and it is designed to operate in the high-speed network bandwidth up to 100 MB) gateways applications can be created at the operating system kernel. Their main task is to pass the protocol that they serve, through the DOE at the packet filter that can significantly improve the performance of the DOE. Through these gates, they pass the data for applications running on the FTP, Rlogin / Rsh and RealAudio.

The Need for Protection Mechanisms. A message transmitted from one user to another is passing through various types of network. In this case, we assume that the logical information channel is established from the sender to the recipient using a variety of communication protocols (e.g. TCP / IP).

Security features are required if you want to protect the information transmitted by *the enemy*, which may pose a threat to *privacy*, *authentication*, *integrity* , etc. All enhanced security technologies have two components:

1. Regarding the secure transmission of information. An example is the type of encoding that the message is changed so that it becomes unreadable to *the opponent*, and possibly, is complemented with a code based on content messages which can be used for the *authentication* of the sender and ensure *the integrity of the* message.
2. Some secret information shared by both participants and the unknown *enemy*. An example is a key encoding.

In addition, in some cases,it is necessary to ensure the safe transfer through *a trusted third party* (Trusted Third Rarty - TTP). For example, *a third party* may be responsible for the distribution between the two parties of confidential information that would not become available *to the enemy*. Alternatively, *a third party* may be used to resolve disputes between the two parties regarding the reliability of the transmitted message.

Data Encryption

In addition to the basic OSI model, ISO has issued recommendations for the establishment of service protection services, whose functions must be implemented with the help of eight security procedures.

Data encryption is used to:

- close all subscriber data;
- close some fields of the message.

There are the following **encryption levels**:

- Encoding of the communication channel (whole stream);
- Inter-ends (subscriber) encoding.

Digital Signature

A digital signature is used to confirm the authenticity of the sender of the message (to certify the fact that the source of the message is the title subscriber). Network resources access control is executed on the basis of a set of rules and formal models that have different arguments:

- subscriber identifiers;
- resource information;
- lists of approved operations;
- time limits, etc.

Data integrity is ensured by additional information which is a function of the message content and is introduced into the transmitted message. There are two types:

- means of ensuring the integrity of a single block of data;
- means of ensuring the integrity of a flow of data blocks or individual fields of blocks.

Authentication procedures are necessary to protect the transmission of passwords in the network, authenticators of logical objects, etc. The goal is the protection from communication with the object formed by the infringer and acting under its control in order to simulate real work object.

The procedure for filling the flow prevents traffic analysis. Efficiency is enhanced if a linear encoding of the data stream is applied simultaneously.

Route data traffic control is used for data transfer only on routes produced by reliable and secure devices and systems.

The procedure for confirmation of these characteristics requires a referee (trusted third party), an arbitrator who authenticates users, the integrity and the transmission of messages.

8.5.2 Networking Model

A secure networking model in a general form can be represented as follows (Fig. 8.6):

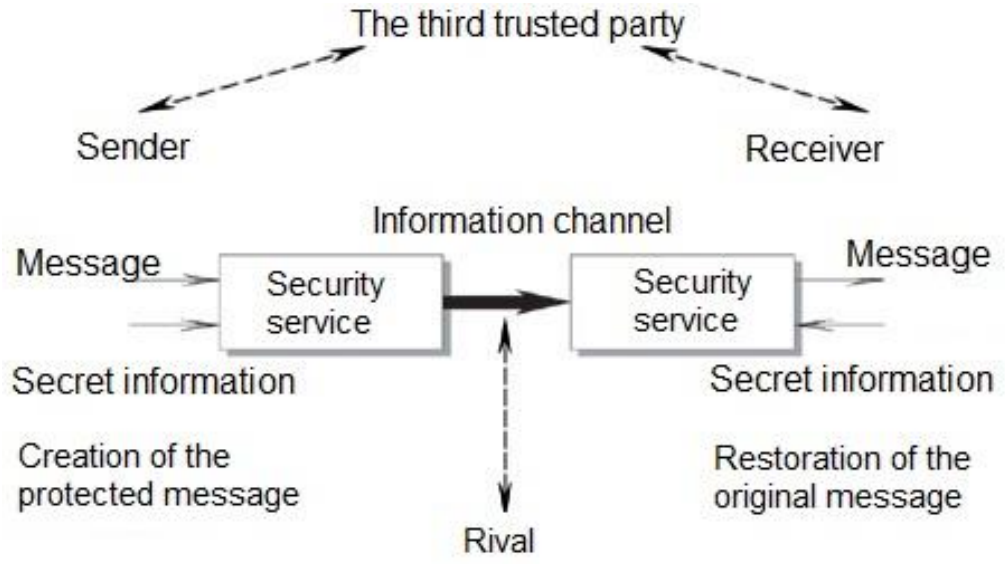

Figure 8.6 – Secure network interaction model

8.6 Standards and Information Security Specifications. The Protection and Security of Information Laws and Standards

Legislative measures provide a level of legal support of information security measures. There are two groups of measures:

– Measures aimed at creating and maintaining a negative social attitude toward violations and violators of information security;

– Directed and coordinated measures that improve the level of knowledge in the field of information security, to help in the development and distribution of security products.

Legal acts of General Purpose

1. The Basic Law of the Republic of Kazakhstan - the Constitution.

Articles of the Constitution secure a number of citizens' rights to protection and information:

–Art. 18 establishes the right of citizens to get acquainted with the documents and regulations affecting the rights and freedoms;

–Art. 31 guarantees the right to knowledge of facts and circumstances endangering the life and health of citizens, the right to obtain information about the state of the environment;

–Art. 18 guarantees the right to personal and family secrets;

–Art. 20 the right to freely receive and disseminate information by any means not prohibited by law.

2. Article 126 of the RK Civil Code defines the concepts of commercial and official secrecy:

–Article 10 of the RK Civil Code stipulates protection of information of commercial value, its owner’s legal right to protect its confidentiality.

3. Article 50 of Decree of the President of the Republic of Kazakhstan

(which has the force of law) of 31.08.95 N°2444 «On banks and banking activity in the Republic of Kazakhstan" defines the concept of banking secrecy.

4. The Criminal Code has introduced a section on cyber crime:

−Article 227 - unauthorized access, the creation, use and distribution of malicious computer programs;

−Article 143 of the RK Criminal Code provides for punishment for violation of the secrecy of correspondence, telephone conversations, postal, telegraph and other communications;

−Article 200 of the RK Criminal Code aims at protecting the commercial and banking secrets.

The Law "On informatization"

Law N°418-V of 24.11.2015 is one of the basic laws in the field of information security. The law legally defines such important concepts as **documented information, information system, user information**, etc. The law identifies the following information protection goals:

1) protection of electronic information resources and information systems aiming to prevent unauthorized actions by:

−ensuring the integrity and preservation of electronic information resources and prevention of their unauthorized alteration or destruction;

−confidentiality of electronic information resources of restricted access;

−the right of access to electronic information resources;

−protection against the tampering means of processing and transmission of electronic information resources;

−preserving state secrets, confidential documentary information in accordance with the law;

−ensuring the rights of subjects in information processes and in the development, production and use of information systems.

2) Protection of electronic information resources and information systems aiming at preventing unauthorized actions by:

−blocking electronic information resources, restriction or closing access to information systems and electronic information resources;

−modification of electronic information resources, that is, changes to the software, databases, text information stored on a tangible medium;

−copying of electronic information resources, that is, the transfer of information to another material carrier;

−use of software without the permission of the copyright owner;

−disruption of information systems, and (or) software or disruption of the functioning of the information and communication network.

Measures to ensure the protection of information by law:

−By legal measures of protection of electronic information, resources are entered into by the owner of information or the owner of the electronic information

resources for users of information agreements, which set out the conditions for access to certain electronic information resources and responsibility for the violation of the conditions of access and use of electronic information resources.

–The organizational measures to protect electronic information resources and information systems are to enforce a special access regime on the territory (in the room), where the information can be accessed (material carriers of information), as well as the differentiation of access to information by the number of persons and the nature of the information.

–Phe physical protection of information systems, the use of means of information security, including cryptography, as well as access control and registration of cases of access to information.

–The technical (software and hardware) measures of protection of electronic information resources and information systems.

Regulation of mandatory conformity assessment of information systems, engineering, hardware and software (products), the technical means of information protection of information security requirements

Regulation number 25 - 1 - 90 of 10/03/2005 determining the organization and conduct of compulsory conformity assessment information systems, engineering, hardware and software (products), technical means of (GIS and computer equipment) information security requirements:

– The use of technical means of information protection;

–Mandatory cryptography certification;

– Provision of information encoding services;

– Development and production of encoding devices are protected with the help of their information systems and telecommunications systems;

– Issuance of certificates of keys with electronic signature, electronic signature registration;

– Detection of electronic devices intended for secret information;

– Development and manufacture of means of protection of confidential information;

– Technical protection of confidential information.

In accordance with Article 1, this law does not apply to the following activities:

– Activities related to the protection of state secrets;

– Activities in the field of communication;

– Educational activities.

Law N«370-20 «On electronic document and electronic digital signature" dated 07.01.2003,

the Law "On electronic digital signature" provides the legal conditions for the use of the electronic digital signature in electronic documents. This law applies to

relations arising in committing civil transactions. The electronic signature is equivalent to a handwritten signature under the following conditions:

−digital signature does not lose legacy at the time of signing of the document;

−authenticity of digital signature in the electronic document is confirmed;

−digital signature is used in accordance with the information stated in the certificate of the signature key.

Legislative Use of Digital Signatures

Law "On electronic document and electronic digital signature" was signed on 7 January 2003. This law regulates the relations arising from the creation and use of electronic documents certified by electronic digital signatures, providing for the establishment, modification or termination of legal relations, as well as the rights and obligations of the participants of legal relations arising in the field of electronic documents, including committing civil transactions.

Basic concepts of electronic signature law

− **electronic document** is a document, in which information is provided in the electronic - digital form and certified by the electronic digital signature ;

− **electronic digital signature** is a set of electronic digital symbols created by means of the electronic digital signature and confirming the authenticity of the electronic document, its appurtenance and immutability of the content;

− **the owner of the registration certificate** is a physical or a legal person, in the name of which the registration certificate is given, legally owning a closed key, a corresponding open key, indicated in the registration certificate;

− **the private key of electronic digital signature** is a sequence of electronic digital symbols known to the owner of the registration certificate and designed for creating an electronic digital signature by using means of electronic digital signature;

−**the public key digital signature** is a sequence of electronic digital symbols which is available to any person and designed to confirm the authenticity of the electronic digital signature in an electronic document;

−**signer** a physical or legal entity legally owning the closed key of the electronic digital signature and having the right to use it on the respective electronic document;

−**registration certificate** is a document on paper carrier or an electronic document issued by a certifying center for confirmation of compliance with electronic digital signature requirements, established by this Law ;

− **electronic document management system** is the system of exchange of electronic documents, the relationship between whose parties is regulated by this Act and other regulatory legal acts of the Republic of Kazakhstan;

−**means of electronic digital signature** is a set of software and technical means used for creation and checking the authenticity of the electronic digital

signature;

– **a certifying center** is the legal entity certifying compliance with the open key electronic digital signature, the closed key of electronic digital signature, and also verifying the accuracy of the registration certificate;

– **authorized body** – is the state body responsible for implementation of the state policy and state regulation activity in the sphere of informatization;

– **a party to an electronic document management system** is a physical or a legal person, public authority or an official involved in the processes of collection, processing, storage, transmission, search and distribution of electronic documents;

– **corporate electronic document management system** is the system of electronic document management, participants of which can be a limited range of organizations or users, defined by departmental, functional or other information relationships.

A Digital Signature Registration Certificate

The registration certificate shall contain the following information:

– registration certificate number and its expiration date;

– identity of the owner of the electronic digital signature;

– public key to the digital signature;

– data on the means of electronic digital signature used to create the corresponding private key of the electronic digital signature;

– information on the scope and limitations of the use of electronic digital signature;

– details of the relevant Certification Authority.

Certification Authority in consultation with the party to the electronic document management system may include into a registration certificate some additional information necessary for the electronic document turnover.

Terms of Use of Electronic Digital Signature

– The law defines the conditions of equivalence of electronic signature in electronic documents to a handwritten signature on paper, electronic signature certificate content, timing and procedure for storing registration certificates.

– The law defines the tasks and functions of certification authorities, their responsibilities.

– The law defines the features of the use of electronic signature in the public administration, in corporate information systems.

Evaluation Standards in Information Security

– Evaluation standards are aimed at the classification of information systems and the protection of the equipment safety.

– The first evaluation standard that is widely used has become a standard of the US Defense Department "Evaluation Criteria for Trusted Computer Systems" (

"Orange Book") - 1983 g .

– This standard deals with the control of access to the data (i.e, ensuring the confidentiality and integrity of information).

– The degree of confidence is evaluated according to two criteria:

Security policy, which is a set of rules that determines how the information is processed, protected and distributed

The level of warranty, i.e. building measures, which may be taken with respect to the IP architecture and implementation.

The Provisions of the "Orange Book”

Defined in the "Orange Book" are three categories of security requirements:

Security Policy:

- The system should maintain a well-defined security policy. The subjects’ ability to accessto objects shall be determined on the basis of their identity and a set of access control rules;

– With objects, this must be associated with security tags that are used as input data for control procedures.

Accountability:

- All entities should have a unique identifier. Access control should be carried out on the basis of the results of the identification of subject and object access, authentication identification (authentication) and access control rules.
- To determine the degree of responsibility for the actions of users in the system, all of the events should be monitored and recorded in a secure protocol. The registration system should carry out a general analysis of the flow of events and identify those events that have an impact on safety.

Guarantees:

- Remedies should include independent hardware and / or software components in order to ensure the efficiency of protection functions. The basic principle of control correctness is that the controls should be completely independent of the remedies.
- All protective equipment must be protected from unauthorized interference and failure, and this protection must be constant and continuous in any mode of the protection system functioning.

The "Orange Book” Classes of of Computer Systems Protection

"Orange Book" provides four groups of criteria corresponding to various degrees of protection, from minimal (group D) to formally proven (Group A). Each group contains one or more classes. The protection level increases from Group D to Group A, with an increase in class:

- Group D. Minimum protection.
- Group C. Discretionary protection.
- Group B. Mandated management access.
- Group A. Verification protection.

The "Orange Book" Requirements Structure

The "Orange Book" introduces three categories of security requirements:

- Security policy;
- Audit;
- Accuracy.

Within these categories, six requirements are introduced: four of them aim at ensuring the safety per se, two - at assessment of quality protection.

Security Policy

- **Requirement 1. The security policy.** The system should strictly comply with the security policy. The subjects' ability to access objects is defined based on their identifiers and access management requirements.
- **Requirement 2. Tags.** Objects must be associated with security criteria, used as the initial information for access control procedures. The system should provide the ability to assign each criterion that defines the degree of confidentiality and modes of access to the object.

Accountability

- **Requirement 3:** Identification and authentication. All businesses should have a universal identifier. Access control is based on the identification of subjects and objects and differentiation rules. Identification and authentication tools must be protected from unauthorized access.
- **Requirement 4. The requirement for registration and control**. For the determination of the responsibility of users, all occurring events in the system, significant for safety must be monitored and registered at a secure protocol.
- Guarantees (correctness)
- **Requirement 5. Control of accuracy of security tools.** Security tools should include independent hardware or software components that provide performance of security features. The basic principle of accuracy control is that the means of control are independent from the security tools.
- **Requirement 6. Protection sustainability.** All tools must be protected from tampering or disabling. This requirement must be observed in any mode of operation of the security system and the computer system in whole.

Security mechanisms of "Orange Book"

The security policy should include the following elements:

- **Random access control** - method of differentiation of access to objects, taking into account the personality of the subject.
- **Safety of objects reuse** - means of access control, protecting from accidental or intentional extraction of information from operational areas, or disk space.
- **Security Tags** - special identifiers that determine the levels of objects and subjects confidentiality.

- **Compulsory access control** – control of access to objects based on a comparison of the security tools subjects and objects.

Safety Classes of "Orange Book"

The difference between the classes of the security of computer systems in the "Orange Book" can be formulated in terms of access control:

- level C - arbitrary control of access;
- level B - forced control of access;
- level A - verification control of access.

Safety Warranty

"Orange Book" considers two types of warranty - operational and technological.

Operating warranty refers to architectural solutions and includes checking the following items:

- system architecture;
- system integrity;
- checking of hidden information channels;
- trustee administration;
- proxy failover.

Technological warranty refers to the methods of developing and maintaining the system. It should cover the entire life cycle of the system, i.e. design, implementation periods, testing, sales and support.

All of these actions should be carried out in accordance with strict standards to prevent information leakage and "bookmarks" in the system.

ISO / IEC Standard 15408 "Assessment criteria for IT security"

ISO / IEC 15408 is an international assessment standard in the field of information security standardization released in 1999. It is often referred to as the "Common Criteria". The "Common Criteria" is a meta standard for determining the tools to assess the information systems security. In contrast to the "Orange Book" and other similar standards, the “Common Criteria” do not contain predefined security classes. These classes can be built for a particular organization or information system.

Types of Information Security Requirements. This standard has two main types of safety requirements, such as:

- **Functional requirements**, appropriate to active protection, security requirements and their implementation.
- **Assurance requirements**, the appropriate passive aspect of protection, requirements to technologies and the process of IP development and exploitation.

Security requirements are imposed for certain hardware and software products, and their performance is tested to assess the level of information security.

Threats to information security

General criteria for the assessment of objects are considered in the context of a security environment characterized by certain *conditions* and *threats.* The following parameters are used to characterize the threats to information security:

- Threat source;
- Method to assess the impact of an object;
- Vulnerabilities that can be used;
- The resources that may be affected by the implementation.

Protection Profile. One of the main concepts defined in the Common Criteria is the security profile.

Protection Profile is a document which includes a standard set of requirements to be met by a certain class of systems.

Security Target (Protection Project) - contains a set of specific requirements to the design, implementation of which ensures the achievement of goals.

Functional Requirements. Functional requirements are grouped into general criteria on the basis of performing a certain role. In total, the general criteria defind 11 functional classes, 66 families and 135 components. Classes of functional requirements:

- identification and authentication;
- user data protection;
- protection of the safety functions (related to the integrity and control of service and security mechanisms);
- security management (related to to the attributes of management and security settings requirements);
- security audits;
- access to the evaluation object;
- privacy (user protection against disclosure and use of his identity);
- resource utilization (demand access to information);
- cryptographic support;
- communications (authentication of the parties in the exchange of data);
- trusted path / channel (for communication with the security services).

Security Assurance Requirements. Security Establishing trust is based on a study of the evaluated the object. In total there have been defined 10 classes, 44 families and 93 components of assurance requirements. Classes of security assurance requirements:

- System design requirements (phased detailing of the security features);
- Support life cycle (requirements to the lifecycle model);
- Testing;
- Vulnerability Assessment (including assessment of the resistance security features);

- Delivery and operation;
- Configuration Management;
- Manuals (requirements for operational documentation);
- Support for confidence;
- Protection Profile evaluation;
- Evaluation of job security.

Kazakhstan is becoming part of a broader cyberspace, in which the two main neighbors - Russia and China - are particularly well known for their high level of cybercrime. In 2011, more than a third of the world cyber crime which caused damage of $ 12.5 billion was committed in Russian-speaking countries.

Groups involved in these activities are more and more controlled by organized crime elements. China is also a haven for criminals, especially for those involved in economic crimes. The US report criticized both countries for the use of high-tech espionage for their own development, while China was called a place with the "most active and persistent perpetrators of economic espionage". Therefore, the development of measures to strengthen cyber-security should be carried out on the platform different from that of its neighbors, and ideally should form their own software platform. Since then, Kazakhstan imported used network equipment, which is able to serve foreign vendors remotely and can be turned off at the right time. All serious information security software of foreign manufacturers, in particular, all information from smartphones, tablets and Apple computers is available to the US intelligence services by means of special programs.

In 2009, South Korea's three cybercriminals were arrested, who engaged in sales of classified information about more than 20 million compatriots. It is the largest leak of personal data in the country's history. Using the solutions of foreign developers, the state has received, in fact, a black box, a ready solution that performs the functions laid down and controlled by a foreign company. Government agencies and e-government utilize foreign anti-virus products, which also makes them vulnerable in terms of safety. In addition, we should develop our own cryptographic software. Affiliation with local developers would be beneficial for the development of technology and knowledge, and experts could create our own controlled decisions. In all developed countries, there are companies dealing in the development of anti-virus software and other solutions in the field of information security. In terms of protection of organizations it may be useful to use China's experience, where the program "Golden Shield" filters the content of Internet sites. The program became known informally as the "Great Chinese Firewall." Thus, data from the internet service provider in the country are not transmitted directly to the user, and there is a special "security server" which, in turn, decides what may be shown to the consumer. There were times in China that Google, Wikipedia and Youtube were banned. Creation of protection in the country at the state level inevitably leads to the need to study the means of attack.

Protection improvement is an ever-growing field, study of existing cyber weapons, technology testing of attacks testing one's own protection systems. Cyber weapons already exist in the world as a separate class of weapons. Leading IT-powers openly declare the need to create one's own cyberweapon and units to conduct cyberwarfare. At the present time, almost every political or military conflict is accompanied by confrontation on the Internet. According to publicly available information, only a few countries (among of which there is already an open confrontation in cyberspace) possess the technology to carry out cyber attacks today, but research in this area is conducted in a variety of countries.

Creation of cyber weapons in Kazakhstan is only a matter of time.

Generation of thecyberweapon industry is necessary now or in the near future as one of the tasks of the state program of cyber defense.

Review questions

1. Explain the subject of information security. Identify information security problems.
2. Describe the concept of information security. Specify the categories of information security techniques and information theft. Explain how to monitor and control access by the operating system.
3. Define the e-RSA signature protocol. Explain the concepts of differentiation and control of access to information.
4. Identify categories of information security. Specify the concept of information theft and major information security threats.
5. Specify the methods of information protection in the BIOS. What are the threats to information security.
6. Define the basics of cryptology and cryptography. Explain the concept of cryptography.
7. Give an example of modern symmetric cryptosystems. Determine the classification of modern symmetric cryptosystems.
8. Give asymmetric encoding algorithms. Explain the RSA cryptosystem.
9. Specify legislative measures to protect information in the Republic of Kazakhstan. Explain the law on digital signatures.
10. Describe the management of cryptographic keys. Explain the difference between the concepts of generation, storage and distribution of keys.
11. Define the term object identification, authentication mechanisms and user confirmation.
12. Explain data protection in electronic payment systems. Define the principles of operation. Describe the principle of electronic cards operation.
13. Describe methods of network systems security**.** Identify network security and messaging protection methods and databases on local networks.
14. Describe the protection of local networks with the central database. Assess the reliability of protection mechanisms.
15. Give an example of a hardware data protection. Explain the concept of

security audit.

16. Expand the classification of information security. Name the information protection services: ensuring the authenticity of the subjects of information exchange, access control, ensuring privacy and confidentiality of information, ensuring data integrity.

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CHAPTER 9. INTERNET TECHNOLOGIES

9.1 Introduction to Internet Technologies

The Internet is a computer network that connects millions of computers across a number of countries. There is no central authority that controls the Internet; different organizations own different pieces of it. The Internet was originally planned by the Advanced Research Project Agency (ARPA) of the U.S. government in the 1960s. The World Wide Web (or "the Web" for short) refers to that portion of computers on the Internet that can communicate with each other using a computer-network protocol called HTTP. All browsers use HTTP to request and receive Web pages from other computers.

The Web is an interesting place. There is very little "law" on the Web and it has been described as a place of "controlled anarchy." Efforts to regulate or govern it have been vigorously resisted by Web users. While there are few rules, there are, however, two major areas of control. One has to do with the naming of the site on the Web and the other with the rules of an Internet Service Provider (ISP). (An ISP is any one of a number of companies that enable people not only to connect to the Internet and surf the Web but also to publish Web pages.) With respect to the first area of control, all Web sites and each machine must have unique names or addresses Therefore, if you want to set up a Web site, you have to apply to register the site name and pay a small fee; after that, no one else can use your site name. Concerning the second area of control, if you wish to publish Web pages, you must do so through an ISP, and ISPs often have rules that you must follow, rules that may govern, for example, the type of content the Web pages may contain, where the pages can be stored, and so on.

Other than these constraints, the Web is a pretty wide-open place. However, on the Web, you are still subject to societal rules and can find yourself in a legal trouble if you slander someone, display information that is copyrighted by someone else, or commit fraud. When browsing the Web, you also need to understand that people who use the Web and create Web pages represent a cross section of the society. As such, there are both good and bad materials on the web ("bad" material ranges from pornography to inaccurate or misleading information). Since there is no specific person or organization in control of the Web, there is no one to certify that the information presented on the Web is accurate, correct, and up-to-date.

A search engine is a program that allows one to search for keywords in files at one or more Internet sites. Popular search engines include Google, Yahoo and Microsoft Bing. To try looking for information using a search engine, you may first pick a topic, then, visit a search engine, such as one of the ones mentioned above and read the help pages to learn how to use it. Then, you are ready to start searching for information on your chosen topic. However, after every fifteen minutes or so of browsing, you should stop and see where you are. Do not be surprised if you find yourself far from the topic you chose originally, having

become sidetracked by something else that caught your eye along the way. Also, be sure to remember that there is no one certifying that what you are reading is accurate. One important rule for Web surfers to keep in mind is "caveat emptor" or "buyer beware."

9.2 Client-server Architecture and Peer Networks

Today, with the development of a wide computer network, the client-server technology already considers a wide area network as a combination of different local computer networks. So, the Internet can be presented in the form of a puzzle made of small networks of different sizes which actively interact with each other, sending files, messages, etc. It is very convenient for the firms having branches worldwide, multinational corporations and management structures, and also, simple users from different corners of the planet. On the wide area network, the servers of local area networks are also clients of higher-level network. For the control of distributed access of clients of the low level and clients of the high level to each other on the Internet global network, they use special devices known as routers. Any signal of the network passes from one computer to another through these devices connected to computers. The router defines the most optimum way of passing of the signal from a computer to a computer. Now, practically all known communication lines (telecommunication networks) are used: from low-speed telephone lines to high-speed digital satellites which get signals from the router.

The majority of telephone lines during the development of the Internet had analog character, but the computer equipment is digital, i.e. to use such telephone lines there were necessary devices which realize conversion of electrical signals from the analog form to the digital one and back as shown in the Figure 9.1. This mechanism also defines the name of the device converter - "modem" (modulator demodulator).

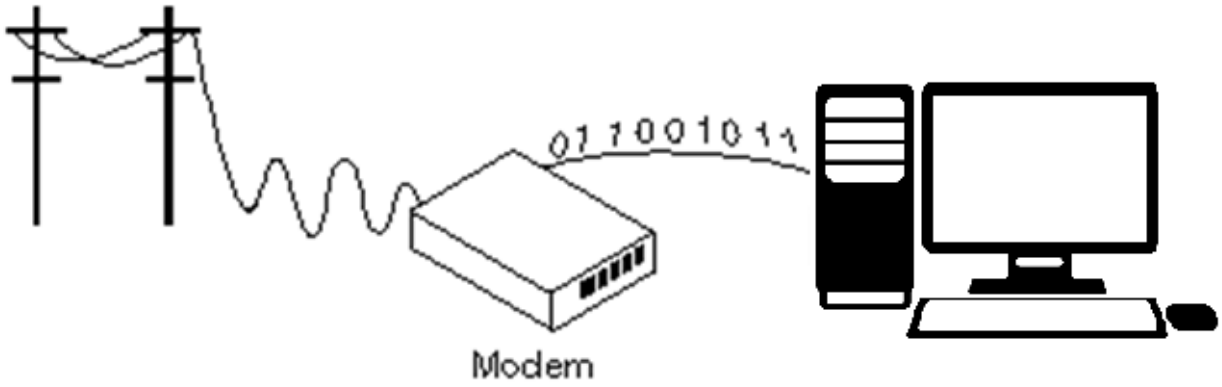

Figure 9.1 The process of modulation and demodulation

Computer networks, i.e. data interchange and correlation of clients operate according to protocols (rules) of interaction. Protocols are necessary for the

development and network management and allow realizing connection and data interchange between two and more devices switched on in a network. The TCP/IP protocol (Internet Protocol) provides a connection to the addressee and there was created a reliable service of data on a specified address between different subnets with a choice of the shortest way of transmission. In the spring of 1974, Vinton Cerf and Kahn started the project by conducting research on reliable data communications across the packet of radio networks, factored in lessons learned from the Networking Control Protocol, and then created the next generation Transmission Control Protocol (TCP), the standard protocol used on the Internet today. TCP/IP uses the client/server model of communication in which a computer user (a client) requests and is provided a service (such as sending a Web page) by another computer (a server) in the network. TCP/IP communication is primarily point-to-point, meaning, each communication is from one point (or host computer) in the network to another point, or host computer. TCP/IP and the higher-level applications that use it are collectively said to be "stateless" because each client request is considered a new request unrelated to any previous one (unlike ordinary phone conversations that require a dedicated connection for the call duration). Being stateless, it frees network paths so that everyone can use them continuously. A client sends a request for a resource. A request consists of a protocol ("How do I get this resource?"), the server ("What server has this resource?") and the resource itself ("What resource specifically?"). The server first locates the resource that has been requested. Using the specified protocol, it then transmits a copy of the bytes that constitutes the requested resource back to the client. When the client receives the resource, he/she prosesses it in an appropriate way (saved, displayed, etc.). The model of management of signals is called feedback control. Such model was also realized by the computer network (Fig. 9.2).

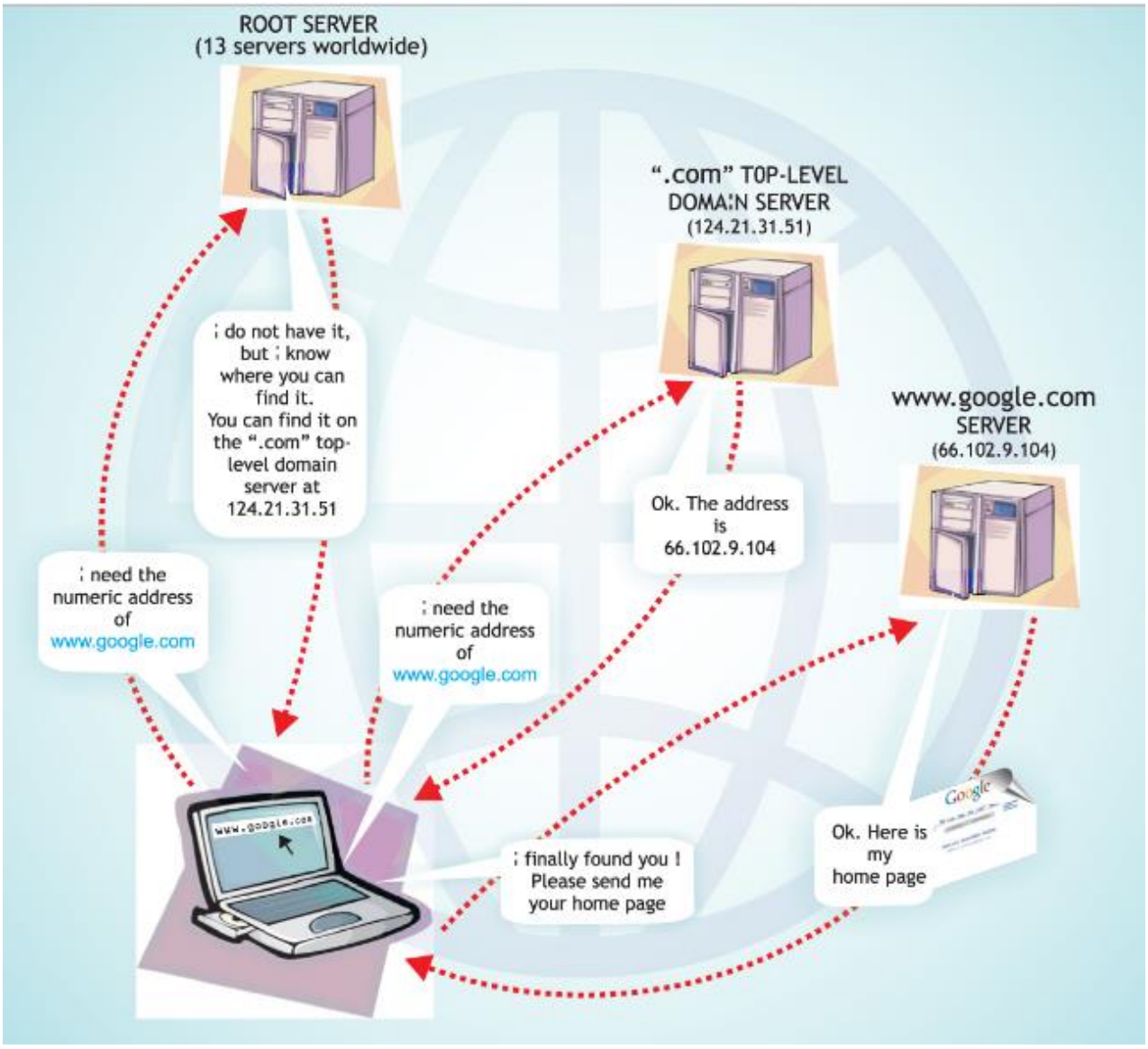

Figure 9.2 Definition of website in the Internet
(source: DiploFoundation,
http://textus.diplomacy.edu/textusbin/env/scripts/Pool/GetBin.asp?IDPool=1175)

9.3 Web Structure

By now, you probably have basic knowledge of Web browsers and how to use them. You may also be aware that there are several competing browsers on the market (e.g. Internet Explorer, Mozilla Firefox, Google Chrome, Safari, Opera, etc.). Web browsers allow us to view a Web page, which is, as you know, what you are currently reading. A Web page is "written" in a formatting language called HTML. When we view a Web page, we normally do not see the elements of this language. However, if you are using a browser such as Chrome or the Internet Explorer, it is possible to see the HTML elements that make up the page you are viewing (known as the page's "source code" or just "source" for short) by

positioning the mouse pointer anywhere over the page in your browser and clicking the right mouse button. Click **View Source** or, **View Frame Source** or, **View Page Source**, or an equivalent command on the menu that appears.

The file type which you see when you consider a page source is the text file. Unlike Microsoft Word, either file of Claris, or WordPerfect text files do not contain special characters of formatting which force the text to look as **bold**, underlined, etc. But if the file which contains the source code of the web page does not contain special characters of formatting, then how does it turn out that web pages show these and many other formats? Response: HTML consists of special formatting constructions, called tags, which report to the browser how to display web page contents. Some of these tags can create connections with other computers on which information (such as the text or images) for display on your computer can be transferred.

The web page consists of three parts: the title which specifies the version of HTML, the title which contains the technical information, and a web page body.

9.3.1 Clients

If earlier, a computer network was used only as a transmission medium of files and e-mail messages, then more complex problems of distributed access to resources are solved today. This access assumes separation of the server (from English – to serve, service), a powerful computer as a control unit servicing a network access to information arrays of the computer network and computers of clients of the computer network, users of information arrays.

The technology of the distributed access is also called the client server technology. It has been known for quite a long time, but was most often used in the local computer networks uniting computers of a specific entity, organization, apartment house, etc., earlier. The clients who decided to connect the computer to the computer network acquire access rights: name (login) and personal key for an entrance to the network (password). The user shall not report the established password to other persons. The client-server technology on the one hand, allows providing information security on the server from unauthorized use and damage, and on the other hand, guards penetration of users to personal information of the client which is not laid out by the client for general use. Strict security requirements to information are due to the fact that the network PC becomes accessible from any point of the network, and therefore is incomparably more susceptible to viruses and to illegal access. So, non-compliance with the mode of protection against illegal access can lead to information leakage, and non-compliance with the mode of protection against viruses – to failure of important systems and destruction of results of multi-day operation.

9.3.2 Servers

In the client-server configuration, the application client requests information from the application server or asks the server to carry out some task. If you launch a web browser on the computer and you use this browser to view web pages from other computers, your browser is considered the client. When the user requests some information from other websites using a browser, the website which provides information is known as a server.

Server applications, as a rule, are launched on powerful computers as they should be able to serve parallel queries from many clients. On the other hand, the clients' applications are mostly executed on less powerful computers, such as PCs or workstations.

To publish a web site, either a static or a dynamic Web server is necessary.

The static Web server consists of the computer (hardware) with the HTTP (software) server. It is called static because the server sends the files placed on it to the browser "as it is".

The dynamic Web server consists of a static Web server and an additional software, most often, application servers and databases. It is called dynamic because the application server changes source files before sending them to your browser on HTTP.

For example, for obtaining the final page which you see in the browser, the application server can fill a HTML template with data from the database. Such websites as MDN (Mozilla Developer Network) or Wikipedia consist of thousands of web pages, but they are not real HTML documents, they are HTML templates and large databases. This structure simplifies and accelerates the use of web applications and content delivery.

Files hosting

First, the Web server stores files of the web site, namely all HTML documents and the related resources including images, CSS styles, JavaScript files, fonts and videos.

You can place all these files on the computer, but it is much more convenient to store them on the selected Web server, which:

- is always available;
- always has access to the Web;
- has one IP address (not all providers provide a static IP address);

For all these reasons, search of a good hosting provider is a key part of creating your website. Consider various offers of companies and choose what corresponds to your requirements and the budget (offers vary from free to thousands of dollars a month).

Neither the client nor the server remembers previous connections. For example, leaning only on HTTP, the server will not be able to recall the password that you entered. For such tasks, you will need an application server.

HTTP sets strict rules of how the client and the server shall communicate. Here are some of them:

- only clients can send HTTP requests, and only to servers. Servers respond only to HTTP of the client's requests.
- when a physical file is requested, the client shall create the URL file.
- a Web server shall respond to each HTTP request, at least, with the error message.

On a Web server, the HTTP server is responsible for processing incoming requests and for responding to them.

1. When receiving a request, the HTTP server first checks whether there is a resource on this URL.

2. If it is there, the Web server sends the file contents back to the browser. If it does not exist there, the application server creates a necessary resource.

3. If it is impossible, the Web server returns the error message to the browser, most often the "404 not found". This error is so widespread that many web designers spend time on the development of 404 pages about errors.

Statics and Dynamics

Generally, the server can give static or dynamic contents. “Static” means that contents "are given as they are". It is the simplest way to set static web sites, therefore, we suggest you should make the first website static.

“Dynamic” means that the server processes data or generates data from the database. It provides more flexibility, but it is technically more difficult in service which complicates creation of the web site.

There are many application servers; it is quite difficult to offer one. Some application servers correspond to a certain category of web sites, for example, blogs, e-commerce shops; other, called CMS (content management systems), are more general. If you create a dynamic website, spend a little time on the choice of the tool which corresponds to your needs. If you do not want to study web programming, then you do not need to create your own application server.

9.3.3 URL

The Uniform Resource Locator provides users with a way to access Web resources with the help of a uniform means for addressing those resources (HTML pages, text documents, images, and the like). A Uniform Resource Locator which is more commonly called as "URL" (pronounced "U-R-L"), is the address of a specific Web resource, and, typically, a URL has three elements.

The first of these elements consists of an identifier that identifies the communication protocol to be used to access the resource of the URL addresses, and this identifier is followed by a colon (:) and two slashes (//). Incidentally, a communication protocol is a generally agreed upon set of standards and rules that machines follow when they communicate with each other, and the most common

protocol identifier found in URLs is "http" (which stands for Hypertext Transfer Protocol); therefore, a large percentage of the URLs you will encounter begins with http://. Other common protocol identifiers you will come across are "file" and "ftp", such as in *file://* and *ftp://*.

The second element of a URL is the name of the machine hosting the resource, for example, “www.iitu.kz”. It is a symbolic name given in the computer of the IITU (International University of Information Technologies). This computer is the web server of University and a computer that stores information about the university. As a general rule, in accordance with the agreement, the host names usually begin with a site "www", although they may as well start with something else - for example, "server", in "server.iitu.kz." The last node of this symbolic name, "kz", adheres to the Domain Name System (DNS) - Agreement on the identification of a resource, located on the territory of the Republic of Kazakhstan with the suffix "kz". Below you will see some other DNS agreements which show the suffixes and types of objects that are used. These suffixes are:

- com - commercial organizations, such as Ford or IBM
- edu - educational facilities
- gov - Government agencies
- net - Network Service Provider
- org - non-profit organizations such as PBS or the Red Cross.

In addition, URLs typically include a third element, which is the name of the resource addressed by the URL. This name is specified in terms of a path, such as /courses.html. Thus, a complete three-element URL might look as this: http://www.dl.iitu.kz /courses.html. And, as such, the URL might be interpreted this way: using hypertext transfer protocol, retrieve the file on www. dl. iitu.kz /courses.html.

So, as software, a Web server includes some things which control access for web users to the files placed on the HTTP server. The HTTP server is a part of the software which understands URL (web address) and HTTP (the protocol which uses your browser for web browsing).

9.4 HTML

The acronym HTML stands for Hypertext Markup Language. Let us examine this term, starting with the last word first:

Language. Language is a term we all understand. A language is a system of signs used for communication, written and oral. For example, we communicate the content of this course in a language known as English. But English is a human language, the language that humans use for communicating with humans; HTML, on the other hand, is a language that humans use for communicating with Web browsers.

Markup. In paper publishing contexts, markup is the process of preparing manuscripts for typesetting by marking them with directions about the font type

and size, indentation, spacing, and the like. The same principle is applied in electronic publishing. Instead of marks made by a pencil or a pen, formatting directions are conveyed by notation called "tags." We mentioned tags in this context earlier; however, we did not mention then that the goal of markup is to make the text more meaningful. Whether markup elements make one part of the text bigger, darker, or of a different color than another part, or whether they add blank lines, indentation, or horizontal bars, markup elements should make the text more meaningful by focusing and guiding the reader's attention. For example, a reader is more apt to notice and recognize a title if it is bigger and darker than the rest of the text.

Text. Text refers to the words on the computer screen that we are marking up. But, the word "text" actually has another, special meaning in computer contexts: the term "text format" denotes plain characters of the ASCII (American Standard Code for Information Interchange) character set. As it is, the text format is the simplest format to store written materials, and text files contain only the characters of the ASCII character set which consists of printable characters such as punctuation marks and alphanumeric characters, but not symbols that render text in special formats such as bold, underscore, and italics. In contrast, word processors like Microsoft Word embed all sorts of hidden characters in their files, and these hidden formatting characters control the appearance of a text as we see it on the screen.

Hyper. This term should be combined with the term "text" in this discussion. Hypertext, as a concept developed from Vannevar Bush's 1932 visionary brainchild known as the "memex," a device that would create links between related topics in different papers, and although the memex was never built, the notion of creating linked, nonlinear structures of information endured. A hypertext document is quite different from a traditional printed document. In a printed document, the order in which information is presented is linear, that is, sentence 1 precedes sentence 2, which in turn precedes sentence 3, and it goes on up the levels, so that chapter 1 precedes chapter 2, which precedes chapter 3, and so on. However, a hypertext document contains links, and by clicking a link, a user is taken to a different page or different part of the same page. If the user then clicks other links, he or she is taken to another page or part of the same page. Thus, the user can follow a nonlinear path through the document or documents, using the links provided by the author and encountering the information there in an order that depends on the choices that both the user and the writer have made.

The remarkable fact about HTML is that it has already become a widely accepted standard, and browsers that can display HTML documents have become commonplace and available for most types of computers. Therefore, most computers, given an appropriate browser, can display HTML files. This was not the case in the days before HTML. Back in those days, there were several competing formats each requiring different software to read and display its

documents, and getting the software to display a particular format on a particular type of machine was often not an easy task.

Choice of Editor

Now, we will consider how to write an HTML document and to view it in your browser. You need an editor for this purpose. The editor which you select shall allow saving documents as text files. The editor shall also allow saving these documents with .html extensions (.htm will work too): "MyFirstWebPage.html" or "MyFirstWebPage.htm". An extension is a suffix in the file name which consists of a period (or "points") and strings. Having saved files in a text format, you force the word-processor not to consider its own special characters of formatting which web browsers cannot read out. When using the extension of .html, you identify the file as such which the web browser can read and display with the use of HTML tag marking in the file. In Windows an extension tells the operating system about the type of the contents saved in the file, that is, about the file type. For example, extension of .htm specifies the HTML file type. In UNIX and Macintosh an extension means nothing to the operating system.

Main Components

As we mentioned earlier, the characters that we add to the text in order to specify to web browsers on how to display this or that text are called tags. There are many types of tags. Each tag consists of a couple of angle brackets (<and>, also known as mathematical operators "it is less than" and "it is more than"). Some tags represent a couple of opening and closing parts which follow the <tagname> and </tagname> syntax with the ending tag which is distinguished by a forward slash (/) after the open angle bracket (<).

An HTML document should begin and end with the following tag pair: immediately after the <html> tag there should be the tag pair to denote the document header:

<head>
</head>

In between, the <head> </head> pair there should be the <title> </title> tags. The title of the document is specified within them. This title will be displayed in the title bar of the Web page, for example,

<html>
<head>
<title>
My First Web Page
</title>
</head></html>

Next come the beginning and ending BODY tags:

<html>
<head>

<title>
My First Web Page
</title>
</head>
<body>
</body>
</html>

Almost all of the Web page's content will come between the beginning and ending BODY tags ("<body>" and "</body>").

Now, we need to consider another type of tags, the "comment" tags. If, for example, we are creating a Web page and we want to put something (a remark, note, etc.) in the page content but we DO NOT want that something to be displayed by a browser, we can accomplish this by putting inside a pair of comment tags. Unlike the label-like tags, we have encountered so far, a comment tags consist of the beginning and ending sequence of characters (""). Below is an example of a comment inside a pair of comment tags:

<!-- This is a comment. -->

The <!-- -- > character sequences the above mark or delimits (a good programming word) the beginning and end of the comment.

Style

In HTML, there are two types of style: **Physical and Logical**

The physical style tags allow us to tell browsers to use certain font styles. The following tag pairs force the following styles:

Bold
Italics
<tt></tt>Monospace(fixed width)
<u></u>Underline
Subscript
Superscript

If an HTML document had the following text:

The following text <B> is bold </ B> while the text <U>, is underlined </ U>.

Logical Styles

When we use logical styles, we allow browsers to decide how to display the text. Here are a few of the logical style tags:

Emphasized text
  Strongly emphasized text
<cite> </cite> Text in citation
<samp> </samp> Text in a computer screen output sample

There are a few other logical style tags you might want to go exploring here.

These are used in a manner similar to the way physical tags are used, but the browser decides how to display the text.

The DOCTYPE elements, organization and validation

There are 4 steps in order to organize DOCTYPE element:

1. determination of content of the web page;
2. planning of the type of the page and necessary links;
3. creation of a web page by writing it in small pieces;
4. a web page is assessed by two methods: a) check that HTML is correct; b) check that the type of the page satisfies you and other people.

9.5 Verification, Validation and HTML Validators

In many professional circles these days, from software development to engineering and design, you will hear the watchwords “verification and validation.” While you do not need to remember these terms, you do need to remember the questions that are behind them. The question behind the term verification is this: "Is the product that has been made the one that the specifications ask for?" For this course, that translates into “Is the HTML page that has been created the one that the specifications (the exercise or exam instructions, for example) ask for?” Stated this way, it is easy to see that this type of verification will play an important role in success in this course.

Behind the term “validation” a question might be stated this way, “Has the product been made in a way that conforms to real-world conventions and standards for that type of product?" Now, that may seem a little abstract, but in many areas of life (medicine, construction, engineering, and other), these real-world conventions and standards are widely recognized and published, and they have come into being for some very important reasons: safety, security, ethics, usability, interoperability, backward compatibility, to name just a few. But that is still somewhat abstract for our purposes. However, fortunately for us, in this course, the question behind validation is a very specific one, and the one that is easy to understand. For us, that question becomes, "Does an HTML page conform to the syntax and grammar published in the appropriate HTML specifications?" Also, fortunately for us, there are tools that can help us to answer this question quickly.

That is, part of what you want to accomplish in step 4, checking that your page's HTML source is correct can be greatly aided by the use of a tool known as an HTML validator. A validator is a tool that checks the source code for not only gross errors that even the most forgiving browsers catch but also for violations of various published conventions. HTML has evolved over the years and some new elements and conventions have been introduced while others have become obsolete. HTML validators help us determine if the HTML code conforms to a particular published specification: HTML 4.01, HTML 4.0, or HTML 3.2, for example. When you work with Java later in this course, you will come across a

similar step, called compilation, in which, among other things, the syntax of a servlet's Java code is validated. HTML validation is an equivalent step for HTML.

Why use an HTML validator instead of a browser to check your page's source? Because most recent Web browsers can be quite "forgiving", that is, they can "fix" a variety of HTML errors before they render a page, hiding the problem from the user. This would not be so bad for page authors such as yourself, if you could assume that all people would read your page using the most current browser and that all of the most current browsers, regardless of their brand, were equally forgiving. But, these are assumptions you cannot make. The capacity of browsers to "forgive" HTML errors varies from brand to brand and from version to version of the same brand, later versions typically are being more forgiving than earlier. But, the situation is even more complicated: there are other applications besides browsers that retrieve and render HTML pages, such as plug-ins and media players. So, as an author of the HTML page, you need to take such situations into account. But, beyond these, there is another consideration. The HTML pages that conform to a published specifications are not only likely to work with a wide variety of software that retrieves and renders Web content, they are more likely to continue to work properly even as HTML and Web technologies evolve.

9.6 XHTML

Now you already know that HTML is a language which defines how the text has to be displayed, i.e., a markup language. Today, it is the standard of display of information on the Internet. However, limited opportunities of HTML, such as difficulties of display, mathematical formulas, hieroglyphs, etc., have pushed web programmers to improvement of this markup language. Taking into account a new specification of the language called XML, created in 1999, the basis for future XHTML has been developed. We will give a definition for Expanded language of a hypertext marking (XHTML Extensible Hyper Text Markup Language). According to W3C (an organization developing and introducing technological standards for WWW), XHTML is a family of real and future types of documents which is a subset and expansion of HTML connected to XML. As it has already been noted earlier, XHTML documents are based on XML, and respectively are used together with the user agents based on XML.

Besides, XHTML is known as a meta-language, more flexible, than HTML. It should be noted as one more markup language: SGML – the Standard generalized markup language (Standard Generalized Markup Language).

There are XHTML benefits in comparison with HTML:

1) more effectively conveys the content of pages to the computer on the Internet;

2) page marking created by XHTML is clear for the browsers started from various platforms or with various permissions. For example, the web page

developed in XHTML easily opens on the laptop, the Smartphone or any other device.

There are a number of things which you need to consider when dealing with XHTML pages:

- XHTML of your page shall be competently written: closing of all elements, quotes around values of attributes, admissible attachment of elements and etc.
- Your page shall boot with the use of the application/xhtml+xml type, i.e. your server shall provide this type. You can check it independently or having communicated with the administrator of the server used by you.
- Surely include an XHTML name space in the element.

As it was already noted, in case with XML, there is a mass of additional things about which it is necessary to know, and also a set of things to which it is necessary to pay special attention. Briefly we will enlarge on each of them.

9.7 CSS

HTML serves for marking web pages, but it does not always correctly draw them in the browser. Again, here's a cascade stylesheet or official name of CSS from the Cascading Style Sheets can come to rescue. The stylesheet gives accuracy in submission of the document and it is clear to the majority of browsers.

The structure of CSS is not similar to that of HTML. Therefore, apply a format to use "property: value". In turn, properties are widely used in tags.

There are advantages of creating web-pages:

- one stylesheet can be applied to a set of documents that allows to adhere to a uniform design and makes it easier to support a code;
- exact design control;
- complexity and development of the design equipment;
- an opportunity to diversify types of representation for various devices (the screen, the press, etc.);
- clarity of the code and its quick loading;
- convenient search systems.

9.8 JavaScript

The next language that allows revitalizing a web page is JavaScript. Let's consider it as special. First of all, the programs created by means of this interpretive language of programming are called scripts. Considering the syntax of JavaScript, in some program instructions it is similar to C, C ++ and Java as experts believe, has an object-oriented potential.

JavaScript is an un-typed language, whereas Java is a programming language developed in the Sun Microsystems company. The initial name of the language was LiveScript and then it was changed to JavaScript.

JavaScript is used in the observer of the Internet. However, input of objects expands its opportunities, respectively, the organization of the user interaction, control of a web browser and editing in a document window.

JavaScript is applied as a scripting language as it is meant more for normal users than programmers. Therefore, the mistakes made by unprofessional programmers are absolved due to absence of monitoring of types in this language. Nevertheless, JavaScript is a programming language with some difficulties.

An interesting feature of this language is division into the client and basic JavaScript. The first option is more widespread and consists of the interpreter and DOM (Document Object Model), an object model of the document. Subsets of client in JavaScript are also a basic option.

The scenarios written on JavaScript apply the DOM model to monitoring the display and change of the document. This statics of contents of the page and its behavior are defined by the JavaScript client that can be a basis of such technologies as Ajax.

Let's look at one of the modern architectures applied by web developers – AJAX (an abbreviation from "Asynchronous Javascript and XML"). This technology allows addressing without reset of the server page. It reduces the response time of the internet application. Therefore AJAX is used for dynamic elements.

9.9 CMS

The control system of content (Content management system, CMS) is convenient for the users trying to create and edit independently contents of Internet pages.

Usually, there are two storages. All data on the website are stored in one of them. There are representation elements (drawings, any templates, etc.). Besides, there are modes, both for the creator of the website, and for the owners of the website.

Today, there are many CMS applications in the market. Let's consider the main classes of such applications.

L*arge production systems*. The most known applications are Microsoft Content Management Server, Documentum, Plumtree Portal, IBM WebSphere Portal, etc. Usually, the sphere of their application is very narrow, since project implementation on their basis is expensive and their application does not go beyond creation of the intranet decisions for large enterprises

Open source systems (systems in open access). Their main benefit is availability of the source code, a possibility of localization. Shortcomings: creators of the websites shall solve the problem of the lack of technical support, i.e. the problems arising in the process of using these systems; a limited scope, since sometimes developers propose this or that solution of their own as CMS. It is undoubted that it is better to apply an already tested option to the similar project.

But unfortunately, it is not always so simple. The most known examples of such systems are Joomla, OpenCMS, PhpNuke, PostNuke, Portal Starter Kit, etc.

A little more in detail about the free software of Joomla. Joomla is a content management system which is written in the PHP and JavaScript languages. Let's get acquainted with the structure of Joomla which consists of such elements as articles, categories, modules, templates, plug-ins, components and settings.

From the first steps of the system installation, the user with the rights of the chief manager is created. Respectively, he can change and configure the system. There are also other users depending on the rights which are available for them. Usually, each user has registration data. Users can be integrated in groups and have a certain privilege level that grants them the right to limit access to the published materials.

Article. One of the expected types of activity of the user is creation of articles. An article usually consists of heading, the text and parameters of the publication. The removed page can consist of one or several articles removed by the list. Formats of the article can be various. Articles can be united in categories, files and folders. Articles from one or several categories can belong to this or that menu item and be removed in the format chosen by the administrator.

Navigation. A great number of References which conduct the published pages are collectively called "navigation" or "menu". The number of the menu and their combination can be unrestricted.

Module. A small separate multipurpose block of content is called a module. For example, a calendar conclusion on the page is a module. A search interface in the system is a module, too. You can create as many modules with different remarkable functions as it is necessary for you and place them in areas of pages determined by the applied template.

Templates. The template is an instrument of making the appearance of the page. The current possibility is carried out at the expense of HTML and CSS. Usually, Joomla is delivered with several previously established templates. Templates are adjusted, therefore, the majority of templates still assume the so-called seats for modules. Modules can be grouped around one or several articles.

Plug-ins. Plug-ins are the expansions performing practical functions which make it possible to establish them any number of times. Usually, they are not visible to visitors. For example, WYSIWYG (abbreviation from English What You See Is What You Get) editor is a plagin. The set of useful plug-ins is included in the initial package of Joomla.

Components. Components are the expansions allowing of creation on your website of almost everything that you can see on others'. Several expansions of this type are included in the initial package of Joomla. For example, feedback forms. The components which can expand a set of functions of your website make up a set.

Settings. Buttons with such signature in the administrative section are called "setup interfaces"; they allow to change the parameters of the system and its

separate elements, for example, of accounting records, categories, modules, components, etc.

Other structures. There are many other structures intended for interfaces of the user, templates providing technical interaction. At this stage, it is possible to be restricted to storage of the ones that are described above.

9.10 XML

The extensible markup language (XML – Extensible Markup Language) represents popular means of data presentation. The XML standards have been adapted to other formats of data, such as HTML (by development of XHTML).

You can create the text and mark it up by means of framing tags, turning each word, the offer or a fragment into identified and sorted information. The files created by you, or *document copies*, consist of tags and the text, and elements that help to understand the document correctly when reading or even to process it in an electronic form. Then more descriptive elements, the more important parts of the document they can identify. From the first days of existence of marking, one of its benefits was that in case of loss of the computer system, the printed-out *data* remain readable thanks to tags.

Markup languages passed the way from the first forms created by the companies and state institutions to Standard language of the generalized marking (Standard Generalized Markup Language - SGML), the Hypertext markup language (Hypertext Markup Language - HTML) and to XML. SGML can seem difficult, and HTML (which, in fact, at first was just a set of elements) was insufficiently powerful for identification of information. XML was developed as idle time in application and a markup language convenient for expansion.

In XML, it is possible to create its own elements that allow to represent fragments of data precisely. Documents cannot just be divided into paragraphs and headings, but it is also possible to select any fragments in the document. For it to be effective, it is necessary to determine the final list of the elements and to adhere to it. Elements can be determined in the Description of the document type (Document Type Definition - DTD) or in the scheme that will be described below. When you master and begin to use XML, do not be afraid to experiment with names of elements, creating real files.

When using the built-in opportunities of the Microsoft Internet Explorer (MSIE) practically, all management systems impose tough restriction, and for publication of information, it is possible to use only the Internet Explorer. At the same time, as in the client part visual editing is not required, no restrictions are imposed on it, and users of your website can use any browser. In the latest version of the Microsoft Internet Explorer, there was an opportunity not to use a separate element of management, but allow performing editing directly in the text of the page, transferring certain parts of the page to an editing condition.

Having acquired several simple rules, you can flexibly develop your own XML elements and their attributes. The XML rules are not difficult. It is simple to type the XML document, too.

When you understand the purpose well enough and you know how to mark up the text, it is possible to create effective elements and attributes. From the point of view of careful marking, everything that is necessary for creation of the XML document can be correctly constructed and suitable for use.

9.11 Web service

The web service is the network technology based on standards of the Internet providing inter-program interaction. By determination of the W3C consortium, a web service is a program system developed for the support of interoperable inter-computer (machine-to-machine) interaction through a network.

Basic principles of the bases of web services:

- The one responsible for web service determines the format of requests to the web service and its answers;
- The request to a web service is carried out by any computer in network;
- The request is processed by the web service, any operation is performed, and then the answer goes.

One more benefit of modern services is an application of XML which is transferred under the HTTP protocol. Therefore, information on work of web services becomes available, which allows web developers to use it.

The Web 2.0 is not a technology or any special style of Web design. The Web 2.0 is an integrated approach to organization, implementation and support of Web resources.

The Web 2.0 service is a special organization of data presentation:

- object-oriented interface;
- a managed selection and data output on the page in many parameters chosen by the user;
- placement of a large volume of information on one page;
- reset only of that part of the page which changes;
- placement of polytypic information in one window.

Web 2.0 technologies are based on the interactivity understood as exchange of information between users, between the user and the supplier of service and between service providers. It leads to mutual use of resources or the distributed system of resources.

Today, there is the whole galaxy of the Internet services positioned as reference books and encyclopedias.

Wikipedia represents the base of reference information providing practically each user with an opportunity to edit data.

Exchange services. These resources are filled at the expense of users, providing them the place for various files – music, movies, documentation, etc. RSS and tags are used here, too.

Websites of a joint use of documents. Similar services give to users a chance of simultaneous and joint use of documents. It is possible to create, change, delete information available for general use. At the same time, there disappears a need for installation of the software on local computers. In the field, the acknowledged leader is the Writely service.

9.11.1 Internet Commerce

Web-based Internet commerce (also known as e-commerce) can take many forms, some of which are relatively new. We will look briefly at three of the most common forms of Internet commerce:

1. Internet Service Providers (ISPs)
2. Advertising
3. Commercial Transactions

Internet Service Providers, as the name implies, sell you access to the Internet. The cheapest form of internet service provided is the ability to log on from your home. You typically dial up a number provided by the ISP and are connected to the Internet, after which you can browse and search the Web. Many ISPs also provide email service, and many allow some minimal Web publishing. However, although one still needs an ISP to establish a major Web presence, establishing and maintaining such a presence can be expensive. The price is usually based on the total size of your Web page files and how many hits you want your site to be able to handle in a given amount of time. If you are going to sell goods through your Web site and are planning to make it popular, it will have to be capable of handling a large number of hits, and that can be expensive. Until recently, ISPs gave you a maximum number of connect hours to the Web for a fixed fee. If you exceeded that number of hours, you incurred an hourly charge. However, things have changed, and many ISPs now offer unlimited Web connect time for a fixed fee, currently about $20.00 a month.

Advertising is one way that the search engine companies make money. While you were using search engines, you probably noticed lots of visual clutter that search engine companies call advertising. The companies that this "visual clutter" advertises pay a search engine company a fee every time their ads are displayed. The fee per display is small, but since there are a lot of people using the Web, the display fees add up. Search engines also select the ads to be displayed on the basis on what a user is searching for. If, for example, a user is looking for information about football, they probably will not be shown ads for the opera. However, if they are searching for classical music, a search engine may show ads related to the opera. Also, note that many of the ads include links to the Web site of the company

they advertise. Follow just a few of these links and you may find yourself spending a lot of time and, possibly, a lot of money.

Commercial transactions do not represent a large percent of Internet commerce, but that percentage is growing. Presently, you can order books from several companies on one day and receive them next day. Furthermore, during the holiday season, you can also order toys, and companies that use printed catalogs are now likely to put their catalogs on the Web: it is cheaper to display a catalog on Web than to print and mail it to many individuals. Doing this also makes the inventory control a little easier; the Web-based catalog can be updated immediately to reflect changes in the inventory. Therefore, if blue shirts sell out, that listing can simply disappear from the catalog on the Web. That is not possible with a printed catalog, and some electronic catalogs display more items than it is practical for a printed catalog to do. To see an example of a sophisticated commercial site that features a Web-based catalog visit «Lands' End» at www.landsend.com.

Recent news articles report that many observers believe that the number of commercial transactions on the Web will continue to grow each year for the foreseeable future, and other forms of Web commerce are possible. Web commerce is, in fact, a field fertile with an opportunity for clever and thoughtful individuals. There are many niches that have not even been filled yet, and Web commerce as an enterprise is still very new. Just remember that prior to 1997 you could not even order books on the Web.

9.11.2 Private Network Services

Personal network services belong to a specific user and are protected by the login and the password. Access to them isprovided only personally by the owner of the service. A personal box of e-mail and a personal website can be an example of such a service or section (blog), as well as a personal telephone number and a password for its use, a personal page on the website of remote learning or distant testing. All personal services on the Internet require personalisation, i.e. registration from the user side following the results of which the user receives a personal login and a password.

Personal information activities on the Internet have generally a retrieval and communicative character. One of the forms of personal service is registration and provision of theses for a conference including video. There are conferences on the most various subjects: public, technical, medical, educational, scientific, etc.

Personal websites, blogs, became a popular personal network service. It is possible to create a blog, for example, having registered on the website www.pedsovet.org.

Blogs (interactive network diaries) represent one of the most striking examples of using the principles of the Web 2.0. A considerable part of the Web content is created by users, not by the resource owners. For this purpose, they actively use RSS and FOAF technologies.

The FOAF technology (Friend of and Friend) gives to the user the chance to sign to news and materials of those users which are in the so-called "list of friends". This encourages communication of users of the Network. The FOAF technology is one of the most important components of social networks.

RSS (Really Simple Syndication, "really simple consolidation (information)") is a simple and effective technology of export of the hypertext used for creation of news feeds.

We will also refer distance training to personal network services. Here, you choose the trajectory of training, perform tasks, they are estimated, and you track the results in the journal of progress.

Besides, there are separate online rates, online tests and certifications. These services allow estimating far off knowledge, determining personal qualities to help with the choice of profession.

Various network services of collective use are provided for a wide range of users. Several users can use such services at the same time.

Modern means of remote interaction, telecommunication, allow to exchange various information very effectively. Now, it has already become a norm to carry out on the Internet such means of remote interaction as online polls, chats, forums, by means of video cameras and teleconferences.

Service of instant messages (Instant Messaging Service, IMS) is a class of programs intended for exchange of messages on the Internet in real time. Texts, sound signals, pictures, videos can be transmitted. The client program, the so-called messenger, is necessary for this type of communication (English messenger – the courier).

The forum is a collective form of communication on the website. Each message at a forum has the author, a subject and its own contents. As a rule, forums are subdivided into subjects, and each of your posts will be a part of the general open discussion of a certain subject.

The circle of forums is not limited by that. One more feature of the forum consists in answering in real time, but in fact it is not obligatory. Subjects and answers are stored during an unlimited period. There are forums existing for years, and for several years, there can go discussions of one subject. Interaction of people on the Internet often has a business character connected with work or its search i.e. interaction with a potential employer, for example, the Linkin community.

9.12 Ethical Considerations

The Internet becomes a total source of information and the environment of interactive communication. With the development of the Internet, there arises the issue of network etiquette, designating a set of the rules developed among users of a wide area network. The first Code of computer ethics was drafted in 1979 in the USA. Acceptance of the code was dictated by understanding that engineers,

scientists and technologists determine by results of the activities the quality and living conditions of all people in the information society.

The principles developed within the computer ethics are:

- **Privacy**, which is a human right to autonomy and freedom in private life, the right to defense from invasion of authorities and other people;

- **Accuracy**, or observance of the regulations connected with exact accomplishment of maintenance instructions of systems and information processing, a fair and socially responsible attitude to the respective obligations;

- **property**, implying immunity of private property, a basis of the property order in economy; following this principle means observance of the property right to information and regulation of the author's rights;

- **Accessibility,** the right of citizens to information, its availability at any time and in any place.

Let's start with some interpretations of the simple question, "What can you put on your Web page?"

1. Can you go to your favorite sports team's Web page, make a copy of the .jpeg or .gif file that is their logo and put that logo on your Web page?

2. Can you put a link on your page to the home page of your favorite sports team?

The answer to number 1 is "No." There is a very strong possibility that your favorite sports team has that logo copyrighted. To use it legally, you need their permission. Whether or not they prosecute you for copyright infringement is beside the point: you need their permission to put the logo on your page.

The answer to number 2 is "Yes." You can put on your Web page a link to any other Web page. If your favorite sports team does not want everyone to access its Web page, it can put a gate on the page and require people to log in with a password.

The use of any material from another Web site that is not specifically marked as free for taking, or for which you do not have permission, is not ethical. In this context, the word “material” is understood very broadly. It means text, pictures, graphics, backgrounds, cute little buttons, and enhancements. There are some sites that provide graphics and enhancements free for taking. If you find something you like, you can send an email to the Web page owner and ask for the permission to use what is there.

9.13 Security

In recent years the number of the attacks aimed at Web servers has increased considerably. Web servers are especially vulnerable because of their openness, as they expect information exchange with users.

The Web server is created by several layers of software, each of which is subject to various methods of attack (Fig. 9.3).

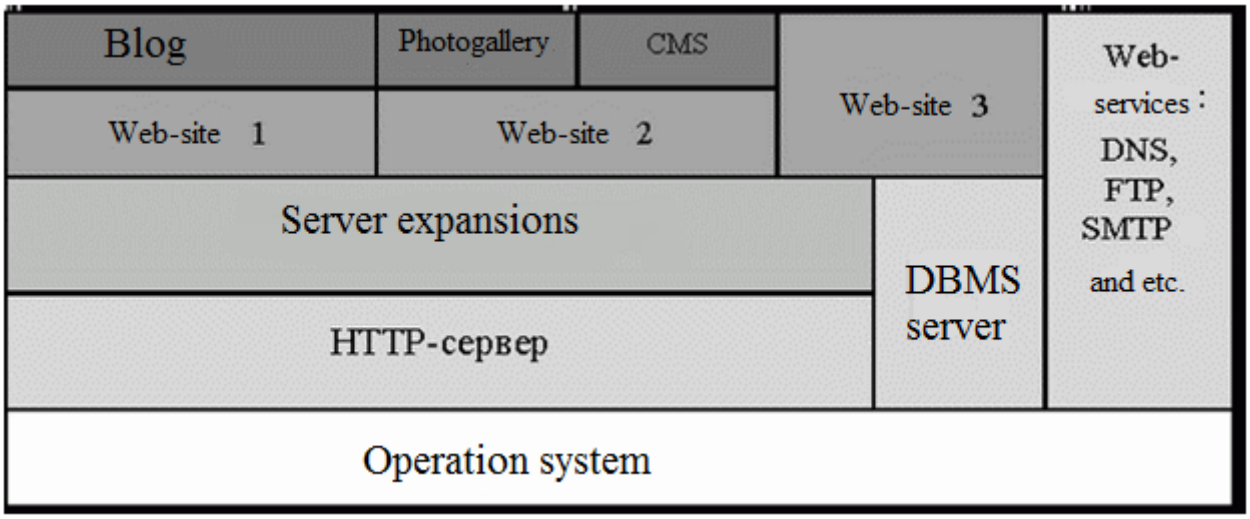

Figure 9.3 - Web server's multilayered structure
(source http://www.intuit.ru/)

Safety of an operating system is enhanced by establishment of the latest updates of security arrangement which are regularly released by developers of this OS.

Also, it is necessary to update all the software working at the Web server. Any software which does not possess necessary components (for example, the DNS server or means of remote administration like VNC, or services of remote desktops) should be disconnected or deleted.

The use of antivirus software is a mandatory requirement for any Web server regardless of the operating system used as a platform. In combination with a flexible fire-wall, the antivirus software becomes one of the most effective methods of protection against security risks. When the Web server becomes an object of attack, the malefactor tries to load instruments of cracking or malicious software to use the vulnerability of security arrangement before it is closed. In the absence of a qualitative anti-virus packet, vulnerability of security arrangement can remain unnoticed for a long time.

The attacks on a Web server can be divided into two categories: local and global.

Local attacks are usually directed to theft of information or interception of control on a separate Web server.

Global attacks are usually directed to several web sites and are meant topurposefully infect all their visitors.

The most dangerous types of network attacks

Phishing is a type of attacks which begins with mailing the e-mails containing reference to the known resource (or imitating such link). The design of the web page is usually copied from the reproduced resource. On the forged page it can be written, for example, that the bank where you have an account, carries out an action of check of safety of access, at the same time it is offered to enter the

number of your credit card and the PIN code. After the input of the specified information, the message that contains correct information is sent, but after a while money disappears from the account. This scheme can be used not only for plundering money. Having got access to the account of the user, malefactors get thereby access to its confidential information.

Social engineering is a method of unauthorized access to information or storage systems of information without using technical means. The method is based on the use of the human factor and it is considered very destructive. The malefactor obtains information, for example, by collecting information about employees of the object of the attack, by means of regular phone calls or by penetration into the organization under the guise of its employee.

Scam is a fraudulent trick used for referring to authority figures to ingratiate and take commercial benefit. One of possible means of the attack is the use of IDN (International Domain Name). The matter is that in the systems supporting IDN, the use of letters of national alphabets is allowed, and, for example, some letters of Latin and Russian alphabets are written identically. Malefactors can use it. They can register names which look as names of well-known companies, where some letters are replaced by Russian ones, so it is not noticeable externally, for example, letters **C or O.**

Spoofing is a kind of phishing. The essence consists in the attack through DNS (or some different way) when the page with the known URL is substituted by the page of the malefactor.

Spyware is the program which writes down all keystrokes on the terminal or a mouse and is capable of writing down screenshots and transferring the data to the remote server.

The spyware kind of programs is not necessarily harmful. Some software developers build in such programs to track the clients' preferences. Some programs of spyware, according to the name, monitor actions of the owner of the computer where this program is downloaded (pressing keys, visited sites, confidential information, etc.) and transfer results to the owner. Infection of spyware can traditionally be carried out through mail, IM (Instant Messaging) or as a result of visiting the compromised website.

Attacks at Web Servers. Legal Web servers are cracked by means of the following types of the attacks:

- SQL-Injection;
- Harmful advertizing;
- Method of readdressing the results of operation of the search server;
- Through the virtual hosting companies;
- Through vulnerabilities of the program servicing forums;
- Cross-site scripting.

The attacks like "drive-by download" (loading files or scripts without the master's knowing) became one of the main instruments of invasion recently. A variety of multimedia formats also facilitate operations of hackers. The user is

usually not surprised by the need of loading the latest version of the codec or the driver for viewing or listening of the material placed on a remote server.

Cross-Site Scripting (CSS or XSS). The term XSS is used to avoid confusion with CSS (cascading style sheets). XSS is one of the most widespread network attacks for receiving personal data by means of web technologies (sometimes this type of attacks is called "HTML injection"). The problem is solved due to execution of a certain Javascript code in the victim's browser. At the same time, the information contained in the victim's machine is obtained (for example, cookies). The method does not do a direct harm, but can precede more serious attacks.

Cookie. The majority of browsers support two methods which web applications can use for saving information on requests of clients: normal cookie files and session cookie files.

The cookie file is a small file created by the browser and stored on the user's computer. Its contents are not regulated, but usually the name, expiry date and a certain data volume is stored in such files, for example: "Visited = 36" or "Selected = true".

The session cookie file allows web applications to store data in memory.

Distinction between the two methods lies in the fact that a normal cookie file is saved on the computer of the user and remains on it until being deleted by the user. The cookie file of the session, on the contrary, is stored only throughout the operating time of the computer and is automatically lost when the application browser is closed. At the same time, both files are subject to manipulations from the outside.

With cookie files it is necessary to aim at restricting the data volume saved in them, in particular when these data are not stored in open access. The optimum approach, reading all data which are stored on the user's computer, is unreliable.

SQL injection. The SQL injection is used for attacking the web sites working with databases. The possibility of implementation of a SQL code arises if in SQL queries they use unfiltered data entered by the users.

Many modern web sites use scenarios and SQL queries for dynamic formation of contents of the page. In SQL queries, the data entered by the users are often used; it can lead to security risks as malefactors can try to implement a harmful SQL code in the input data. Without appropriate measures of protection such a code can be successfully executed on the server.

Review questions

1. How was the Internet created?
2. Is it possible that the Internet has no central governing body? Is it true?
3. How does DNS organize the Internet?
4. What is the difference between the IP address and the domain name?
5. How is correlation of the network clients executed?
6. What is web structure?

7. What is the difference between a static and a dynamic Web server?
8. List the main HTML components.
9. What types of the URL links do you know?
10. What are the web standards?
11. What types of attacks at Web servers do you know?

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CHAPTER 10. CLOUD AND MOBILE TECHNOLOGIES

10.1 General Characteristics of Cloud Computing and Its Definition

Currently, there are four major categories in the IT-industry – cloud computing, users' mobility, big data and social systems.

The concept of cloud computing is the result of evolutionary development of information technology over the past few decades and the answer to the challenges of modern business. Analysts from Gartner Group (Gartner Group) have referred to cloud computing as the most promising strategic technology of the future, predicting the transfer of information technology into the "cloud" in the next 5-7 years.

Cloud computing is a service that provides a remote user with an access to hardware capacity or software. Cloud computing is a sort of analogue to email services such as Gmail or Hotmail, where every user can store all the e-mails, personal data, files and software on their servers.

The rapid development of computing power and communication lines resulted in a significant expansion of the use of cloud technology. Creation of large-scale computing systems and data centers, telecommunication development have led to the possibility of remote information technology services. Using the cloud a user is able to access necessary information at any time and from any location, which frees him/her from having own storage facilities. The cloud service includes not only hardware component but also software. It is attractive to those users who cannot buy a lot of equipment and software licenses, but also for those who want to store their data on external resources.

Instead of buying, installing and managing their own servers, the cloud computing users get an access to the servers of Microsoft, Amazon, Google, etc. on a rental basis. Moreover, they pay only for the actual use of processing and storage operations via the Internet.

Initially, the cloud computing concept was greatly influenced by the technology of **distributed computing (grid computing).** Distributed computing technology allows the implementation of large resource-intensive computing tasks done by multiple computers in a network connected to a powerful computer cluster or the Internet.

According to the National Institute of Standards and Technology CSHA (NIST) **cloud computing** is a model for ubiquitous on-demand access to a shared pool of configurable computing resources that can be rapidly implemented and can provide a minimum of administrative effort or interaction with the service provider.

Cloud computing is a dynamically scalable way to access external computing resources through the Internet, where a user does not need any special knowledge and skills.

There are many definitions of cloud computing. The choce of a definition depends on the aspects and the role of service [2]. The following examples demostrate definitions of "cloud computing" from different points of view:

– **Cloud computing** is a software and hardware available to users via the Internet or a local network as a service allowing the interface to be a user-friendly for a remote access to the dedicated resources (computing resources, programs, and data). The user's computer is an ordinary terminal connected to the network. The computers engaged in cloud computing are linked to each other with the data distributed automatically between them.

– **Cloud computing** is an information technology concept, which implies providing a universal and convenient network access on demand to the total pool of configurable computing resources (e.g. data networks, servers, storage devices, applications and services - both together and separately) that can be provided quickly and released with minimal operating costs or calls to the provider.

– **Cloud computing** is a new approach to reduce the complexity of IT systems through the use of a wide range of effective technologies managed independently and available on demand within a virtual infrastructure and consumed as a service. Referring to the private cloud, customers can get a lot of benefits such as lowering the cost of information technology, business agility, improved quality of service and others.

– Cloud computing is a way to create new business models enabling small producers of IT-products enter the market and offer their business ideas.

The NIST has named the following mandatory characteristics of cloud computing:

1. **Self service on demand** – when a consumer determines and modifies the computing needs such as server time, access speed, data processing, the amount of stored data without an interaction with a representative of the service provider;
2. **Universal access network** – when services that are available to consumers through the data network are used regardless of the terminal device;
3. **Resource pooling** – when a service provider combines the resources that are available to a large number of customers in a single pool for the dynamic reallocation of power between consumers under the conditions of constant changes in power demand. In this case, consumers control only the basic parameters of services (e.g. data access speed) whereas a supplier is responsible for the actual distribution of resources;
4. **Elasticity** – when a service can be provided, expanded or limited at any time, without any additional costs for the interaction with a supplier usually in an automatic mode;
5. **Accounting for consumption** – when a service provider calculates the resources consumed at a certain level of extraction automatically (e.g. volume of stored data, bandwidth, number of users, number of transactions), and on the basis of this data estimates the volume of services provided to consumers.

The above mentioned characteristics are derived from the following features of cloud computing:

- Shared infrastructure is an ability of virtualization technology to restructure physical environment. Such connectivity provides less computational resources and server components, thereby making the solution is more flexible.
- Dynamic resource allocation (scalability) is an ability to automatically allocate additional resources or reduce resources available on request.
- Network availability is an ability to connect to the external resources.
- Managed account is an ability to track and manage the consumption of resources, optimize the use of resources.

Cloud computing involves pooling a large number of computers in a single computing resource using virtualization technologies through a single computer or a system of multiple virtual devices used by different users. Thus, the clouds form a pool of configurable computing resources.

10.2 Trends in the Development of Modern Infrastructure Solutions

In any area of science, technology, industry or business, there are always a lot of problems that require the development of computer technology and the concentration of computational tools and resources. They include, for example, a complex high-performance computing (scientific problems, mathematical modeling), as well as maintenance tasks involving a large number of users (distributed databases, the Internet services, hosting). Nowadays, the business requirements for services have increased. In this regard, the largest IT vendors have started to produce and implement more functional and reliable hardware and software solutions. The following infrastructure solutions have heavily contributed to the emergence of a cloud computing concept:

- computers productivity growth;
- invention of multi-core and multi-processor computer systems, the development of blade systems;
- development of systems and storage area networks;
- infrastructural consolidation;

The development of the IT industry has led to the introduction of several models of information systems (Fig. 10.1).

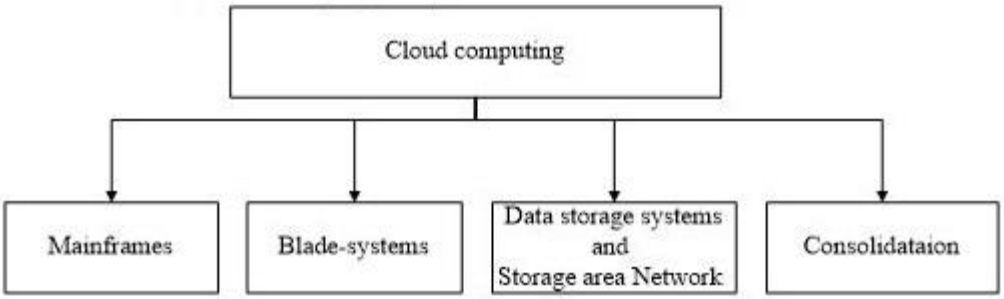

Figure 10.1 - Driving the development of cloud computing

According to the diagram of cloud computing (Fig. 10.1) invention of IBM System/360 universal computer system laid the basis for the mainframe.

1. Mainframe is a host computer center with large internal and external memory or mainframe. It is an all-purpose, high-performance, fault-tolerant server with significant input-output resources, large volume of operational and external memory for the use in the mission-critical systems with intensive packet and operational transaction treatment.

The high concentration of computing resources requires an increase in the power of processors. The manufacturers of processors have reached a reasonable limit of increase in processing power in which its performance is very high at a relatively low cost. An increase of processing power makes it necessary to use unconventional methods of cooling processors that are quite inconvenient and expensive. The necessity to increase the number of individual computing modules rather than their performance has led to the creation of a multi-processor and multi-core computing system. A multiprocessor system includes more than four processors. Currently, there are a number of processors with eight cores and more, each of which is equivalent in performance.

2. An increase in the number of computing units in the data center requires new approaches to the placement of servers, and also leads to an increase of premises costs for data centers, their power, cooling and maintenance. The new type of a server of the XXI century was created to solve these problems, a modular server which is often called Blade-server or Blade. According to the definition given by the analysts from IDC, Blade-server or blade is a modular single-board computer system that includes a processor and memory. The blades are inserted into a special chassis with a backplane providing them a network connection and power supply.

The first models of Blade-servers were developed in 2001 with the help of the manufacturers under the rule of "1234". They had some benefits: "In comparison with the conventional servers Blade-servers occupy half of the space, consume three times less energy and cost four times cheaper" (Fig. 10.2).

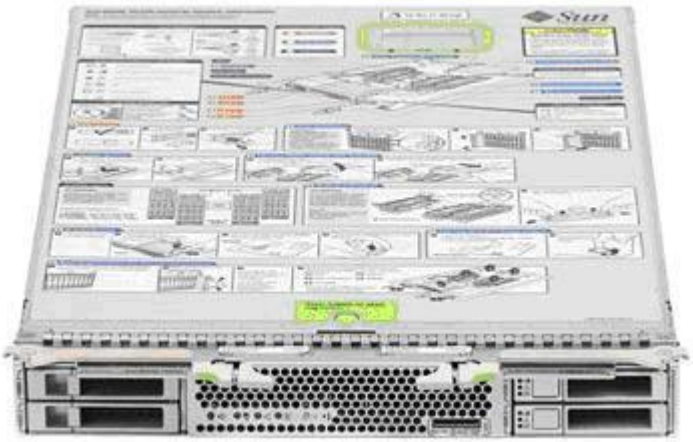

Figure 10.2 - A typical blade-server (Sun Blade X6250)

The principal difference between the blade server and the traditional one is that the blade server has the intelligence in the form of a control unit that is not in the rack placement of traditional servers. The blade system is controlled by a central control unit and a special remote control processor on each blade server. In order to increase productive capacity, it is sufficient to purchase additional blades and connect them to the chassis. The servers and infrastructure elements in the composition of blade systems are smaller and occupy less space than comparable rack-mount solutions that help to save energy and space dedicated to IT. Due to the modular architecture, they are easier to deploy and upgrade. Installing additional equipment, switching equipment and network components in order to improve the reliability of blade systems, which provide redundancy, lead to additional costs. When one server fails a system administrator simply replaces the blade for a new one and then remotely installs OS and application software on it. The usage of blade architecture generally reduces power consumption and heat generation as well as decreases the space occupied by it.

3. Another feature of the current development of computer systems is the development of specialized systems and Storage Area Networks (SAN). Today, storage systems are one of the key elements on which the business continuity of a company depends on. In current corporate IT infrastructure data storage systems are usually separated from the main computing servers adapted and configured for a variety of specialized tasks. Storage systems implement a variety of functions and play an important role in building the operational backup and data recovery, failover clustering, issues of high availability, and virtualization.

Storage Area Network or SAN is a high-speed switched data transmission network of servers, workstations, disk storage and tape libraries. Data exchange takes place in accordance with the Fiber Channel protocol. It is optimized for fast and guaranteed messaging that allows sending information over a distance of several meters to hundreds of kilometers.

The driving force for the development of storage networking comes from an explosive growth in the volume of business information (such as e-mails, databases

and overloaded servers), which requires a high-speed access to the disk drives. SANs help to increase the efficiency of storage resources usage as they provide an opportunity to allocate resources to any node in the network.

A data storage system is a reliable storage facility that might be connected to the server in several ways. The most productive way is the connection throug Fiber Channels which makes it possible to access a storage system with speeds of 4-8 Gbit/s. Storage systems also have reservations for major hardware components: several power supplies, raid controllers, FC adapters and optical patch cords to connect to the FC switches (Fig. 10.3).

Figure 10.3 - A Typical Storage System of entry-level data (Sun StorageTek 6140)

The main advantages of using the storage system are:

- high reliability and fault tolerance
- high data availability
- powerful management and monitoring tool
- high performance
- trouble-free scalability

Storage systems are one of the key elements on which the business continuity of the company depends on. In modern corporate IT-infrastructure storage systems are separated from the basic computing servers, adapted and configured for a variety of specialized tasks. Storage systems implement a variety of functions; provide a system of operational backup and recovery, failover clustering, support high availability and the level of virtualization. Specialized technical solutions are used for storing and processing large amounts of information, powerful servers and disk storage. Creating and maintaining a modern storage system independently are quite difficult and expensive, as a content server requires special technical conditions, individual rooms and experienced staff. Thus, large data centers not only allow users to store and process certain data within itself, but also provide an opportunity to create their own virtual data centers enabling young companies not to create an entire infrastructure from scratch.

The storage data processing centers (DPC) are created for better allocation, service and suitable conditions of technical solutions of storage systems.

Data center or center of the data processing (storage) is a specialized building for (hosting) server and network equipment and for connecting users to the Internet channels.

Data centers include:

- highly reliable server hardware;
- data storage and transfer system;
- software;
- architectural and engineering solutions;
- engineering infrastructure;
- physical protection of premises;
- complex arrangements;
- monitoring and control system.

The main task of data centers is to provide a guaranteed uptime of the enterprise information system with the specified levels of availability, reliability, security and manageability. Experience of data center creation allows backup headquarters of enterprises maintaining the possible highest functionality of the information system while emergency. To maximize business efficiency, the executives know that it is better to spend a little more money to modernize the processes than to lose a huge amount in case of unexpected circumstances. Therefore, a data center should solve a number of basic tasks:

- storing and analyzing large amounts of information;
- ensuring security of IT-systems;
- maximazing data availability;
- testing the reliability of the systems;
- ensuring the integration of distributed systems;
- ensuring the smooth operation.

Data Centers are divided into several types:

- Large Data Centers have their own building which is designed and built to provide the most convenient conditions of placement (4.3 level of reliability according toTIA-942 standard).
- Middle Data centers are located in a rented for a long-term room or building not originally adapted for the equipment placement and has to be remodeled for customers' needs (2.3 level of reliability according toTIA-942 standard).
- Small Data Centers are located in unsuitable building (1 level of reliability according toTIA-942 standard).

The modern requirements for data center reliability are regulated by the international standard TIA-942 for data centers infrastructure. Different levels of reliability contribute to the centers' constant readiness factor which should not be less than 99.671%. A data center should consistently work 24 hours a day, 365 days a year, disregarding weather conditions. A data center's temperature of the walls may undergo any changes, but the inside temperature indicators should

remain constant. These factors form a prerequisite that enables stable operation equipment.

4. Consolidation is the first step to the “cloud”. One of the characteristics that describes cloud computing is a general infrastructure. In order to start to use “cloud” technology the companies first of all have to solve the problem of their non-consolidated IT infrastructure. It is clear that without consolidation it is impossible to build an effective process-oriented management.

Consolidation is the process of bundling computing resources or management structures into a single center (Fig. 10.4).

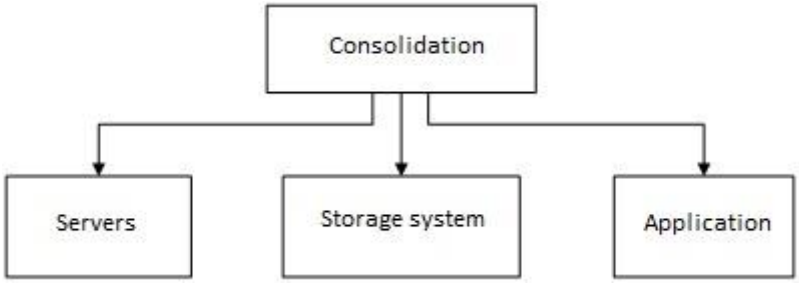

Figure 10.4 - Different types of consolidation

According to information presented in Figure 10.4 consolidation is divided into the following types:

- Server consolidation – moving decentralized applications distributed on different servers of the company into one centralized cluster of homogeneous servers;
- Storage system consolidation – sharing of centralized storage multiple heterogeneous hosts;
- Application consolidation – placing of multiple applications on a single host.

In this case there are two basic types of consolidation: physical and logical. Physical consolidation involves geographical relocation of servers on a single platform (data center) whereas logical type is more about centralized management. Placing computers into a single data center allows to provide equipment and technical personnel with a comfortable environment, as well as to increase the level of physical protection of servers. A good example of equipment that can successfully meet the challenges of computing resources consolidation in organizations of any level is blade systems as well as systems and storage area networks.

Logical consolidation involves the restructuring of IT infrastructure management system. This is necessary both to increase the scalability and manageability of the complex distributed computing system and to integrate the corporate network segments. Logical consolidation involves centralized management and administration approach to the unification of work with the company's resources on the basis of open standards. As a result, it is possible to

create global information services of an enterprise, the LDAP directory, a corporate portal or an ERP-syste which will ultimately improve the manageability of an enterprise due to current and complete information about its functioning.

10.3 Virtualization Technology

There are many characteristics that describe cloud computing but the major is common infrastructure. The use of virtualization technology allows companies to restructure physical environment involving less computing resources and server components thereby making the solution more flexible.

The process of virtualization is based on the possibility of one computer to do task of multiple computers by distributing its resources across multiple environments. Moreover, virtualization makes possible to host multiple operating systems using virtual servers, virtual desktops and multiple applications at a single location. Virtualization means running multiple/virtual computers on one physical computer (Fig. 10.5).

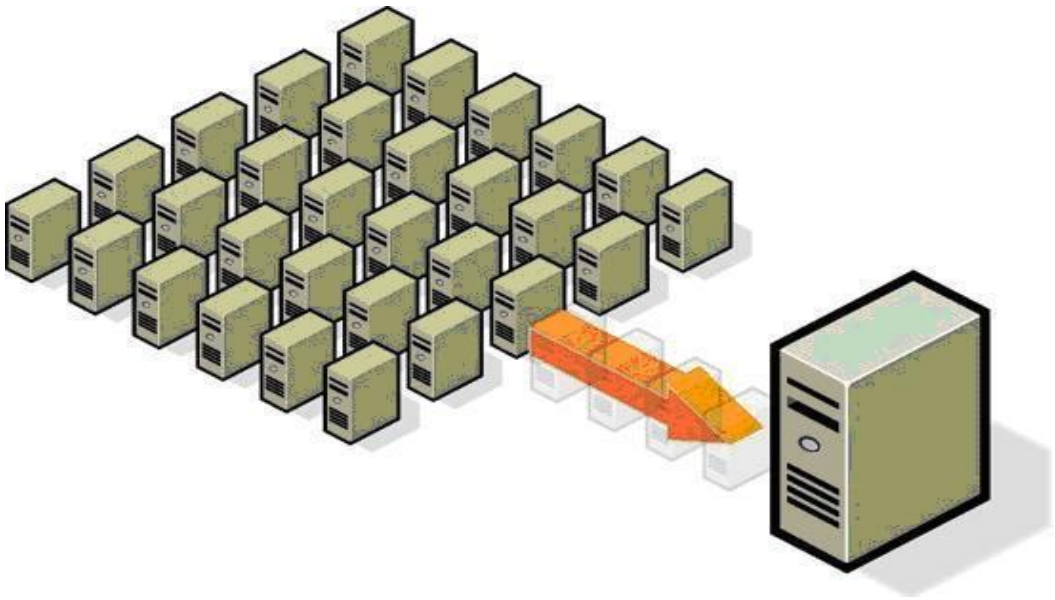

Figure 10.5 - Virtualization means running multiple virtual computers on one physical computer

In addition to energy efficiency and reduction of costs through more efficient use of hardware resources, virtual infrastructure provides a high level of resource availability, more efficient management system, increased security and improved recovery system in critical situations. Virtualization is also designed to differentiate software from hardware. In computer technology the term “virtualization” generally refers to the abstraction of computer resources by providing the user with a system that “encapsulates” (conceals) own implementation.

Today, vendors of virtualization technology offer a reliable and manageable platform. Virtualization technology is a key component (including marketing) of the latest and future Intel and AMD processors, operating systems from Microsoft and other companies.

Virtual Machine is a fully isolated software container that works with its own operating system and applications like a physical computer. The virtual machine acts just like a physical computer and contains its own virtual (i.e., software) RAM, hard drive and network adapter.

The main features of virtual machines are:

- Compatibility. Virtual computers are generally compatible with all standard computers. Like a physical computer, the virtual computer runs its own guest operating system and performs its own applications.
- Isolation. Virtual machines can share physical resources of a single computer and still remain completely isolated from each other, as if they are separate physical computers. Isolation is an important cause of much higher availability and security of applications running in a virtual environment compared to the applications running in a standard, non-virtualized system.
- Encapsulation. Virtual computers fully encapsulate computing environment. A virtual computer is a software container that binds or "encapsulates" a complete set of virtual hardware resources, as well as the operating system and all its applications in a software package. Through encapsulation virtual computers are incredibly portable and easy to manage.
- Hardware independence. Virtual computers are completely independent from the underlying physical hardware on which they work, as they can use different operating systems (Windows, Linux, etc.) at the same physical server. In combination with the properties of encapsulation and compatibility, hardware independence provides freedom to move virtual computers from one computer to another without changing device drivers, operating system or applications. Hardware independence also gives the ability to run in conjunction with totally different operating systems and applications on a single physical computer.

The main varieties of virtualization are:

- server virtualization (paravirtualization and full virtualization);
- virtualization at the level of operating systems;
- application virtualization;
- presentation virtualization.

Server virtualization is becoming the most popular solution in the IT market. Server virtualization means running multiple virtual servers on a single physical server. Virtual computers are servers or applications running on the host operating system that emulates the physical server device. Operating system can be

installed on each virtual computer. Typical representatives of such type are VmWare (ESX, Server, Workstation) and Microsoft (Hyper-V, Virtual Server, Virtual PC) products (Fig. 10.6).

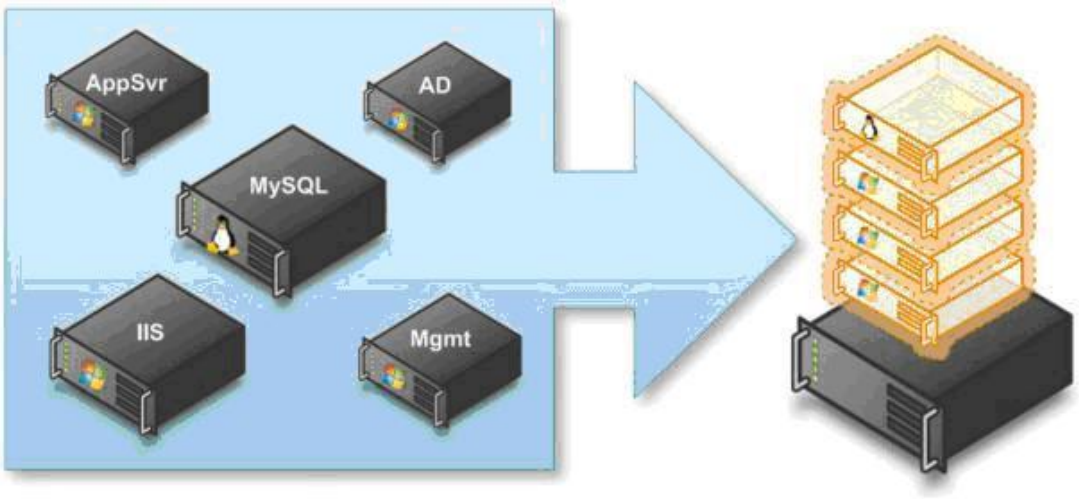

Figure 10.6 - Server Virtualization

Hardware support for virtualization technology was installed for the first time on the latest generation processor architecture x86 AMD and Intel. Before that, only virtualization support software had been used laying the path for a greater performance overhead. Virtualization for server infrastructure was applied a little later, and this was associated primarily with the tasks of computing resource consolidation.

There are two basic methods of server virtualization: full virtualization and paravirtualization. In full virtualization (full, native virtualization) unmodified copies of the guest operating systems are used. To make this system work a normal operating system is put on the top of the host OS. This technology is used in particular in VMware Workstation, VMware Server (formerly GSX Server), Parallels Desktop, Parallels Server, MS Virtual PC, MS Virtual Server, and Virtual Iron. The advantages of this approach are relative ease of implementation, flexibility and reliability of the solution while all control functions are assumed by the host OS.

In paravirtualization modification of guest OS kernel is performed in such a way that it is included in the new set of API through which it can work directly with the hardware without conflicting with other virtual computers. There is no need to use a full-fledged operating system as host software which function in this case takes a special system called a hypervisor.

Virtualization at the level of OS kernel (operating system-level virtualization) involves the use of the host OS kernel for the creation of independent concurrent operating system environments. For the guest software it is its own network and hardware environment. This option is used in Virtuozzo (for Linux and Windows),

OpenVZ (free version of Virtuozzo) and Solaris Containers. The advantages of virtualization at the level of OS kernel are high efficiency of hardware resources, low overhead technical expenses, excellent handling, minimizing costs of licenses, while shortcomings are the implementation of homogeneous computing environment (Fig. 10.7).

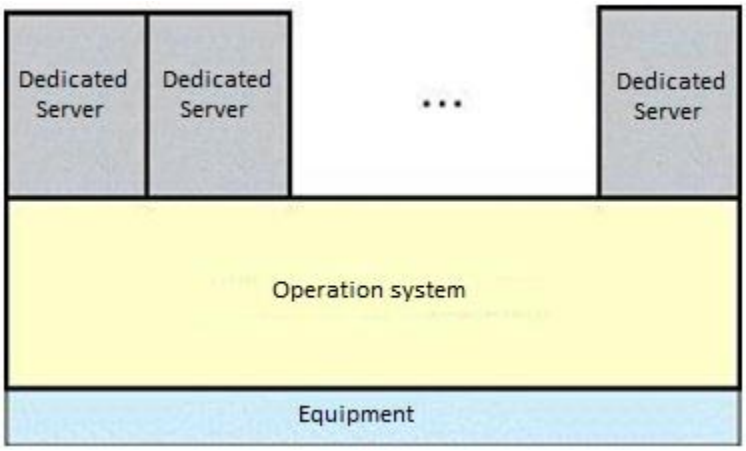

Figure 10.7 - OS-level virtualization

The virtualization of application involves the use of a model in which each virtualized instance of the application is used: files (including system), registers, fonts, INI-files, service of COM-objects. This application works independently without making any changes to the operating system being executed without installation of procedures in the traditional sense and can be run directly from the removable media (such as flash memory cards or network folders). This technology can be used on one computer in the same operating system running several incompatible applications at the same time (Fig. 10.8).

Figure 10.8 - Virtualization of Application

In fact, virtualization is an option used in Sun Java Virtual Machine, Microsoft Application Virtualization (formerly known Softgrid), Thinstall, and Symantec/Altiris.

The way of virtualization is understood as emulation of a user's interface, i.e. a user sees the application and works with it on his/her device, although in fact the application runs on a remote server transmitting a picture of the remote application. Depending on the mode the user can view the remote desktop and application running on it or only the application window itself (Fig. 10.9).

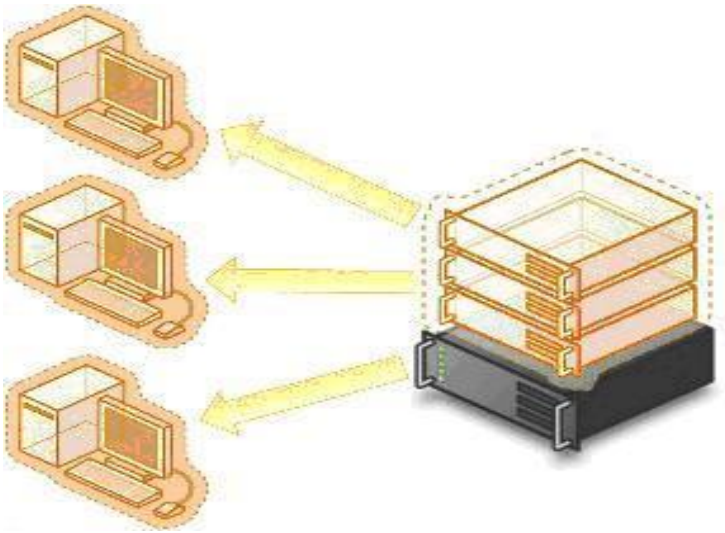

Figure 10.9 – The way of virtualization

Business needs are changing our understanding of the workflow. Real user tool is software that is tied to a PC and makes it an intermediary for the corporate information system. As a result, cloud computing is developing successfully, where users have an access to their own data, but do not run and think about the infrastructure, operating system and proprietary software with which they work.

10.4 Fundamentals of cloud computing

One of the key ideas of cloud computing is to give customers flexibility to move data between own and rented IT infrastructure. Currently, cloud infrastructure is mainly deployed on servers and data centers where using virtualization technology actually allows any customer to use the computing power absolutely without thinking about technological aspects. Thus, a "cloud" is understood as a single point of access to the calculations of the user.

Cloud computing includes cloud service and deployment models for cloud systems (Fig. 10.10).

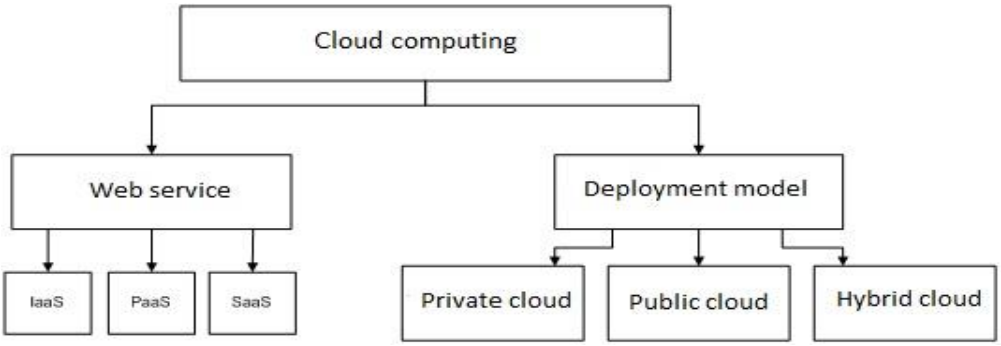

Figure 10.10 Deployment models and cloud Web services

Cloud computing represents a system of software and hardware services available to users via the Internet or a local area network in a user-friendly interface for remote access to selected resources (Fig. 10.11)

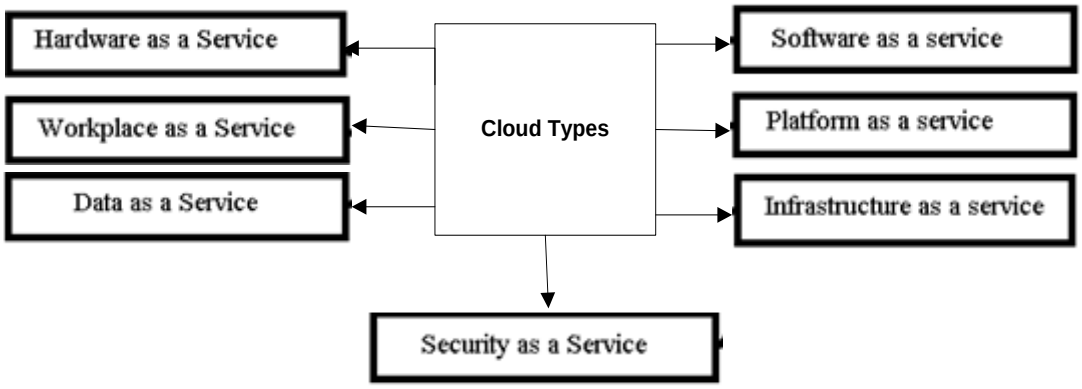

Figure 10.11 Cloud computing services

According to Figure 10.11 cloud computing offers the following web services:

- Infrastructure as a service (IaaS);
- Platform as a service (Paas);
- Software as a service (SaaS);
- Hardware as a Service (HaaS);
- Workplace as a Service (WaaS);
- Data as a Service (DaaS);
- Security as a Service (SECaaS).

Infrastructure as a service (IaaS) is a rent service of virtual servers, which is a cost-effective way to provide modern and efficient enterprise computing resources. Available in data centers cloud IaaS solutions provide customers with the development and maintenance, rapid expansion or reduction of the required IT-systems in accordance with the needs of the enterprise without investing in the development and maintenance of the server system.

IaaS providers supply the components of the following levels:

- virtualization platform for running virtual machines;
- hardware (usually grid with a massive horizontal scalability);
- computer network (including routers, firewalls, load balancing, etc.);

Instead of buying space, servers, software, network equipment, etc. in data centers IaaS customers essentially rent the resources of the IaaS service providers. Users generally pay only for the resources consumed. The advantages of this type of services include:

- free access to pre-configured environment;
- use of the latest generation infrastructure;
- protected and isolated computing platforms;
- reduced risk through the use of third-party resources supported by third parties;
- ability to manage peak loads;
- less time, cost and complexity by adding or extending functionality.

IaaS is a server infrastructure located in a special secure data center available for a monthly subscription model and is serviced by professionals.

Modern virtualization technology infrastructure (IaaS) allows users to implement all the functionality on one platform applicable for the necessary IT infrastructure outsourcing business units. The first company which used YaaS was Amazon company which today offers two main IaaS-products: EC2 (Elastic Compute Cloud) and S3 (Simple Storage Service). EC2 is a Xen-hosting with VPS-static properties that do not expand on the fly (although many of these services are already providing so-called auto scaling). Storage S3 has a WebDAV interface and supports many existing programming languages.

For instance, Go Grid company is among other infra-service companies that have a very user-friendly interface for VPS management and offer cloud storage with support for SCP protocols, FTP, SAMBA/CIFS, RSYNC where the storage size is scaled on the fly. In the near future the developers promise to add control via API.

Enomaly company provides a solution for deploying and managing virtual applications in the cloud while the services are managed through a browser. A good addition to this approach is the automatic scaling of the virtual computers under the current load and load-balancing. Virtual architectures have already been supported by Linux, Windows, Solaris and BSD Guests. Virtualization is used not only by Xen, KVM, and VMware. Eucalyptus is also a program open for the implementation of cloud computing on cluster systems. Today, its interface is compatible with Amazon EC2.

The consolidation and virtualization of IT infrastructure are the two key trends that have predetermined the emergence of cloud computing concept. The third key component or the third whale in cloud computing is the concept of Software as a Service (SaaS).

Software as a Service (SaaS) is a service or business model of selling and usage of software in which the supplier is developing a web application allowing customers to access the software via the Internet.

The main advantage of the SaaS model for customer service is the absence of costs associated with installing, upgrading and technical support when working on this software. SaaS applications could be derived from the SaaS-provider's server directly, and users can access them through a web browser.

SaaS cloud applications are available in the following types: BusinessApps, OfficeWebApps, ManagementApps, Communications, Security, etc. The most popular cloud applications are: CRM (customer relationship management system), HRM (System for Human Resources, i.e. personnel), ERP (such as 1C), office applications, communications, etc.

Platform as a Service (PaaS) is used to provide an integrated platform for development, testing, deployment and support of web-based applications as a service organized on the basis of cloud computing concept. The development of cloud computing has led to the emergence of platforms that allow users to create and run web applications. In this model all information technology infrastructure including computer networks, servers, storage systems is completely managed by the provider. The provider defines the set of available consumer types of platforms and sets control parameters for consumers to create their virtual copies to install, develop, test, and operate on their application software with the dynamically changing amount of computing resources consumed.

Platform as a Service (PaaS) provides users with programming languages, application development environments, libraries, services and tools, with which end users develop and deploy the application. Figure 10.12 illustrates services provided by the PaaS service.

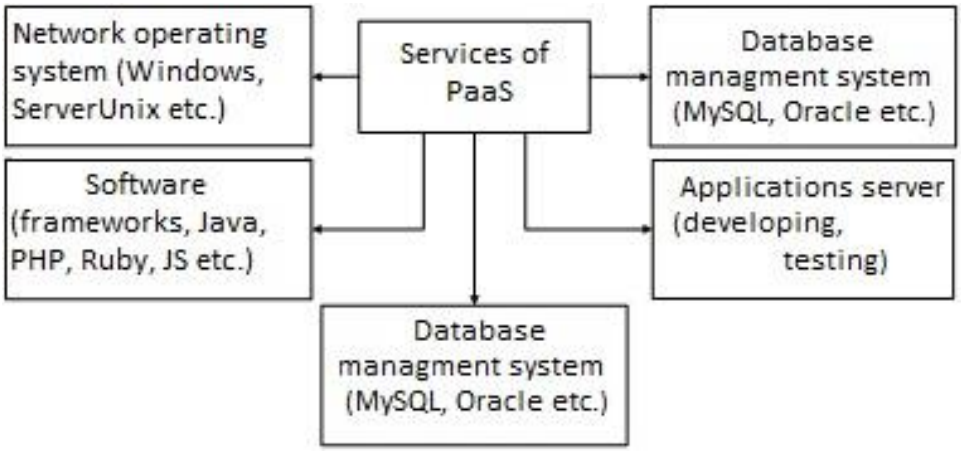

Figure 10.12 - Services provided by PaaS service

PaaS service provides a software platform and offers the following services as a service of:

- OS - network operating system (Unix-systems, including Ubuntu Server, BSD/OS Family, Solaris/SunOS, etc. or Windows Server)

- Database - database management system DBMS (MySQL, Microsoft SQL, SQL Database, Postgre SQL, Oracle, and others.); Middleware - the software middle layer or connecting (intermediate) software which is designed to ensure interoperability between different applications, systems and components.
- Software development tools and testing - software tools for web application development and testing (software development environment: policy frameworks, libraries, etc. for creating web applications in programming languages: Python, Java, PHP, Ruby, JS for Node.js, etc.).
- App server - application server for developing, testing, and debugging of Web applications.

Similar services are provided by a large number of companies such as Microsoft, Amazon.com, and Google. Platform as a service is based on the License Logging model or subscription model, so users pay only for what they use. PaaS includes workflows for creating applications, application development, testing, deployment and placement, as well as application services, virtual offices, database integration, security, scalability, storage, wealth management, dashboards tools, etc.

Platform Microsoft Windows Azure is a group of cloud technologies that provides a specific set of services to application developers. Windows Azure platform consists of the following components:

- Windows Azure provides environment based on Windows to run applications and store data on servers in Microsoft data centers.
- SQL Azure provides data services in the cloud based on SQL Server.
- NET Services provide a distributed infrastructure for the cloud and local applications.

Computer Service Windows Azure works on the Windows base. In addition to the applications developed on the platform of "NET Framework" Windows Azure also allows developers to run applications on the Windows languages: C #, Visual Basic, C ++ and others - using Visual Studio or other development tools.

10.5 Models of Cloud Computing Deployment

In addition to various ways of providing cloud services, there are several models of deployment of cloud-based systems to provide cloud resources:

- Private cloud;
- Public cloud;
- Mixed (hybrid) cloud.

Depending on the type of a cloud models can own and manage a service provider and the user or both (Fig. 10.13). In this case the rights of an access to resources may also vary.

- Public cloud – an access to resources is performed by any user with a subscription, from any location, with the Internet access.

- Private cloud - resources are only available to a limited number of users (e.g. employees of a company).
- Public cloud - resources are available to multiple organizations with similar needs in terms of information resources.
- Hybrid cloud – a cloud consisting of two or more different types of a cloud, for example, public and private.

End home users or small businesses mainly use public clouds.

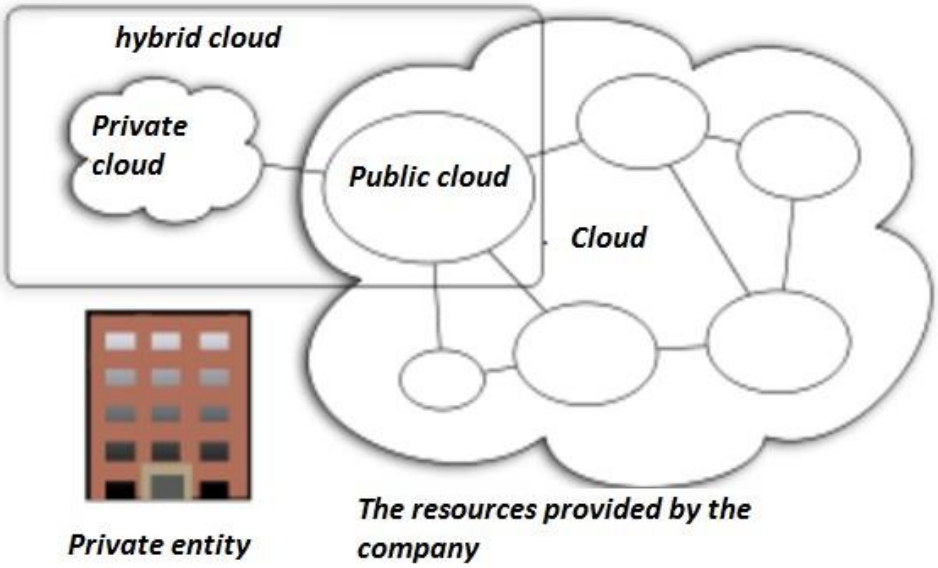

Figure 10.13 - Types of cloud resources

Private cloud infrastructure is intended for the use by a single organization. Private cloud covers the needs of the company's IT services, its subsidiaries or departments, and/or customers, contractors and others. Private cloud is usually owned, managed and operated by an organization-holder (Fig. 10.14). Private cloud has the flexibility to reallocate available computing power and load data in a shared infrastructure according to the needs to ensure optimal performance and reliability required.

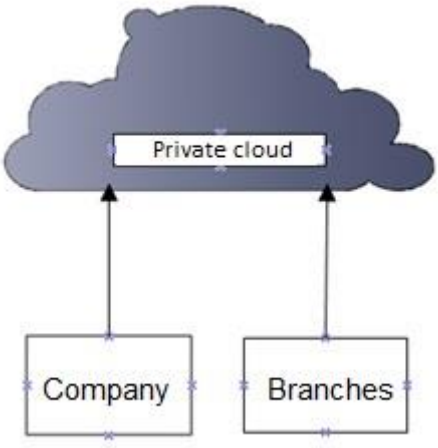

Figure 10.14 - Private Cloud

Monitoring and management tools allow IT professionals to track the use of hardware resources within the organization to predict and optimize the load. Private clouds are a viable option when:

- The entire business is built on the applications and data, the level of data protection requirements is critically high.
- A business belongs to one of the sectors such as military industry or public sector where security and privacy requirements are historically very high.
- The company is large enough to create its own modern data center and be profitable.

A public cloud is an infrastructure for a free use by the public. A public cloud may be in the ownership, management and operation of commercial, academic and government organizations (or any combination thereof). A public cloud physically exists in the jurisdiction of an owner who is a service provider. A public cloud is a viable option when:

- standardized application is used by more people (e.g. e-mail);
- a user has to test the code or application;
- the usage of SaaS-app from a trusted provider has outlined strategies in the field of security;
- the user needs to back up his/her own infrastructure opportunities in a situation of peak loads;
- cloud services are necessar to work together.

A hybrid cloud is a combination of two or more different cloud infrastructures (private, public) that are unique objects but they are interrelated (e.g., short-term use of resources for balancing load between the clouds) (Figure 10.15)

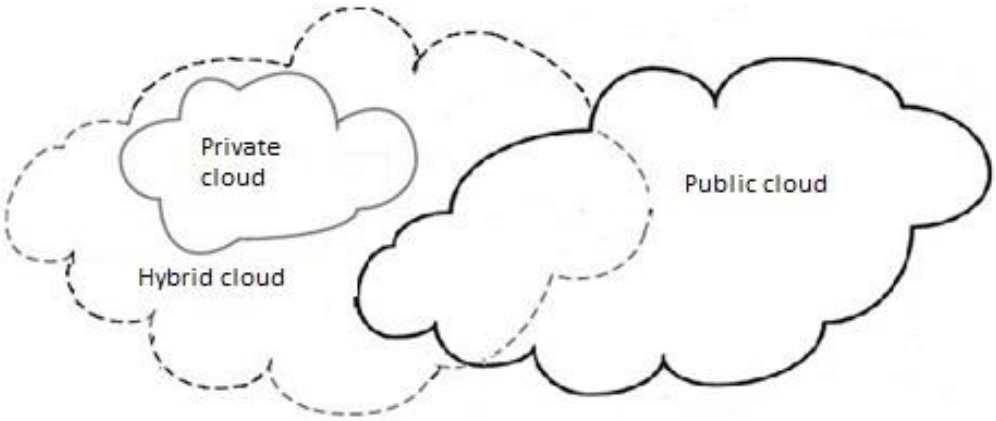

Figure 10.15 - The structure of the hybrid cloud

The basic idea of a hybrid cloud is to take advantage of using external resources without revealing the data that remains inside the company's structure. As a result, the number of resources is increased and internal control applications using those resources are greatly enhanced. Currently, most cloud infrastructure is

deployed on servers and data centers using virtualization technology that actually allows any user of the application to use the computing power absolutely without thinking about the technological aspects.

All three types of cloud services are interrelated forming a nested structure.

10.6 Overview of Companies Providing Services in the Cloud Computing

Google, Microsoft, and Amazon.com are the main players on the market of cloud computing with their key services such as Azure Services Platform, Google Apps Engine, and Amazon Web Services. In its turn, Microsoft uses its own product called Windows Azure to provide cloud-based services.

Windows Azure is an open and flexible cloud platform that allows users to create, deploy and manage applications quickly in a global network of data centers under the control of Microsoft. Applications can be developed using any language or platform instrument. Furthermore, applications in public cloud can be integrated with existing IT-environment. This definition means that Windows Azure is a cloud-based platform which allows its users to work with business applications, services, and tasks in the cloud.

Windows Azure cloud services provide companies with four basic types:

- computing services;
- network services;
- data processing services;
- application services.

Windows Azure computing service arranges computing resources on which cloud applications run. The current version of the Windows Azure supports four computing services:

- Virtual computers provide universal computing environment in which users can create, deploy and manage virtual computers to Windows Azure cloud.
- Web sites provide a managed cloud-based web environment where it is possible to create new web sites and transfer existing ones.
- Cloud service allows users to create and deploy a nearly unlimited scalable application of high availability in virtually programming in any language and with minimal administration costs.
- Mobile service is ready to use solution for creating and deploying applications and storage for mobile devices.

Amazon Web Services offer the following services of cloud infrastructure:

- Amazon Elastic Cloud Compute (Amazon EC2)
- Amazon Simple Storage Service (Amazon S3)
- Amazon Simple Queue Service (Amazon SQS)
- Amazon CloudFront
- Amazon SimpleDB

- Amazon EC2 serves as the Amazon's cloud "heart". This service provides API web-services for the separation of virtual servers, managing and releasing once they are no longer needed with the return of the liberated resources in the Amazon cloud. In other words, any application running in the Internet can be run on the virtual server on Amazon Cloud with a single call to the Amazon Web-services.
- AmazonS3 is a cloud data store accessible in real time through API web-service from the Internet. Using the API users can store any number of objects the size of which varies from 1 byte to 5 GB of more or less flat namespace.
- AmazonSQS is the cornerstone of all projects in the Amazon region data grid processing. In case of a service message queue Amazons KS receives messages and transmits them to the servers signing the message queue.

As a rule, the messaging system allows multiple computers to share information without knowing each other. A sender simply sends a short message (in Amazon SQS its length does not exceed 8 KB) to the message queue. A recipient receives the message from the queue and operates with its content. Amazon Cloud Front is a cloud of content distribution network (CDN) which is a new offering from Amazon Web Services. This service allows the users to distribute the content (e-content) on the edge of the network taking into account the fact that the information will be delivered from a point close to the location of the user who is requesting it.

Amazon Simple DB is a combination of structured data storage with higher resiliency than the typical instances of the Oracle MySQLili and very modest basic needs in a relational repository. This is a very powerful service that provides an access to relational data regardless of the degree of complexity of the relational model or transaction management. For the provision of cloud services Google us its products Google Apps.

Google Apps form the environment which offers popular collaboration tools such as: mail service GMail, client of sharing instant messaging Google Talk (in fact, the service is completely suitable for communication with any jabber-user), Google Calendar, Google Docs & spreadsheets, i.e. tools for working with documents and spreadsheets, "a central page" a place for comfortable placement of the information that will be shared by all users as well as a page editor from Google which allows the users to create and publish relevant information quickly.

Google App Engine guarantees the performance of web applications on Google's infrastructure. App Engine applications are easy to create, maintain and improve without an increase in traffic and data storage. The application can be made available for all or allow an access only to the participants of your team.

Google App Engine supports apps written in several programming languages. Due to the runtime Java App Engine users can create applications using standard Java technologies. In addition, App Engine provides a special Python runtime environment which includes a fast interpreter and the Python standard library. Java

and Python are specifically designed to allow applications to be performed quickly and safely without interaction with other applications in the system.

10.7 The History of the Development of Cloud Technologies in different Countries

The first possibilities of the cloud computing were appreciated by the American companies. In February 2011 Vivek Kundra (VivekKundra), CEO of the US Federal Department for IT technologies, issued a strategy for the transfer of the information systems in the cloud. The document entitled "Federal Cloud Computing Strategy" clearly describes the procedure and terms of the transfer of the systems in the cloud. Its goal was to reduce the complexity in IT technology management, increase the utilization of equipment up to 70-80%, reduce the number of data centers which is now more than 800.

The most prosperous country for the “cloud” was Japan. Today, there is the most favorable technological and legal framework for the effective implementation and development of cloud technologies in this country. Panasonic Corporation of Japan is expanding its range of “smart” household appliances and launching a new cloud service in Japan that allows controlling remotely a wide range of home appliances starting from refrigerators and air conditioners and finishing with kitchen appliances and appliances for beauty and health. Panasonic Smart App allows the owners of smartphones on Android OS to control remotely the compatible appliances setting various programs for devices and tracking energy savings, the number of calories consumed and energy expended to perform certain tasks.

The experience of the Korean government on the use of “cloud” computing technology was marked as a great example in the UN report. The paper reported that the effective management of public information resources had reduced budgetary costs and had increased energy efficiency as well as the possibility of countering cyber attacks. Two illustrative cases highlighted in the report included the huge budget cuts and increased system responses to cyber threats. The report described the Korean government as a “high-end sample of network interoperability and management of information data center”.

There is a vivid example of virtualization in Russia: a project of the mobile operator MTS and VMware. As the international experience shows at the initial stage of the market development of cloud IT-services the SaaS model dominates as the market share of the growing segments of the inferior IaaS and PaaS is rising. According to the IDC analysts the Russian market of cloud resources is in the middle stage of its development and the growing interest in cloud-based delivery model of IT-services is noticeable.

Kazakhstan launched its cloud projects in 2011. “KT Cloud Lab”, owned subsidiary of JSC “Kazakhtelecom”, became the curator of the “cloud” projects. A representative office of the company “NEC Neva Communications Systems” was

opened in Almaty. The representatives of the company expressed their willingness to meet the needs of small and mid-sized businesses in the IT solutions in the field of cloud computing. The IT company NEC has been working in Kazakhstan since 2006. The main customer of the company is “Kazakhtelecom”. The NEC services are also used by the other representatives of the IT market in Kazakhstan, for example, by “KazTransCom”. Such companies as LLP “Akademset”, LLP “ST Integrator Company”, ARTA Company ™, LLP “KT-Cloud-Lab”, the representatives of Cisco, Microsoft and many others are successfully being developed in the sphere of cloud technology. Due to the demand for the virtualization in business investigation “Study of the demand for information and communication services in the corporate business segment” was conducted. According to its results, VirtualDataCenter service is attractive for 13% of companies in Almaty, 4% of companies in Astana, 1% of companies in Karaganda and 5% of companies in Ust-Kamenogorsk which totally constitute 353 medium and large enterprises. Some local companies have gone further and have already built data centers for the commercial exploitation, and soon they will start work. The Kazakhtelecom project “Private Cloud” organized on the basis of data centers for corporate clients can serve as an example. It can be assumed that the development of smart technologies using clouds in Kazakhstan is moving at a good pace. For example, Kazakhstan Institute for Problems of Informatics and Control Systems has developed an intelligent computer of 3D vision-based technology. It is designed to create artificial images that mimic human behavior. There is a development center of low-average power data for the banking sector and for small-medium businesses in Kazakhstan. It is located in Pavlodar with 300 server cabinets. Though it is inferior to foreign analogs, it is still the largest in Kazakhstan.

10.8 Mobile technologies

10.8.1 Generations of mobile technologies

Speaking about mobile technologies, generally all kinds of gadgets, applications, processors, displays, batteries are involved. It is difficult to assess the impact of mobile technology in our daily lives. They penetrated into all spheres of our life, and their role is growing. The availability of all kinds of smart phones, tablets, e-readers, smart watches and glasses contributes to their rapid spread around the world and all the billions of mobile devices have a major impact on quality of our life. In a short period of time the development of the first mobile phones has undergone significant changes. The first mobile systems were based on the principle of analog communication systems. The first cell phones were used only as an alternative to the usual analog terminals. The first "handsets" steel cordless phones are so-called the first generation of 1G cellular. 1991 is the birth of generation of 2G cellular communication. 3G standard was developed and began to be implemented in 2000, and by 2008 4G format had been developed.

The history of the development of wireless mobile technology began since the introduction of several innovative network technologies in the 1980s: AMPS in the United States and the combination of TACS and NMT in Europe. Although several generations of mobile services existed before, AMPS triple, TACS and NMT are considered the first generation - «1G», because these technologies have allowed mobile phones to become a mass product.

In the generation of mobile technologies the letter «G» means the generation, 1G - analog cellular, 2G -DIGITAL cellular communications, digital 3G- widely way cellular communications, switched multi-purpose computer networks, including the Internet), 4G - wireless high-speed data network of new generation.

Generation of 1G mobile technologies provided by NMT. *NMT - Nordic Mobile Telephony NMT (Nordic Mobile Telephony)* – is the first fully-automatic cellular standard in the history. Its specification began in 1970 by Nordic telecommunication administration committees, which included Sweden, Norway, Denmark, Finland and some other European countries. In 1981 the first network NMT standard was introduced. NMT is an analog network. NMT specifications were free and open providing a large number of companies able to produce equipment for the NMT network standard and promote it in the mobile market. The success and widespread of NMT largely have been achieved thanks to the Nokia and Ericsson.

NMT standard provides only a basic service to subscribers - telephony. In consequence the opportunity to use low-speed user data is appeared. The main drawback of the NMT is the lack of encryption of data transferred over the network. Therefore, anyone who has a simple frequency scanner can easily listen to the transmitted data over the air interface. In addition, it requires considerable technical resources and the process of connecting with the networks of other operators (especially other standards) for the organization of roaming in the NMT network often ran into great difficulty.

«2G» generation. The most famous is a 2G standard *GSM (Global System for Mobile Communications*). About 80% of cellular networks around the world are built by this standard. It refers to the second generation networks («2G» Generation). GSM standard differs from its predecessors by the best transmission quality, signal protection including additional services and data transmission at a low speed. Mobile GSM technology provides the user with roaming services for ease of movement across countries and continents without changing a subscriber besides the cellular operator. Depending on the number of frequency bands and the variation depending on the region single-band phones are divided into classes: dual-band (Dual Band), tri-band (Tri Band), Quad (Quad Band). GSM is the most common communication standard. According to the GSM Association (GSMA) 82% of the global mobile market, 29% of the world population use the GSM technology global. The GSMA is currently composed of operators in more than 210 countries and territories.

GSM provides support for the following services:

- Data Services (synchronous and asynchronous communication including packet data transmission - GPRS). These services do not guarantee the compatibility of terminal devices and provide only the transfer of information to and from them.
- Transmission of voice information.
- Short Message Service (SMS).
- Sending Faxes.

Almost immediately after the development of second-generation mobile systems, it was necessary to design the next generation of mobile communication standards. The studies were conducted both at the global and regional levels. The new frequency range is selected within the boundaries of 2 GHz, and therefore often designated as the 2000.

There were various projects transitions to the third generation - 3G. The primary task of the third generation network was to improve the quality of the second-generation networks adding a variety of new services. The third-generation technology (*3G - wideband digital cellular*) provides high-quality sound transmission (speech), images, multimedia content; the transmission rate has been increased from 9.6 kbit / s to 2 Mbit / s. In addition, 3G meant Internet access and data exchange between the PC and mobile phone. CDMA2000 standard is the third generation of cellular standards (3G). It is also known as IMT-CDMA Multi-Carrier or IS-2000. The main purpose of CDMA2000 was to increase bandwidth and maximum allowed data rates compared to the prior CDMA One standard.

The third generation of mobile technology includes:

- *IP-telephony;*
- *voice calls;*
- *video telephony;*
- *audio / video streams (video filming, photography, television);*
- *mobile office;*
- *Web browsing;*
- *services associated with the subscriber's location (navigation in an unfamiliar place), guides and maps, security);*
- *games;*
- *mobile e-commerce (search and selection of products, services, products payment).*

The third-generation standards enable to provide a wide range of multimedia services and support data rates up to 14Mbit / sec. This is consistent with the needs of customers today. However, the volume of information transmitted in telecommunication networks is increasing every day. To meet the needs of users for data transfer rates and range of services for at least the next 20 years a new standard for the *fourth generation* is necessary.

The development of the first standard for *the fourth generation 4G - LTE (Long Term Evolution)* began in 2004 by 3GPP. The main requirements applied in the process of work on the standard were the following:

- Data transfer rate higher than 100 Mbit / sec.
- High level of system security
- High energy efficiency
- Low latency in the system
- Compatibility with the standards of the second and third generations.

At the end of 2009 in Sweden, the first LTE standard network was put into commercial operation. LTE networks support data rates up to 326, 4 MBit / s. For example, downloading a movie in a good quality takes less than one minute. Thus, the upper limit on the data transfer rate is almost removed.

10.8.2 Software for Mobile

Modern mobile phones are becoming more and more like a full-fledged computer. The smartphone is mobile installed version of the best-known operating systems. Many companies produce not only additional software, but also the special operating system that complements that.

Software for mobile is software designed to be installed on the mobile phone, smart phone, to expand and complement its functionality.

Any device without software is a meaningless piece of iron. Software connects wires and chips in a single well-functioning system. For the proper functioning of such system the operating system is provided. In fact, it allows the user to communicate with each other. With the help of the user operating system additional software can be installed, the work of additional devices can be monitored and so on.

The basic software for mobile:

- *OS;*
- *office programs;*
- *anti-virus software;*
- *graphic editor;*
- *games in Java and so on.*

Mobile operating system is a system that allows the All-phone to do a full PC. Operating systems are installed on smartphones and communicators to ensure quality of work. In recent years, the mobile market has been flooded with software solutions running on Windows, Android and Bada. Choice of a mobile phone depends on the operating system installed on it.

The main operating systems for mobile phones are:

- **Android** - mobile OS developed on the Linux kernel by Android Inc., which is currently absorbed by Google.
- **Bada** — platform developed on Samsung Hand-Held Platform by Samsung. It should be noted that Bada is still not operating, but more open-platform.
- **Maemo** is based on Debian Linux. It is a platform for mobile devices, which is more commonly used in tablets and communicators Nokia. At the heart of

Maemo is Gnome components, including the graphics library gtk. Applications for Maemo are often free of charge.

- **Palm webOS** — exotic mobile operating system of Palm, which was created for the smartphone Pre and Pixi. Palm web OS platform is optimized for touch screen devices.
- **Apple iOS (iPhone OS)** is an operating system for mobile devices based on Apple's Mac OS X. It is installed on the iPhone, iPod Touch and iPad. Apple iOS is created on the Darwin kernel, which in its turn is based on the Mach microkernel.
- **Windows Mobile** is a mobile operating system running on a number of devices, which include Pocket PC, namely smartphones and communicators.

Office applications allow you to work with text, tables, facilitate record keeping, systematize data, provide a comfortable transfer of information, etc. Antivirus protects your device from malware. Graphic programs offer the opportunity to work with photos, create images and graphics regardless the level of complexity.

The most common mobile software is games, players and browsers. Recently, however, in addition to entertainment and special programs momentum began to gain office and graphics editors, which indicates the transition of business-oriented people in the world of mobility. Related to this, and the popularity of smartphones and communicators, in fact, constitute a personal digital assistant, the installation of additional software which can solve at least daily task manager.

Thus, the distribution of software for the mobile phone depends on the objective reasons rather than the consequence.

10.8.3 Flash for mobile

Many owners do not use cell phones for incoming and outgoing calls, as well as receiving SMS-messages. Due to the rapid growth of the mobile terminal, mobile phones have an increasing number of functions. Moreover, cellular devices are so popular on the market. They pushed the PC turning from the receiver-transmitter in a multi-media center.

Modern Terminals are called smartphones or communicators. Many phones have a camera, an opportunity to work with Internet devices if operating systems, applications for entertainment, flush for mobile are available. In addition to functionality, modern smartphones also have large color screens able to display the video in full spectrum correctly.

Due to the rapid growth of technology the requirements for filling a multimedia phone have also increased. The developers get the tasks to create a variety of applications. To requirements of almost all parameters to their respective compiles flash technology. It is known that users are browsing on a desktop computer using a flash player in SWF format.

A special flash player which allows you to use flash videos on various mobile devices has been developed for mobile devices. In the latest version of Flash for mobile an application that allows you to develop content for your mobile phone is provided.

Little funds for the development of mobile applications for cell phones are available now. Flash specially designed for mobile is useful not only for programmers and designer as well as for users who like to experiment and want to see the results of their creative research on the screens of their own mobile phones.

Features of mobile functions depend on the version of the program, as well as memory, CPU.

Let's consider some of the features:

- *View flash* – with this function it is possible not only to get, send flesh cards, but also to play videos, watch cartoons;
- *design the appearance of the phone* – in this case, it is necessary to use the flash screensavers, screen servers, menus, etc.
- *games in flash* which are gaining more and more popularity;
- mobile encyclopedias and dictionaries developed in flash.
- *Programs for training* on the basis of mobile devices;
- *Dynamic sited in flash* which allows you to implement a dymanic polling remote server. These features allow you to actively interact with the web services.

It is worth to remember that Flash for mobile devices is different and has its limitations, so clips for mobile devices should be tested very carefully.

Creating mobile games is a process not inferior to the complexity of the creation of the classic computer game. Creation of a mobile game takes place in several stages corresponding to the stages of the development of any other game.

In the game development programmers are involved connected by mutual obligations and divided into specific positions.

Creation of the game is a time-consuming process, which is complicated as the complexity of the tasks to be solved in a particular development. The number of employees who cooperate in the creation of games also depends on the complexity of the game.

10.8.4 Java applications for mobile

Java applications for mobile are, in fact, the only effective technology to expand the functionality of your phone. Depending on what class the phone belongs to, it has the basic functionality which sometimes needs to be expanded.

Desktop or notebook computer, of course, is better suited to the business and office tasks, but they are not always easy to use, and sometimes to work with them is almost impossible. Today each manufacturer of mobile phones complements the office software, the functionality of which is not always the idea of the perfect office.

A variety of companies design and sell Java applications for mobile. However, often there is a problem, which is caused by the application of standard and commonplace. The most interesting thing is that the programming environment for developers is open, accessible and a zone of free navigation, but not everyone has the Java language.

The most popular applications are Java games. Now Java games for mobile phones are presented in a variety of genres. Most of the games on a PC are copied to the phone, of course, with certain restrictions, but nevertheless they are not worse than the classical computer. Progress never stands. With the advent of phones equipped with faster processors and flash-memory in everyday life broke and 3D games. Shooters, racing simulators perfectly fit into mobile phones.

Java applications for mobile now have become an integral part of any mobile phone that supports these functions, and an entertainment function of a mobile phone is the most in demand of today's consumers.

10.8.5 Applications

Undoubtedly, new mobile applications are more expensive than the currently existing phones. Innovative 3G terminals also include many functions.

New mobile applications will be divided into several types. The simplest 3G phones will be used primarily for telephone calls saving all the information on the network. More complex models will be able to support video streams, providing the user with news and online content. Next difficulty will be information centers, which will allow you to download information from the internet and save it to the device. The most complex devices will be managed by a wireless keyboard, replacing the cutting-edge electronic organizers. Experts call all the possible new functions of the new 3G mobile applications, up to voice control, not to mention the transmission of streaming video at high speed.

The most used feature in all usual cell phone was and still is the possibility of sending SMS. Features of new generation of 3G phones are not limited to sending a text message longer than 160 characters. Sophisticated mobile applications allow users not only to write about favorite team goal, but also to send a postcard-picture, as well as an audio file, where the winning roar from the crowd will be recorded.

The latest 3G phones will be able to be controlled via the network, so mobile operators can provide their customers with a wider range of mobile applications. With the new terminal with its advanced features, the operator will be able to provide subscribers with an unlimited range of information: to find the nearest ATM or to get out the maze of streets.

According to experts, the mobile application can contain an unlimited variety of functions, up to those which seemed impossible recently. Thus, the development of 3G technology leads to evolution of e-commerce, as well as personal communication.

Review questions

1. What influenced the emergence of cloud computing concepts?
2. What are the main characteristics of cloud computing?
3. What trends in the development of infrastructure solutions have led to the concept of cloud computing?
4. List the stages of the development of cloud computing.
5. What is meant by virtualization?
6. What are the main varieties of virtualization?
7. What are the ways to provide services?
8. List the advantages of cloud computing.
9. What Web services does cloud computing provide?
10. What levels of components are provided by IaaS?
11. How many cloud deployment models do you know? List them.
12. Why is a private cloud used?
13. What are the four main types of cloud services provided by Windows Azure?
14. Describe the procedure and terms of the transfer of the system to the cloud.
15. What is the purpose of the Data Centers?
16. What is meant by mobile technology?
17. List generation mobile technologies and overview the history of the development of generations.
18. What services are provided by mobile technology of 3rd generation?
19. What functions can 3G mobile generation technology perform?
20. What is soft for mobile and the parts of soft?
21. What are the main OS of mobile phones of 3rd generation?
22. List the basic functionality of modern smartphones.
23. What application is used for the development of functionality of mobile phones and games?
24. What functions can flash for mobile perform?

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CHAPTER 11. MULTIMEDIA TECHNOLOGY

11.1 Key Multimedia Concepts

Development of multimedia technology is a promising and popular area of ICT. It is aimed at creating a product containing "a collection of images, texts and data accompanied by sound, video, animation and other visual effects including an interactive interface and other control mechanisms." This definition was formulated in 1988 by the largest European Commission dealing with the problems of implementation and use of new technologies.

Multimedia is a modern computer information technology which allows combining text, sound, video, graphics and animation in a computer system.

Today, multimedia are multiple information mediums: interfaces providing input/output information of various types into the computer, computer creation, processing and display of information of different levels and structures for the perception by various organs of human senses simultaneously.

Main media:

- Binary media including processor instructions, a binary code and data files;
- Contact media comprising tactile, strain gauge, electric contact, capacitive and other touch media serving to enter the mechanical code and a space-dependent information;
- Text media which are text data for people, software texts for interpreters, other textual information;
- Audio streams representing audio files, digital audio series, sets of musical audio and other types of digital audio;
- Graphical media which are drawing files, photos, and other two-dimensional graphic information;
- Video streams representing video and dynamic series of graphic information;
- Virtual reality which is an interactive 3D-video stream.

11.2 Multimedia Capabilities

The undoubted advantage and main peculiarity of multimedia technology in providing information are:

1) Navigation of information and access to the main menu (enlarged content), the full table of contents or exit out of the multimedia product in any place (on any tab) and on the basis of touch management.

2) Hypertext and hypermedia technologies are those that can select in the accompanying text, graphics or other visual material the so-called "hot words" (areas) that are subject to immediate transfer to another page (form) including visual information

3) Ability to work with various applications (text, image, sound and video editing, cartographic information, and mobile apps).

4) Ability to store large amounts of diverse information on one carrier (up to 1000 volumes of copyright text, about 40,000 high quality images, 10 hours of video, and 100 hours of sound);

5) Ability to process and analyze images by means of diverse software tools for research or cognitive purposes;

6) Interactive features of multimedia product. For example, a possibility to affect a further plot of the movie by means of SMS messages or multimedia simulator training depends on the current performance of the student and default settings.

7) Possibility of increasing (detailing) image or its most interesting fragments on the screen, sometimes fortyfold increase ("loop" mode) while maintaining the image quality. This is particularly important for working with cartographic information (geolocation) and images of the Earth from the space.

8) Possibility of ensuring continuous music or any other audio corresponding to a static or dynamic visual range, for example, for non-linear editing.

9) Possibility to use video clips from movies, videos, animations, presentations, and so on; a "freeze frame" function, frame by frame video "swipe".

10) Possibility to create one's own "gallery" (samples) from the information presented in the multimedia product ("pocket" or "my notes" modes) as well as "remembering the traversed path" and creating "bookmarks" on the screen "page" that one finds interesting.

11) Possibility to automatically view the entire contents of the product ("slide show") or create an animated and voiced product "guide" ("talking and showing the user instructions"); inclusion of game features with the information component to the product content.

11.3 Multimedia Classification

All multimedia can be divided into 2 types: *linear* and *nonlinear*. These two types differ from one another:

Linear type: a user who is viewing a document will not be able to influence its output (e.g., video).

Nonlinear type: a user, on the contrary, can participate in the process of displaying information (e.g. an interactive menu program or computer games).

There are several types of multimedia:

- multimedia presentations (held on the stage or via the Internet through the use of webinar service for online broadcasting and Power Point program, for example, to create a slide show);
- multimedia games (games in which a player can easily interact with the virtual game space);
- multimedia Internet resources (Internet resources that contain information presented through multimedia technology. For example, YouTube service enables

users to upload their own videos which will be available for viewing and downloading to other users of the service).

The main carriers of multimedia technologies are CD-ROM (an optical disk which is designed for computer systems), CD-I (Universal CD format designed for video play stations), Blue-Ray drive (a modern drive for reading Blue-Ray-disks which provide the highest image quality).

11.4 Computer Graphics

11.4.1 Definition of Computer Graphics

Computer graphics is an area of the computer science which deals with preparation of various images (paintings, drawings, animations) on the computer.

Working with computer graphics is one of the most popular ways of using a personal computer; moreover, not only professional artists and designers are engaged in this work. In any company from time to time there is a need to supply advertisements in newspapers and magazines or to produce promotional leaflets or booklets. Sometimes, companies refer to special design bureaus or advertising agencies but they often do it themselves using available software.

No computer program can work without computer graphics. Work on graphics takes up to 90% of time of the programming teams that produce mass application programs.

The main efforts in the work of editors and publishers also include art and design works with graphics programs.

The need for extensive use of graphics software has become especially noticeable in connection with the development of the Internet, and above all, owing to the service of the World Wide Web that linked millions of "home pages" in a single "web". The page that is designed without computer graphics has a little chance to attract wide attention.

11.4.2 Types of Computer Graphics

Computer graphics is divided into vector, raster, 3D-graphics and fractal graphics.

Vector Graphics is intended to create decoration and drawings, and to a lesser extent, for their processing. In the vector graphics the main point is the form of the object. Design possibilities based on the use of fonts and simple geometric forms (lines) by means of vector graphics are much less. The quality of vector images when magnified is not changed. Vector graphics is widely used, for example, in mapping where it is required to enlarge individual parts by many times without losing quality. Here, the image is made up of lines and curves which are called vectors and have such properties as color and location coordinates. Vector image is not dependent on the resolution.

Raster graphics is used in processing publications and printing. The smallest element is a dot on paper or pixel on the screen. However, the disadvantage is its deterioration with the increase - there appears a "grain" on the image - the effect of pixilation. Raster graphics always operates a two-dimensional array (matrix) of pixels. Each pixel is mapped to a value - brightness, color, transparency or a combination of these values. Raster image has a certain number of rows and columns.

3D graphics (3D - from the English Three Dimensions) operates with objects in 3D space. All visual transformations in 3D-graphics are controlled by the matrix: rotation matrix, shift matrix and scaling matrix. In 3D-graphics all objects are represented as a set of surfaces or particles. A minimal surface is called polygon. Triangles are generally selected as polygons. Any polygon can be represented as a set of coordinates of its vertices. So, a triangle will have 3 vertices. The coordinates of each vertex are vectors (x, y, z). By multiplying the vector by a corresponding matrix we obtain a new vector. Having made such transformation with all the vertices of the polygon we obtain a new polygon and by converting all polygons we obtain a new object rotated/moved/scaled relative to the original one.

Fractal graphics is designed for automatic generation of images through mathematical calculations. The images are based on the formulas (equations) and their coefficients are stored, not the image itself. By changing the coefficients of these equations we can obtain other illustrations sometimes very unusual. A common snowflake can serve as an example of a fractal object.

Fractal is an object the elements of which inherit properties of parent structures. Objects are described by several mathematical equations. Fractals allow describing the whole image classes for a detailed description of which relatively small memory capacity is required.

Advantages and disadvantages of graphics types are presented in Table 11.1. Comparison of raster and vector graphics is given in Table 11.2.

Table 11.1 – Comparison of types of graphics

Name	**Advantages**	**Disadvantages**
Raster graphics	- High image quality due to the transfer of all colors and shades	- Large file size; - When the image is enlarged the quality is lost; - A lot of memory for processing.
Vector graphics	- When the image is enlarged the quality is not lost; - Small file size; - Small processing memory.	- A small number of colors and shades.
3D graphics	- Realistic image in space; - When the image is enlarged	- Large file size; - A lot of memory for

	the quality is not lost	processing.
Fractal graphics	- When the image is enlarged the quality is not lost; - Small file size.	- Low quality of the image; - A small number of colors and shades.

Table 11.2 – Comparison of raster and vector graphics

Comparison criteria	Raster graphics	Vector graphics
Method of image representation.	The bitmap is constructed of many pixels.	Vector image is described as a sequence of commands.
Presentation of real-world objects.	Raster images are used effectively to represent real-world images.	Vector graphics cannot produce photo-quality images.
Quality of image editing.	When scaling and rotating bitmap images appear distorted.	Vector image can be easily converted without loss of quality.
Features of the print image.	Raster images can be easily printed on printers.	Vector figures sometimes cannot be printed or appear on paper as desired.

11.4.3 General Information about the Image and its Preservation

Most often, image editing is done for some purposes, for example, for printing as an illustration in the magazine or for placing on a Web-page. It is important that the image has the right size and necessary resolution. A too small image when increased will lose in quality. Strong reduction of the large image will result in the loss of details. In addition, an excessive size and resolution increase the file size slowing down the computer. Resolution is the second most important characteristics of the image.

The resolution may be in the range from 72 to 1200 or more (depending on the resolution capability of the scanner). The number of pixels per inch is denoted (ppi). The image size is measured in kilobytes (K), megabytes (MB) or gigabytes (GB). The file size depends on the image size (Fig. 11.1).

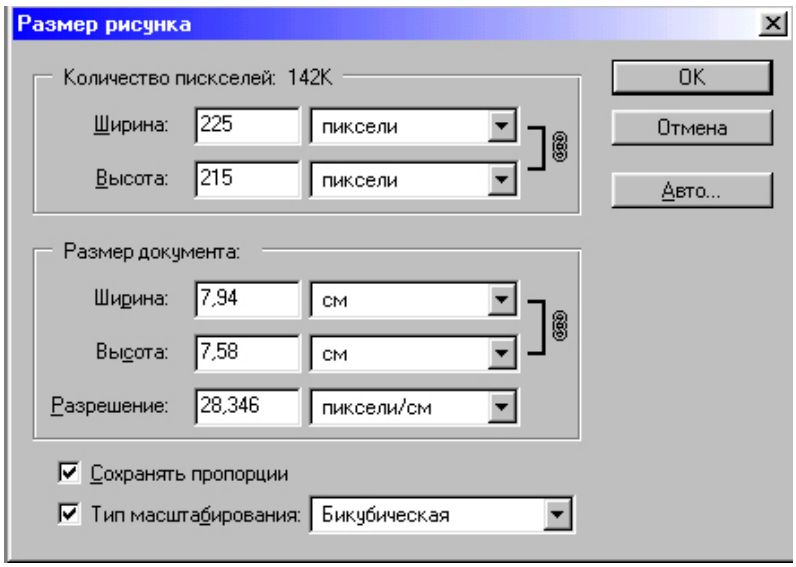

Figure 11.1 – Image size

Graphic file formats:

***.BMP** is the most common type of files, drawings, photographs. It features good quality but the larger image size.

***.JPG** is a format of multi-color photos with a high degree of compression. For black and white images is not effective.

***.GIF** is the densest graphical format for few color images (cartoon illustrations). It supports animation.

***.TIF** is a compressed polygraphed format that can store in the image file additional information about the unseen layers of auxiliary channels.

***.PSD** is an image processed and stored in Photoshop (retains layers channels sequence).

Important to know

If you open any scanned color photo or drawing (size 672 * 483, 150 pixels/inch with 12 in the options) and save it in different formats, then comparing the quality and dimension of the image we get the Table 11.3.

Table 11.3 – Comparson of the size of image file depending on the file format

Image format	***.BMP**	***.JPG**	***.TIF**	***.GIF**
File size	951 kB	193 kB	959 kB	132 kB

There is no difference in the quality of the resulting images on the screen or on paper when printing. **JPG** format compresses the file almost 5 times compared to the extended format of **BMP**. **TIF** format retains not only the integral image but also layers (parts) and channels which were previously used.

GIF supports 24-bit color implemented as a palette up to 256 colors. Special features of this format should include a sequence or overlap of multiple images (animation) and display with alternating lines (interlaced). Several customizable

options of the GIF format allow you to control the size of the output file. The biggest impact has the depth of the color palette. The GIF-file can contain from 2 to 256 colors. Accordingly, the lower content of colors in the image (the depth of the palette) with all other things being equal gives a smaller file size. Another parameter that affects the size of GIF-file is diffusion. It allows you to create a smooth transition between the different colors or a color display which is absent in the palette by mixing pixels of different colors. The use of diffusion increases the file size but it is often the only way to adequately transfer the pattern of the original palette after the reduction. In other words, the use of diffusion allows a greater degree of depth to trim palette GIF-file and thus, contribute to its "relief".

When you create an image that will be subsequently transferred to the GIF file format you should consider the following feature of the LZW compression algorithm. The compression ratio of the graphic information in GIF depends not only on its level of repeatability and predictability (single color image is smaller than the random "noisy") but also the direction because pattern scanning is performed line by line. This is well illustrated by creation of a GIF-file with a gradient fill. Two figures are shown as an example. In the case of equal conditions a file with vertical gradient is compressed to 15% stronger than a file with a horizontal gradient (2.6 kb vs. 3.0 kb). In fact, there is no JPG format. In most cases JFIF file format and JPEG-TIFF are compressed by JPEG technology. However, in practice, it does not matter, so we will stick to the common terminology.

JPEG compression algorithm does not handle images with few colors and sharp boundaries of their transition. For example, an image or text painted in the usual graphic editor. For such images, it may be more effective to present them in GIF-format. At the same time, it is indispensable in the preparation of web-sharing photos. This technique can recover a full color image almost indistinguishable from the original using approximately one bit per pixel for storage. JPEG compression algorithm is quite complicated, so it works slower than most others. In addition, several compressions closed by their properties to JPEG technologies belong to this type of compression. The main parameter of all formats is the image quality (Q-setting) measured in percentage. The size of the output of JPG-file is directly dependent on this parameter, i.e. when «Q» decreases, the file size decreases.

11.4.4 Use of Computer Graphics

Computer graphics is used in many branches of science, engineering, medicine, business and management. Graphs, charts and diagrams built with the help of computer and intended for visual display of various types of information are widely used. Designers developing models of new cars and airplanes use three-dimensional graphics to present the final form of the product. Architects create on the screen a three-dimensional image of the building and it allows them to see how

it fits the landscape. Animators and visualizers use 3D graphics to create computer games.

Research graphics. The first computers were used only for scientific and industrial applications. To understand the obtained results better researchers implemented their graphic processing, built charts, graphs, and drawings of the designed structures. The first machine graphics were received in the character printing mode. Then, there were special devices, plotters, to plot drawings and graphs with an ink pen on the paper. Modern scientific computer graphics makes it possible to carry out computational experiments with visual representation of the results.

Business graphics is a sphere of computer graphics designed to visualize various indicators of the institution's activities. Anticipated indicators, reporting documentation, and statistical reports use illustrative materials created with the help of business graphs. The software business graphics is included in the spreadsheet.

Design graphics is used in the work of design engineers, architects, and inventors of new technology. This kind of computer graphics is a must-CAD (computer-aided design systems). With the help of graphic design one can produce both flat images (projections, sections) and spatial three-dimensional images.

Illustrative Graphics is an arbitrary drawing and sketching on a computer screen. Packages of illustrative graphics are considered as a software application of a general purpose. The simplest means of illustrative graphics software are called image editors.

Art and advertising graphics has become popular largely because of television. With the help of computer commercials, cartoons, computer games, video tutorials, video presentations are created. Graphic packages for these purposes require large computer resources regarding speed and memory. A distinctive feature of these graphics packages is an ability to create realistic images and "moving pictures." Obtaining drawings of three-dimensional objects, their turns, movments back and forward, and deformation are associated with large amounts of computation. Showing the lighting of the object which depends on the position of the light source, location of the shadows, the texture of the surface requires calculations taking into account the laws of optics.

Computer animation is receiving moving images on the display screen. The artist creates paintings on the screen of the start and the end positions of the moving objects, and all the intermediate states are calculated and showed by the computer that performs calculations based on mathematical description of this kind of movement. The images displayed sequentially on the screen at a certain frequency create an illusion of movement.

11.5 Presentation

A variety of public performances often require the use of demonstration material. This need arises when making presentation at a conference, presenting a new technical development or a new kind of product, a report on the developed project and in many other cases. Many years ago people drew posters on the sheets of paper for this purpose; then project equipment appeared: overhead projectors, slide projectors, simple projectors.

Recently, multimedia presentations have replaced these methods.

Multimedia presentation is an electronic document consisting of slides. The slides are a substantial part of the information, formatted text, pictures, charts, graphs, sound and effects that attract the listener's attention.

The undeniable advantage of multimedia presentations is a possibility of introducing them virtually in any format: text, graphics, audio, and video.

11.6 Basics of Sound

11.6.1 Concept of Sound and Basic Operations with Audio

Sound is mechanical vibrations of the environment: air, etc. What we hear is the result of processing oscillatory movements of eardrum and representation in the form of signals of the nervous system. Beyond the medium of sound waves transmission the sound does not exist.

Basic operations with audio:

- Recording;
- Adding/deleting a track;
- Changing the size of the track;
- Splitting the track into fragments;
- Editing a sound curve;
- Changing the sound volume.

In practice the conversion of audio information from the continuous form into the discrete one is carried out by electronic devices called *analog-to-digital converters* (ADCs) and *digital-to-analog converters* (DACs). Modern electronics associated with phonics pays great attention to the development of new, more sophisticated converters. For example, the sound quality of a CD player to a great extent depends on the design and quality of the converter from digital to an analog form.

Techniques and methods of working with sound information appeared in computing later. Moreover, unlike numeric, text and graphical data audio recordings did not have long and proven coding history. As a result, methods of coding audio information by a binary code are far from being standardized. A lot of individual companies have developed their own corporate standards, but generally speaking, the two main trends can be identified. FM method (*FrequencyModulation*) is based on the fact that theoretically any complex sound can be decomposed into a sequence of simple harmonic signals of different

frequencies, each of which is a regular sine wave, and therefore can be described in numerical parameters, i.e. a code.

Method of Wave-Table synthesis better corresponds to the best state of the art. Speaking simplistically, we can say that somewhere in the predefined tables there are stored samples of sounds for a variety of different musical instruments (but not only for them).

The sound card was one of the most recent improvements of the personal computer. It is connected to one of the slots in the motherboard and a daughter card performs computational operations relating to the processing of sound, speech and music. The sound is played through the external speakers connected to the sound card output. A special connector allows you to send audio signal to an external amplifier. There is also a microphone jack that allows you to record speech or music and save them on your hard drive for further processing and use.

Audio file formats:

*M**idi** – a format of an audio file of the instrumental sound: the piano, guitar, flute, organ, bass, etc., which takes up little space on the disk.

ATRAC - format used in MDs.

Audio – a format for recording on optical disks (CD-Rom). It is impossible to store an audio file on another format. When viewed in Windows Explorer or file manager of the optical disk tracks are displayed only as a label of the track, for example, Track01.cda. with the compression ratio of 1: 1 (no compression). Typical properties: 16 b /44.1 kHz / 1411,2 kbps.

wav - used as a container for storing uncompressed audio while encoding algorithms may be different, so the properties can vary. Typical values: 16 b / any / to 6,144 kbps. If compared in quality with recording on the audio disk, it does not allow storing tags.

mp3 - one of the most common formats of digital coding of audio information with losses. It belongs to the group of standards for the MPEG storage formats (Moving Picture Experts Group). Typical properties: 16 b /44.1 kHz / 128 kbps. Thus, compression ratio reaches 1:11 to the size of the original file with the CD-audio. It is played by almost all modern devices.

wma (Windiws Media Audio) - an audio encoding system developed by Microsoft. The sound quality and average characteristics are almost identical to the format of MP3. It allows you to set the protection of copyright and limit the spread of records using DRM (Digital rights management). It saves the recorded sound using a standard Windows program "sound recording". It is played by most devices.

Ogg\Vorbis - a container that stores the data encoded with losses in Vorbis, Opoos, Speex formats or without losses in a FLAC format. It is developed by Xiph.Org Foundation – a foundation for creation and promotion of free software. There are no patent or license restrictions for using it. Features: up to 32 b / up to 193 kHz / 1000 kbps.

m4a **-** one of the **Advanced Audio Coding (AAC)** formats, the format of the audio file and a coding algorithm with less loss in quality than mp3 when encoding with the same bit rates. It is commonly used in mobile devices – smartphones and tablets. Format Options: **m4b** is used for audio books; **m4p** is used to protect the file copy when downloading music in online stores; **m4r** - files ringtones. Features are: 16 b / 44.1 kHz / 128 kbps recognized by most devices.
dss - a Digital Speech Standard File, a special digital format for recording speech. It provides high compression ratio at a relatively low quality. Usually, it has characteristics of 16 b / 22 kHz / 64 kbps. It is used in voice recorders and other mobile devices. A special program is required for playback, for example, Olympus DSS Player or converting the file into one of the more popular formats.

11.6.2 Key Features of Audio Formats

Bit quantization - a number of bits to store a single sample, usually 16 b, 24 b, 32 b, rare - 64 b and more.

Sample rate - a number of signals measured per second, it takes the value of 22; 44.1; 48, ..., 192 kHz.

Flow rate (bit rate) - a number of bits used to store one second of the multimedia content. It represents the degree of compression of the flow. The size of bit rate is used to estimate the speed of stream in bits or kilobits per second, typical value of 64 kbps, 128 kbps, 320 kbps. For Audio DVD a bit rate can be up to 6912 kbps.

Audio file formats also differ by:

- An ability to create files tags, i.e. to help save the recording information in a file;
- The software that is necessary for recording and reproduction of sound;
- Technical devices which are intended to create, play and process sound in a specific format.

There are dozens of different formats of audio files. Many manufacturers of digital recording devices develop their own formats for storing audio data. *Codecs* are installed in computers so that digital processing programs could “understand” new formats.

11.6.3 Sound Editing

Audio Editors – a program for editing digital audio recording to eliminate defects or create certain effects.

The main functions of Audio Editor:

- Recording a sound signal coming from the sound card input usually done without compression;
- Playing a sound in the editor is used for monitoring performed operations;
- Tone mapping in the form of a sequence of samples which are united by one envelope corresponding to the amplitude of the audio signal called signalogram or

waveform (Fig. 11.2). This mapping allows you to visually detect the locations of required changes;

Audio conversion:

- Eliminating extraneous sounds;
- Noise reduction;
- Removing or inserting pauses;
- Change in volume;
- Creation of growth and attenuation of the sound and much more.

One of the commonly used transformations is normalization - volume alignment process with respect to any level of, for example, the maximum possible value for a digital audio without distortion (*peak normalization*) or the rms value of the sound level in the file (the RMS-normalization);

- creating and editing metadata (tags) i.e. reference text information stored in the same file as the sound;

- preservation of records in the audio file with the desired characteristics, at this stage compression of audio data takes place.

It is recommended to store intermediate processing results in an uncompressed format, and only the final version - in a format with the required degree of compression.

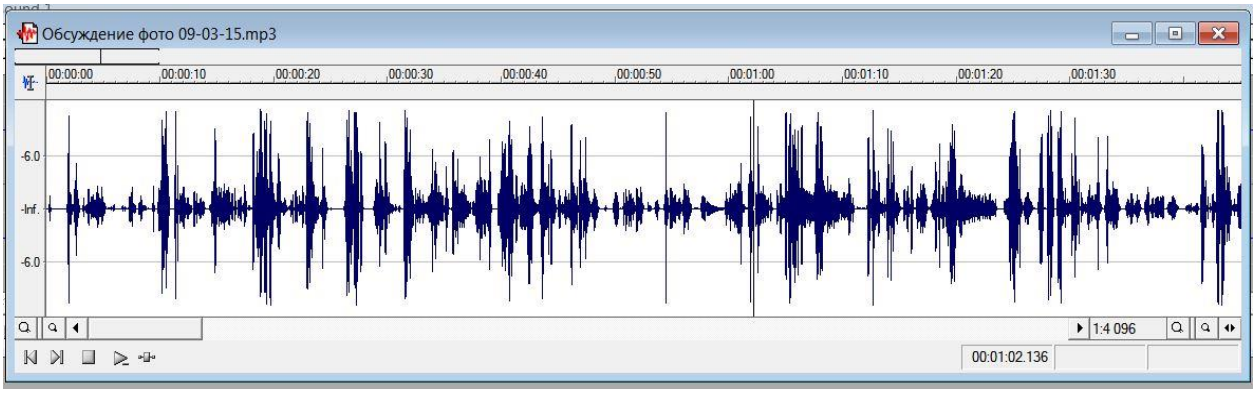

Figure 11.2 - Signal display in the audio editor (voice recording in mono)

11.7 Basics of Video

11.7.1 Concept of video

Video is electronic technology for recording, processing, transmission, storage and reproduction of image signals based on the principles of television and audiovisual work. It is recorded on physical media (hard disk, video tape, video disc, flash media, and so on.).

Video is an ordinary number of images recorded one after another. As it is known, video recording appeared long before the first computer, i.e. in an analog form. This imposed great restrictions on its further processing and editing. Up until the early 1990s this type of video recording dominated. Later, the digital video recording technology and storage have been developed. This gave a great impetus

to the development of not only the cinema but home videos as well. It means that recording videos and creating home movies became a very popular pastime. All these factors forced the developers to improve the technology of recording, storing and processing of video information.

11.7.2 Video Features

Digital video has five main features: resolution, frame rate, color depth, bit rate (the width of the video stream) and image quality.

Screen resolution (Resolution) denotes the number of dots (pixels) horizontally and vertically that the image (video frame) on the screen possesses. When denoting resolution first the number of points per line (horizontal resolution), then the number of rows in image (vertical resolution) are indicated. The higher the screen resolution is, the better video quality is.

Frame rate is the value indicating the fact on how many frames per second are replaced. The standard speed of playback video shall be equal to 30 frames/sec. For movies the figure is somewhat smaller and is 24 frames/sec.

The depth of color (color resolution) is characteristics indicating the number of colors that can be used in the video formation. The number of colors in a digital video is measured in bits. Thus, one bit may accept two different values (0 or 1), and respectively, it allows only two encode colors (usually black and white). By means of two bits there can be coded 4 colors (22 = 4) with three bits - 8 colors (23), four - 16 (24), and so on.

Typically, color resolution is described with special color models. The computer technology uses RGB (red-green-blue) which can be represented by the following most common modes of color depth: 8-bit (256 colors), 16 bit (65 536 colors) and 24 bits (16,777,216 colors). Incidentally, the human eye according to various opinions can absorb 5 to 10 million colors.

Bitrate (the width of the video stream) shows the number of processed bits of video per second. In other words it is a speed of the video stream which is measured in megabits per second (Mbits /s). The higher it is, the better the quality is. For example, the standard DVD-video stream width is about 5 Mbit/s, for a television of HDTV high definition format - 10 Mbit / s. Incidentally, the value of the bit rate is commonly used to assess the quality of the video transmitted through the Internet.

Image quality is characteristics designed to assess the quality of the processed video in comparison with the original and is defined by a set of values of resolution, color depth, and the stream speed.

11.7.3 Video File Formats

VHS (Video Home System) is an analog video format. The features of which were limited to a resolution of 240 TV lines. VHS-width tape cassette of 12.65 mm

and a speed of 23.39 mm / s which had 240 minutes during recording at a standard tape speed SP (Standard Play) and the lowest cost of shooting was used for recording. Record-playback mode could also be carried out at the LP speed (Long Play) - 11,695 mm / s. The main drawbacks of the VHS format are low clarity (240 lines of horizontal resolution) and sharp loss of quality with every rewrite. Later, the video format went through several stages of modernization. In particular, VHS-Compact (VHS-C) and Super VHS (S-VHS) formats have been developed. Currently, this format is considered outdated and in 2008 production of VHS video cassettes was stopped.

DV (**Digital video**) is a digital format which provides a resolution of 500 lines. Video and audio in **DV** format are written separately. This gives a possibility to add sound after the completion of recording or video editing, and also to re-record the sound. The **DV** format offers the highest quality photo and video shooting and allows you to save all the data in digital form on tape, memory card or computer hard drive.

Advanced Systems Format (ASF) is the preferred Windows Media file format. If you have appropriate codecs installed on your computer, by using Windows Media Player you can play video, audio and mixed recordings compressed using these codecs and stored in the ASF file. In addition, these notes can be converted to a stream file using the Windows Media Services or compressed using Windows Media Rights Manager. ASF format is an extensible format for storing synchronized multimedia data. Typically, ASF format files that contain sound recordings packaged with the help of Windows Media Audio (WMA) codec have the WMA extension. Similarly, ASF format files containing audio, video or mixed records that are packaged with the Windows Media Audio codecs (WMA) and Windows Media Video (WMV) have the WMV extension.

Audio Video Interleave (AVI) is a special kind of Resource Interchange File Format. AVI format was developed by Microsoft. AVI format is the most common format for presenting video and audio data to the computer.

If you have appropriate codecs installed on your computer by using Windows Media Player, you can play video and audio recordings, compressed with the help of these codecs and saved as an AVI file. AVI files often use video codecs for MPEG-1, MPEG-2, MPEG-4. MPEG-4 appeared in 1998. It was designed for digital video and audio compression and basically comprised compression principles formats used in MPEG-1 and MPEG-2. A feature film in MPEG-2 format usually fits one DVD, while the same film compressed by the MPEG-4 algorithm easily fits a single CD drive with the capacity 6 times less.

MPEG-4 format as well as MPEG-2 provides storage of reference frames, i.e., frames in which the frame image changes substantially. However, this format does not store intermediate frames as MPEG-2 does. Instead, the MPEG-4 file contains information about the changes (including the projected) in the picture between the two reference frames. Also, the received information about the changes is

compressed in the same way as the compressed file with the help of the program for data archiving.

QuickTime (MOV*)* is developed by Apple Inc. for creating, editing, viewing and publishing multimedia files. The files in QuickTime format can contain video, audio, animation, graphics, three-dimensional objects, and objects of virtual reality. Windows Media Player can play files in QuickTime version 2.0 or earlier format. Later versions of this format required the Apple QuickTime player.

FLV (Flash Video) is a video format for distribution and transmission on the Internet through RTMP-connection. It is used by such host sites like YouTube, RuTube, Tube.BY, Google Video, Movie and etc.

SWF (Shockwave Flash) is extension of animation created with Adobe Flash and video in flash format. It is played by browsers using Flash Player. Flash videos are also widely disseminated on the Internet.

M2TS is a video file of Blu-ray format used for the format container Blu-ray Disc Audio-Video (BDAV) MPEG-2 Transport Stream. Its operation is based on the use of the transport stream MPEG-2 container. The main purpose is storing video on Blu-ray discs.

M4V is a video file downloaded from the Apple Itunes store that includes TV shows, feature films, music, and videos. It looks like a MP4 file but may be copy-protected using FairPlay DRM from Apple.

3GPP (Third Generation Partnership Project) is a format designed for video on mobile phones in the third generation of mobile communications as a format for multimedia files.

11.7.4 Video Editing

Any footage before releasing a file on TV or publishing on the Internet, recording final video or movie needs editing. Some fragments of video need processing, i.e. removing "extra" video clips, creating transitions between them, adding special effects and explanatory captions.

There are three types of video editing: linear, nonlinear and hybrid.

Linear editing involves overwriting footage from two (or more) video sources on the video recorder with cutting out unnecessary and "gluing" the desired video scenes and adding effects. The main drawback is quality loss, high labor intensity and a large number of video equipment.

Nonlinear editing is carried out on the basis of computer systems. In this procedure original video materials are inputted into the computer, and then they are edited. There is no loss of quality during multiple "movements" of videos that can be considered as an advantage and with significant savings of video equipment. Disadvantages are that it is not real time operation, much video processing time, high labor intensity. It has limited amount of recorded video to input into the computer.

Hybrid editing combines advantages of linear and non-linear editing (non-linear video editing system acts as a video source). Disadvantage is usually higher price.

In recent years non-linear editing dominates other types of video editing.

11.8 Application of Multimedia

Multimedia finds its application in various fields including advertising, art, education, entertainment, engineering, medicine, mathematics, business, scientific research, space-time applications, and other information processes involving people.

Education. In education multimedia is used to create computer-based training courses and reference books, such as encyclopedias and collections. Training courses allow the user to go through a series of presentations, name of the text and associated illustrations in various presentation formats. Entertained education (edutainment - a term used in the US) combines education and entertainment, especially multimedia entertainment. Learning theory in the past decade has been greatly developed in connection with the advent of multimedia. It highlighted several areas of research, such as the theory of cognitive load, multimedia training, and others. Opportunities for training and education are almost endless. The idea of media convergence is also becoming one of the most important factors in the field of education especially in higher education. Defined as separate technologies, such as voice (and telephony features), database (and derivative applications), video technology which now share resources and interact with each other, the complex creating new efficiency, media convergence is rapidly changing curriculum subjects taught in universities around the world. Newspaper companies are also trying to embrace the new phenomenon by introducing it into their work practices.

Equipment. Software developers can use multimedia in any computer simulations from entertainment to training, such as military or industrial training. Multimedia for software interfaces are often created as collaboration between creative professionals and software developers. They create more user-friendly software which breaks the barrier between the user and the program. Multimedia are used for the development of identification systems in various fields: banking, retail, security, medical and research.

Industry. In the industrial sector multimedia are used as a way of presenting information to the shareholders, management and colleagues. Multimedia are also helpful in organization of staff training, advertising and sales of the product worldwide through virtually unlimited web-based technology.

Computer graphics combined with imaging technology allows you to discover new mineral deposits, explore the internal state of technical objects inaccessible by other means.

Mathematical and scientific research. In mathematical and scientific research multimedia are mainly used for modeling and simulation. For example, a

scientist can look at a molecular model of a substance and manipulate it in order to get the other stuff. Exemplary studies can be found in journals such as the Journal of Multimedia.

Medicine. Doctors may also practice through virtual surgeries or simulations of the human body affected by a disease, thus, trying to develop techniques to prevent it. Multimedia graphic tools combined with the tomographic technique can effectively study the human body and its organs.

Review questions

1. What does the term "multimedia" mean?
2. What are the main components of the multimedia application? Is it necessary to have all the components?
3. What is the difference between preparation of materials for printing for the Internet and for multimedia applications?
4. Can the web-site be considered as a multimedia application?
5. What are the main differences between raster and vector graphics? What are the most common formats of vector and raster graphics?
6. What programs are used for working with raster graphics?
7. What are the main parameters of digitizing footage?
8. What are the known formats of digital video?
9. What programs are used for assembling and installation of multimedia applications?
10. What is the «shockwave»? What are the areas and features of the application?
11. How is synchronization of video and audio in the project implemented?
12. What parameter characterizes the degree of compression of the audio stream?
13. What is a codec?
14. What are the main characteristics of the video?
15. List the major video file formats.
16. What is the difference between linear and non-linear video editing?
17. Where are multimedia used?
18. What are the main trends in the development of multimedia technologies?

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CHAPTER 12. SMART TECHNOLOGY

SMART is the abbreviation which is integrated by Piter Druker in 1954. There are 5 main criteria which define correctness of the goal setting:

Specific - the goal should target a specific area of improvement or meet a specific need;

Measurable - the goal must be quantifiable or at least allow progress to be measured;

Attainable - the goal should be realistic based on available resources and existing constraints;

Realistic - the goal should align with other business objectives to be considered worthwhile;

Time-bound - the goal must have a deadline or a defined end.

First of all, SMART is the information environment. The goal should be defined clearly at the time, must have a specific time frame (and intermediate control points) to achieve it.

Smart-technology is actively implemented in many industries: engineering, construction, information technology. However, the technology itself is 70% of software.

A good example of the SMART concept implementation is a "smart" home system.

The mechanism of the system is as follows: a large number of special sensors are connected to the central bus, which collects the different information (security system, the room temperature, the wind speed in the ventilation shaft, etc.). Then, the result is analyzed and the decision is made according to the operator settings. It follows that the person does not become a hostage to the machine. Access control is completely in his hands. Control can be done with the help of a remote control.

12.1 Main directions of SMART technology

12.1.1 Intellectual networks

The purpose of the idea of intelligent networks is separation of the traditional switching call process from the process of introducing new services. To do this, you must have special interfaces between the network switches and a special device, which are called an intellectual superstructure, an intellectual platform, or a platform of intelligent networks, and certain types of data transmitted by them. Modernization of the services, in this case, is made only by modernization of the intelligent network platform software. This allows you to quickly and cost-effectively implement any services, regardless the manufacturer of switching equipment to existing networks.

General simplified view of the intellectual network is represented in the Figure 12.1:

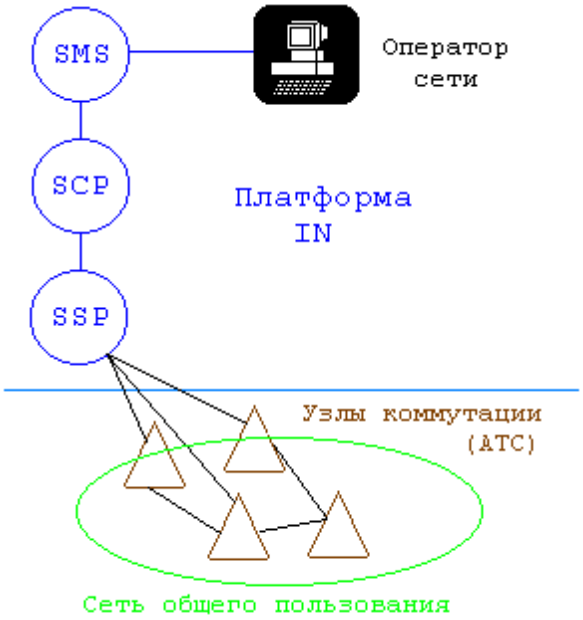

Figure 12.1 – Intellectual network

There is basic intelligence in the form of certain pre-programmed algorithm services and a collection of different databases in the SCP (Service Control Point) of Service Management. SSP (Service Switching Point) detects the call from the common network to the intellectual network and sends them to the SCP for processing, being the interface to an intelligent network platform. The intelligent network platform may comprise multiple SCP and SSP. Service Management System SMS (Service Management System) can introduce new services, modify old ones and it stores information about all provided services, about subscribers and their admission to certain services, as well as the originals of all service programs. Surely, the smart network can be created not only in the telephone network, but it will be discussed later on.

In this case, the public network and the intelligent network platform can be developed independently from each other, but the most important is the development of the interface between them.

The exchange of information between the points of the intelligent network platform is produced in the ideal case, using SS7 interface (Common Channel Signalling (CCS) № 7) which is applied to digital telephone networks for signalling (we do not use it yet).

This high-speed network with packet switching is parallel to the speech and data transmission, which transmits signal information in the connection-oriented mode and the transaction mode (not connection-oriented) which allows providing various services. In order to provide the service, an intelligent network services platform in the process of establishing a connection needs to perform a lot of transactions in the form of the database view, various confirmations, broadcast calls, etc.

The concept of the intelligent network construction is currently being implemented in the form of a series of standards which are set in the ITU (International Telecommunication Union) recommendations, series Q.1211 – 0.1219.

There have already been described a number of basic services integrated into a set of CS-1 (Capability Set) which includes free calling services, shared payment, corporate networks, call forwarding and others. The work on standardisation of the following sets of CS-2 and CS- 3 is already underway. In addition, there are Bell Communications Research company standards where the intelligent network is called AIN (Advanced Intelligent Network). Apparently, these standards will eventually be merged, and soon the development of communication networks will be required.

The intelligent network supports telephone networks of public use, the mobile telephone communications network, data networks and a wide range of services including (but not limited to) all existing and future services of the narrow-band N-ISDN (Narrowband Integrated Services Digital Network) and broadband B-ISDN (broadband ISDN).

The operator of the intelligent network strives to meet the user's expectations in the case of information services, and must solve a variety of tasks. It should be kept in mind that different users have different perception of different services: business subscribers use services to improve productivity and reduce costs; residential subscribers prefer services to home entertainment and access to various databases and computers; spyware is more interested in one specific database. All these differences in the test should be considered in advance.

Regarding this, the approaches to the implementation of the smart grid may be different from the creation of a smart host with a centralised set of features to the distribution of "intelligence" between multiple switching nodes. When offering services provider, its users do not have to belong to the same network. Therefore, it requires appropriate arrangements between the various network operators.

Intelligent Network Services shall have the same validity and reliability of delivery, and must not violate mode PSTN. At the same time, the confidentiality of information, lack of access to the individual PIN-code, personal records and accounts should be ensured.

A serious problem is an emergence of delays in establishing communications in the provision of complex services. It is called by a large number of transactions between the SSP and SCP nodes and it is solved using a faster transmission and more powerful processors.

Thus, the smart grid offers a new approach to the telecommunications network as a whole, as well as creation of new services for subscribers.

12.1.2 «SMART» building

The aim of 'Smart' building is reduction of electricity consumption and sometimes creation of areas with better energy coefficient using sustainable design principles and ICT. According to experts the 'smart' buildings deal with a significant part of the greenhouse gas emissions reduction through ICT.

REEB Consortium (The European strategic research roadmap to ICT-enabled energy efficiency in buildings and construction) funded under the European Commission Programme of FP7 (Seventh Framework EU Programme, Eng. The Seventh Framework Programme), considers the use of ICT to reduce energy consumption in the following directions in the short, medium and long terms:

The use of ICT is supported to improve energy efficiency in buildings mainly through the designing tools, automation and control systems and decision support to the different stakeholders:

- in the short term: ICT will be used to ensure that the existing and new buildings meet current and emerging requirements for energy efficiency;
- in the medium term: ICT tools will help in optimising the life-cycle design and management of using energy during the operation;
- in the long term: ICT will promote and support new business models for the implementation of energy efficiency processes. The buildings will evolve from energy consumers to "prosumers" (producer + consumer).

The concept of «smart» buildings is similar to the concept of the smart network. They include microprocessors equipment (sensors, actuators, etc.) of all power and movement mechanisms in the building, as well as all surfaces, exchanging energy, such as internal and external covering constructions and spaces of the building.

The idea is to connect and to measure energy consumption and the factors affecting energy consumption. The obtained data will be used to inform the building owners, residents and other stakeholders, as well as to control the consumption of energy and resources (eg, water, air, fuel, building materials) in order to achieve the highest possible energy efficiency, reduce energy consumption in the building, and, at the same time, increasing comfort and "liveability" of buildings.

The idea of the "smart" building is extensively used on the base of eco-friendly ICT technologies such as the BIM, distributed energy resources (DER) and other technologies directed to enhance energy conservation in the process of construction and operation, and in some cases, to optimise energy harvesting from the natural environment.

The building equipping means an ability to use ICT for measurement and control of heating, ventilation and air conditioning, lighting, as well as access to the building (including doors, ducts, pipes, etc.), pumps, lifts, windows and automatic control, skylights, doors and other open or close passages, public

address systems, fire-fighting equipment, closed video surveillance system, as well as any and all other elements of consumption or energy production, such as engines, household appliances, office supplies and etc.

This also includes incorporation of sensors and actuators, in some cases, all the structural components and all the physical objects that can be used to measure and control climate, as the energy transfer inside the building and outside the building structures. The sensors can also be used for monitoring physical condition and integrity of the building infrastructure for maintenance and safety, as well as within DRR initiatives.

The sensors may have either a wired or wireless connection. The sensors may include occupancy sensor in the room, CO2 sensors, light sensors, temperature and humidity sensors, air flow measurement sensors, and sensors for measuring loads and stress pillars, etc. The Building Management System (BMS) processes the information sent to it by sensors, meters and other devices, and uses this information to control pumps, fans, ventilation shafts, appliances, and security systems, lighting, power management, heating, ventilation and air conditioning. In fact, "smart" buildings use the concept of the Internet of things and embedded devices, and WSN in the architecture environment.

Different components of «smart» building are interconnected and can be controlled by a centralised ICT-system. The systems can also be connected to the Internet and controlled from a distance. Large multinational corporations such as IBM and others use the Internet connection CPS to monitor their remotely located buildings to optimise energy efficiency and reduce greenhouse gas emissions.

Through the Internet and technologies such as AMI, «smart» buildings can be connected to a smart grid. Building owners can negotiate with municipal energy companies in order to increase energy efficiency in their buildings that are connected to the intelligent network.

Ecological building

An environmental ("green") building uses various facilities to reduce its impact on the environment during their life cycle. The certain conditions, for example, the prevailing local climate, taken into consideration, "green" buildings can be designed and constructed more or less exclusively on the use of passive technologies and techniques.

A passive house has few or does not use drive systems, such as heating or cooling systems (air conditioning). In colder climates, heating of a passive house is provided by isolation through energy-saving windows and the heat generated by internal sources and residents. In Germany, energy supply to passive houses uses 80 percent less heat. Furthermore, they save space, require less maintenance and are less complex to develop. In warmer climates, there are many passive technologies that reduce waste heat, including cool roofs, walls with reflective coatings, glass, low-emissivity window film, heat radiation reflectors, exterior shading, external and internal insulation, and various ventilation techniques. Buildings which use these technologies and methods may not need air

conditioning, or the volume of the required air conditioning is reduced significantly.

ICT can play an important role in the development of the passive house using BIM software (Building Information Modelling), as well as software for fast modelling energy performance of buildings. ICT can also help to optimise energy metabolism and flows through the judicious use of sensors and actuators for the expansion and optimisation of energy metabolism, the flow and the use of air, water and electricity in the building.

The use of appropriate methodologies for the design and integration of energy analysis of the building project can lead to significant cost savings. According to the IEA (International Energy Agency), available technologies could reduce projected energy use in buildings by 41% by 2050, and to eliminate 40% of current global CO_2 emissions arising from the combustion of fossil fuels. IPCC (Intergovernmental Panel on Climate Change) states that "integrated design and operation of buildings could result in an average of 75% energy savings compared with the usual practice, often with little or without any additional costs."

The idea of using natural materials and contrasting techniques and methods of new buildings with more traditional or natural methods of cooling and construction are well known and are a constant subject of interest in the community for AEC (Architecture, Engineering and Construction) and among students and practitioners in the field of architecture.

ICT can be combined with different passive technology and method of projecting for significantly decreased energy consumption and greenhouse gas emission to promote the objectives of creating a building with zero energy-supply. ICT can help to optimise the effectiveness and pay back the investment to this technology. Main conditions are an increase of the level of knowledge and awareness as well as also enhancement of human potential.

12.2 Smart city Conception

Smart cities are cities built on “Smart” and “Intelligent” solutions and technology that will lead to the adoption of at least 5 of the 8 following smart parameters:smart energy, smart building, smart mobility, smart healthcare, smarinfrastructure, smart technology, smart governance, smart education, and smart citizen (Figure 12.2) .

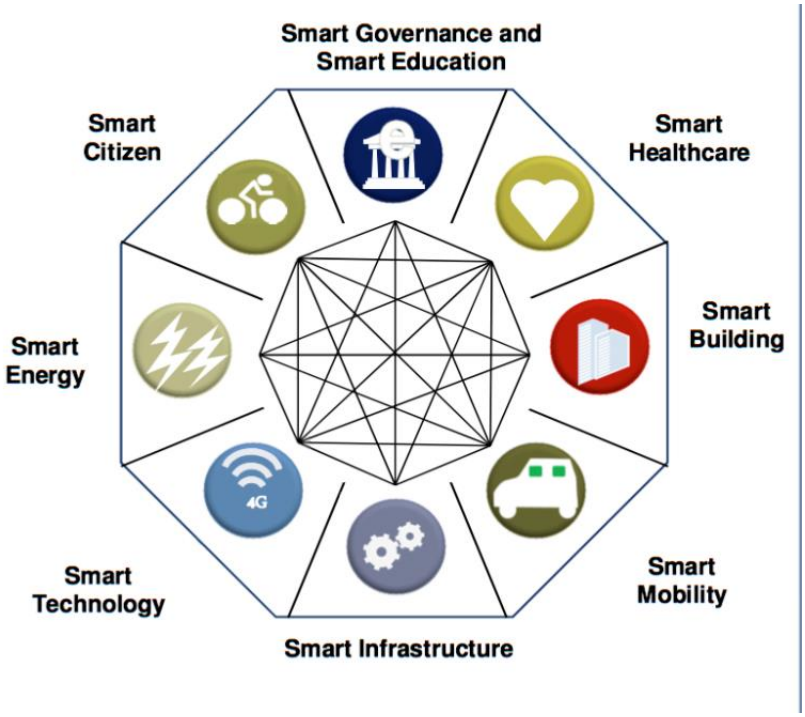

Figure 12.2 – Smart city conception

Table 12.1 - Key Parameters that will define a Smart City in 2020

Parameter	Definition
Smart energy	Smart energy uses digital technology through advanced meter infrastructure (AMI), distribution grid management, and high-voltage transmission systems, as well as response for the demand for intelligent and integrated transmission and distribution of power.
Smart building	Smart buildings are green, energy efficient, and intelligent, with advanced automated infrastructure that controls and manages aspects such as lighting and temperature, security, and energy consumption independently or with minimal human intervention.
Smart mobility	Smart mobility enables intelligent mobility through the use of innovative and integrated technologies and solutions, such as low emission cars and multimodal transport systems.
Smart technology	Smart technology will connect home, office, a mobile phone, and a car on a single wireless IT platform. Smart technology includes adoption of a smart grid system, smart home solutions, high-speed broadband connection, and roll-out of 4G technology.
Smart healthcare	Smart healthcare is the use of eHealth and mHealth systems, intelligent and connected medical devices. It also involves implementation of policies that encourage

	health, wellness, and well-being for its citizens in addition to health monitoring and diagnostics as opposed to treatment.
Smart infrastructure	Smart infrastructure includes intelligent and automated systems that manage, communicate with, and integrate into different types of intelligent infrastructure, such as energy grids, transportation networks, water and waste management systems, and telecommunications.
Smart governance and smart education	Smart governance and smart education includes policies and digital services from the government that help and support adoption of green and intelligent solutions through incentives, subsidies, or other promotions.
Smart security	Smart security includes technology and solutions such as video surveillance, public safety LTE, and managed security services that are designed to protect people, property, and information.
Smart citizens	Smart citizens possess interest in embracing smart and green solutions in daily activities. More citizen pro-activity is expected in adopting smart concepts and smart products, including lifestyle choices.

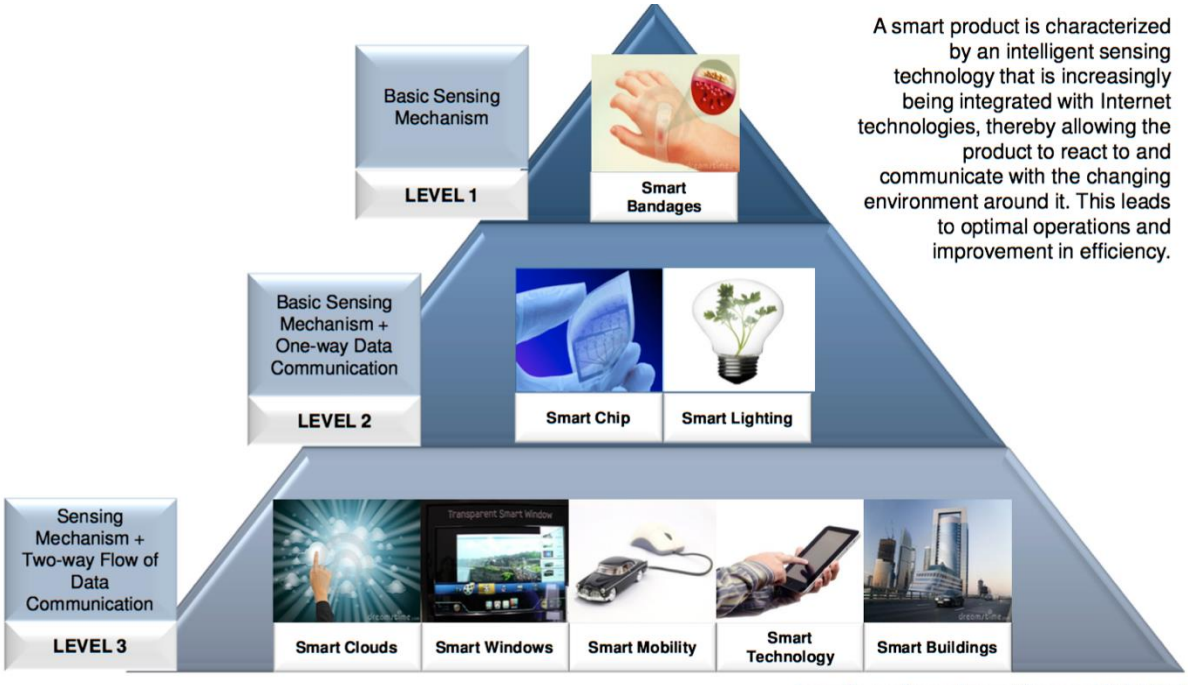

Figure 12.3 – Conception of the «smart city», including 3 levels of «smart» products and technology

A smart product is characterized by an intelligent sensing technology that is increasingly integrated with Internet technologies, thereby allowing the product to

react and communicate with the changing environment around it. This leads to optimal operations and improvement in efficiency.

Figure 12.4 –Global Smart cities in 2025 (source: *Forbes Smart City List 2009; Innovauon Ciues Global Index 2012 – 2013; specific Smart Project Websites for each city; Frost & Sullivan*)

More than 26 global cities will be smart cities in 2025, more than 50% of which will be from Europe and North America.

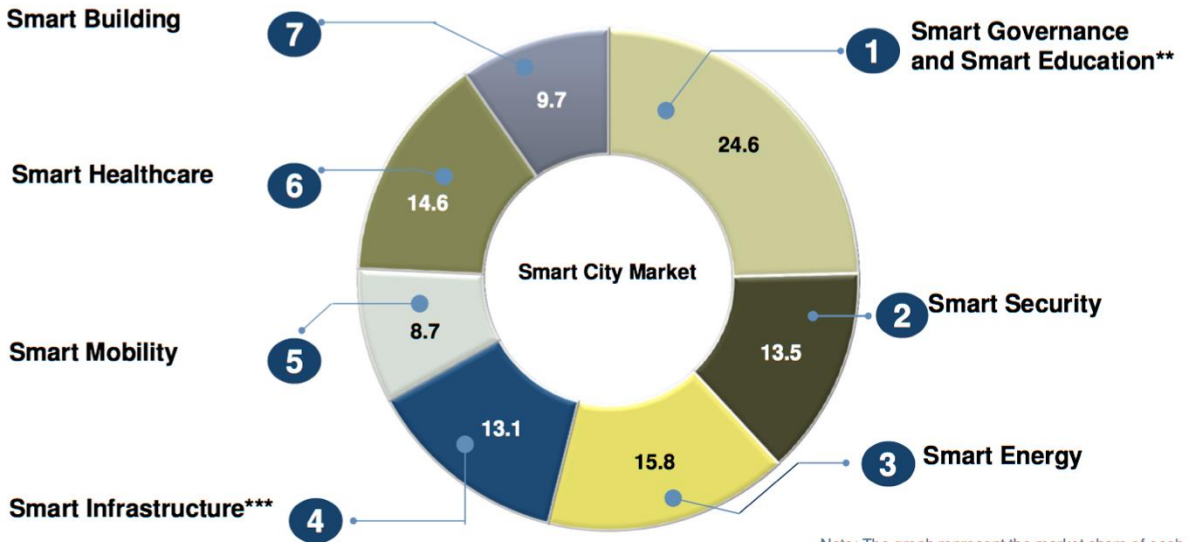

Figure 12.5 – Smart City Market by Segments*, Global, 2012-2020 (source: *Frost & Sullivan*)

Table 12.2 - Smart City Scoring Criteria* Global, 2013

	1	2	3	4	5
Energy	CO2	CO2	CO2 emissions	Zero	Innovationg

Efficiency	emissions (<10%)	emissions 10%–50%	(>50%)	CO_2 emissions	to Zero
Project Timeline	More than 20 years	Up to 20 years	Up to 15 years	Up to 10 years	Up to 5 years
Infrastructure Development	Less possibility to link existing infrastructure	Medium possibility to link existing infrastructure	High possibility of linking existing infrastructure	Upgrading existing infrastructure	Building new infrastructure
Technological Approach	Secure, fast, and wireless technology	Cloud-based services/ enterprise-grade platform	Open data central/ holistic platforms	Better assimilation of data through predictive technologies	Fully networked, open and expandable ICT architecture
Business Model	Only public/only private investment	Contractor/vendor model	Private consortiums	Public-private partnerships	Open collaboration
Governance Maturity	Smart city vision	Smart city strategy	Dedicated organization	Smart city leadership	Smart city consortiums

Each city is a system where all production requirements are built into the modular system of the city. For example, renewable energy sources are located near the outer perimeter. Food is made closer to the centre of the city in industrial greenhouses. This is very different from the globalised economy, based on the squandering of labour and outrageous amounts of energy and resources due to unnecessary transport and handling as it is today.

The ecological crisis is manifested more clearly over time, forcing humanity to seek best strategies for their development. We can distinguish two prevailing trends in the choice of such a strategy: environmental conservatism, rigidly restricting the development of industrial areas, questioning the very legitimacy of its existence, and over-industrialisation (partly manifesting itself in the concepts of the information society), where the emphasis is on the breakthrough of the modern economy in the post-industrial world, where it presumably largely takes the edge off the situation.

Industrialised countries are experiencing a transformation, characterised by the following features: knowledge-based, capital-intensive, priority development of energy- and resource-saving production methods, technologies and products, including large-scale service industry, highly skilled labour force, a high degree of environmental protection.

One of the visible results of such a development is a multidisciplinary environmental monitoring. In other words, there are advanced sensor systems that are connected to the artificial intelligence (expert system).

Mankind today goes to a particular socio-economic reality, Ecopolis system («Ecopolis», «Eco-city», «Smart-city», «Sustainable city»). Ecopolises through appropriate information and communication infrastructure can unite by creating local "zone of stability".

Such Ecopolises can be characterised by the synthesis of 4 factors:

1. Economics of recreation, including social protection and rehabilitation, providing social infrastructure of the life of population;

2. microelectronics and pharmaceutical production. For example, decryption of human genetic code, vehicles for the disabled, including replacement of hearing and vision, will take to the next level, the global network of rapid delivery of organs for transplants; cloning technique inevitably leads to the great surprise in applications - the children of tubes become commonplace, automatic translators from one language to another reached such a level that there is no longer need for translators, humans influence the pharmaceutical industry and its products in everyday life will be many times stronger, increase the influence of genetically modified food;

3. Economy of the knowledge, cognitive economy. This economy of science and arts, implements intellectual creativity of the man, uniting in a single whole upbringing and education, as well as a highly productive innovation. The sphere of art is one of the key spaces of the post informational creative society. Transformation of underlying foundations of modern science is closely related to its transformation into a direct productive force;

4. Green economy. Infrastructure alternative energy and new, sustainable urbanisation.

Basically, Ecopolis network is a combination of self-organizing, synergetic systems based on the actualization of endogenous energy sources which inmates in the person, not in nature. There is a fundamental difference between the new scheme from the usual industrial and commercial networks (i.e. met mechanisms requiring continuous, ever-increasing influx of external energy). Selection of the sample ultimately determines the primacy of social creativity of the industrial expansion, and vice versa.

At the United Nations General Assembly on Environment in Nairobi, 23-27 June 2014, regarding the "smart cities" it was noted that the digital age allows you to build a "smart city", where information technology is used for coordination and dissemination of data in order to obtain a single view of the entire system that provides a comprehensive picture of decision-making and provides information in real-time to both suppliers and users to improve water supply, transport and energy (look http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/ and http://ec.europa.eu/digital-agenda/living-online/smart-cities.).

The positive experience of "smart cities" was the foundation of SmartAstana project. The Head of the State noted that until 2017 this project should run in full and the infrastructure construction of EXPO-2017 should use the principles of the "smart city." SmartAstana is based on the experience of European countries. In

world practice, the SmartCity concept has already proven itself by showing its efficiency in terms of energy savings, cost of maintenance of utilities and reduction of accidents on the roads. For example, in the United States, heat consumption reduced up to 25% and energy consumption for lighting up to 60% and it is also expected to save about 1.8 trillion dollars by 2020. In London, traffic delays are reduced by 15-40%, the capacity of the road network increased by 10-15%, travel time reduced by 15-20%, harmful emissions reduced by 20-25%, and an average speed increased up to 20 km /h. In Italy, the number of accidents decreased by 20%, while the number of fatal accidents has decreased 2 times. Projects of "smart" or called in the other way "open" cities are actively developing all over the world. In the short term, the "smart city" came to a fairly high level of development with the use of the main factors such as safety, environmental friendliness and economy.

The scale of the project and the use of the international practice taken into consideration, «SmartCity» attracted an international consultant, the Price Waterhouse Coopers (PwC) company, which has extensive consulting experience in the construction of SmartCity. Consultants assure that the project will cover infrastructure, social sector, intellectual, innovative part of the environment, ICT, culture and recreation, and participation in political life. Today, the project developers have begun to implement its two directions: Security city and Intelligent Transportation System (ITS).

By the end of 2017 in Astana, 42 "smart" traffics will operate on six streets: Saryarka, Turan, Kunaeva, Dostyk, Sarayshyk and Syganak. Traffic lights will be able to distribute the traffic flow while avoiding congestion on city roads. Experts estimate that the capital's residents will be able to significantly reduce the time they spend on the road, for example, to get from home to work. ITS project is implemented by the Spanish company Typsa, which has experience in more than 60 countries. Implementation of ITS is particularly relevant for Astana, where about 400 thousand cars daily pass its streets.

The main objectives of the project are adaptive management of traffic, priority to public transport in front of private, road safety, reduced harmful emissions, increase of speed and elimination of congestion. In the area of AstanaSafe, city streets will be equipped with cameras for day and night surveillance, as, for example, in London. The project developers have entered foreign design engineers who have used the experience gained to ensure safety. Photo and video fixation systems will also be installed on the roads for automatic monitoring of compliance with traffic rules. A part of the project will ensure the safety of public transport at the expense of video surveillance in the bus and the driver, smoke and fire sensors, emergency call buttons and a dashboard. All information about the situation in the city will come to the City Centre of operative management (CCOM) in real time. On the streets, there will be emergency communication centre operators' terminals and reference information. The centre-line will receive information about the state of public safety, city services activities

of state communications, transport streams and the enterprises. It is predicted that thanks to the development of the SafeCity project there will increase the efficiency of operational activities of the city services. Obtaining operational information will improve coordination of municipal and emergency services of the city responsible for the safety and life support of Astana. It is planned that the project will cover 69 schools, 72 kindergartens, 18 health centres and 11 hospitals, as well as places of mass gathering of people, more than 50 commercial, entertainment and business centres. The introduction of new technologies into the daily life of the city will improve the performance indicators and the SmartCity will allow Astana to enter the Top 50 "smart cities" of the world.

12.3 «Smart» systems of transportations and logistics managed by ICT

Freight is a global business that, as a separate sector, is responsible for 14% of global emissions, according to the Smart 2020 report. According to the growth of international trade report, packing, transport, storage, consumer purchases, and emissions are becoming an increasingly important source of energy and greenhouse gas emissions. Most of them fall on the transportation and storage. Logistics optimisation through ICT can lead to reduction in transport emissions by 16% and all global emissions by 27%.

GeSI Smart 2020 report evaluates reduction of the capacity 1,52 GtCO2e from 'smart' logistics systems. CO2 reduction potential by reducing the use of ICTs transportation and storage can be divided as follows (decreasing, which may be associated with the use of sensors and sensor networks are underlined):

- 34% through optimisation of logistics networks;
- 33% by optimising the collection and delivery route planning;
- 25% of the use of eco-driving for commercial transportation. Eco-driving requires adoption of measures to reduce emissions through ecological driving and implementation of other steps to ensure that the vehicle is in optimal condition: tires well inflated, onboard equipment used, etc.
- 22% by minimising the packaging;
- 18% due to lower stocks;
- 10% from the optimised route planning;
- 3% by optimising vessel loading factors;
- 3% by optimising ship operations;
- 2% by switching to intermodal transport, i.e. in the commercial sector this means using more than one mode of transport for the trip;
- 1,4% due to reduction in unnecessary flight time;
- 1% due to reduction of damaged goods;
- 0.4% reduction in fuel consumption and on the ground, and as a result, the efficiency of flight.

«Smart» transport systems (intellectual transport systems)

Optimisation and improvement of the flow of people and goods, as well as provision of services in the cities and on motorways, is another important application that can significantly reduce greenhouse gas emissions and energy consumption, while at the same time cleaning up all the more compacted roads and the city.

To help reduce emissions, an intelligent transportation system (ITS) can be created to optimise transport via traffic flow monitoring, planning and simulation technologies. ICTs "enable elements within the transportation system, vehicles, roads, traffic lights, message signs, etc., to become intelligent by embedding them with microchips and sensors and empowering them to communicate with each other through wireless technologies." 53 ITS can be grouped into five categories:

Advanced traveller information systems provide drivers with real-time information about road and weather conditions, and other related information.

Advanced transportation management systems include traffic control devices, such as traffic signals, ramp meters, variable message signs, and traffic operations centres.

ITS enabled transportation pricing systems to include systems such as electronic toll collection, congestion pricing, fee-based express lanes, and vehicle-miles-travelled usage-based fee systems.

Advanced public transportation systems, for example, allow trains and buses to report their position so passengers can be informed of their real-time status (arrival and departure information).

Fully integrated ITSs, such as vehicle-to-infrastructure and vehicle-to-vehicle integration, enable communication among assets in the transportation system, for example, from vehicles to roadside sensors, traffic lights, and other vehicles.

These technologies can be used to reduce congestion and enhance traffic flow in cities. Making transportation more efficient precludes or at least reduces the need to build more highways by enhancing carrying efficiency of existing roadways and transportation infrastructure. The use of real-time traffic data can improve traffic flow by reducing stops by as much as 40%, travel time by 25%, gas consumption by 10%and reduction in GHG emissions by 22%.

Most of the countries have already integrated ITC, including Japan, the Republic of Korea and Singapore. The ITS was integrated through PPP (Public-private partnership) in Japan and Korea.

Japan's VICS, Vehicle Information and Communication Systems, provides an up-to-the-minute, in-vehicle digital data communication system sending traffic information to drivers through an onboard telematics unit. VICS, which makes extensive use of probe data to generate real-time traffic information, was launched in 1996 and has been available nationwide since 2003. Following upon VICS, Japan is now launching Smartway as "Version 2.0" of the country's state-of-the-art ITS service. The system will be able to connect knowledge of the vehicle's location on the roadway with context specific traffic flow information, enabling it,

for example, to warn the driver, via voice instruction, “You are coming up to a curve with congestion backed up behind it, slow down immediately.”

South Korea will invest $3.2 billion in ITS deployment from 2008 to 2020, about $230 million annually, as part of the country’s ITS Master Plan. It built its ITS infrastructure on a city-by-city basis, establishing four initial “ITS Model Cities” that implemented: 1) adaptive traffic signal control, 2) real-time traffic information, 3) public transportation management, and 4) speed violation enforcement in these model cities. 29 South Korean cities have now deployed similar ITS implementations. 9,300 buses and 300 bus stops have deployed real-time bus location and status caption systems. South Koreans use T-money, an electronic money smart card (or mobile phone application) to make 30 million contactless transactions per day on public transit. The country’s Hi-Pass ETC system covers 50 percent of highway roads (expanding to 70 percent coverage by 2013) and is used by 31 percent of vehicles.

Some of the used technologies are illustrated in Figure 12.6.

Stephen Ezell, Explaining International IT Application Leadership: Intelligent Transportation Systems, (Washington, Information technology and innovation Fund, 2010).

Many ICTs that enable operation of the ITS have been described previously. These include wireless technology, mobile devices and applications, centrally managed data and network operating centres, which collect whole information to one place and provide access to it to drivers, passengers, operators of buses and taxis, and others through the ITS network. WSN and broadband technologies have crucial importance for the ITS.

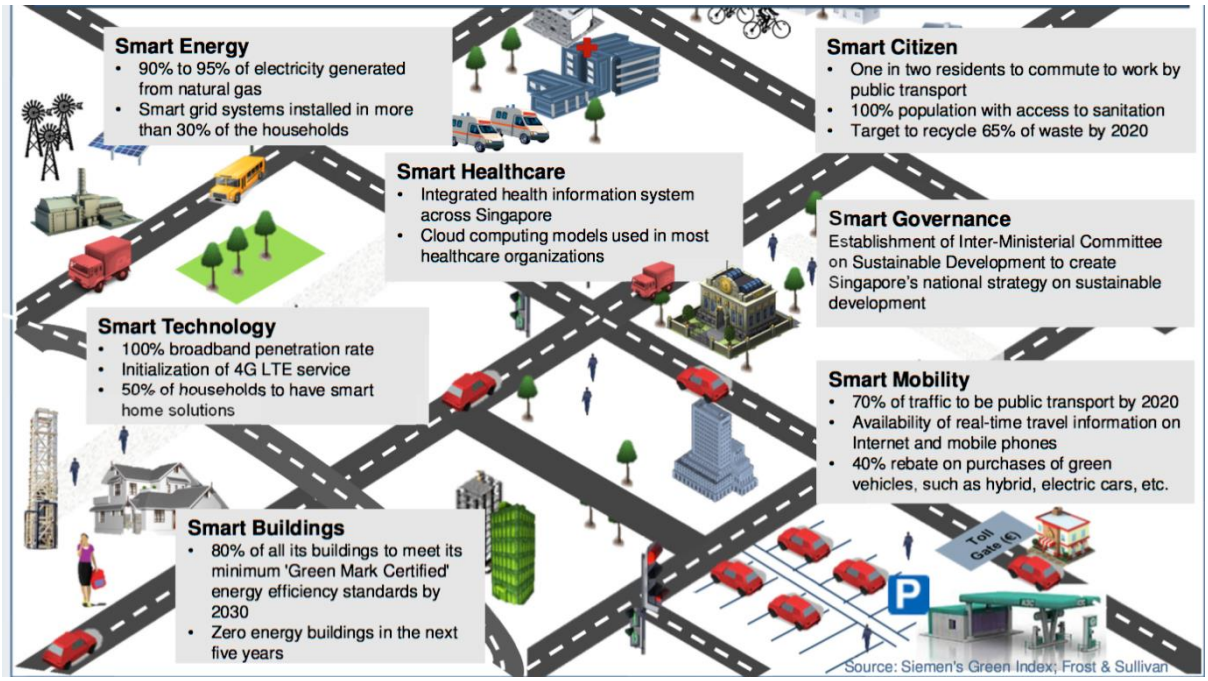

Figure 12.6 – The use of technologies associated with system traffic information in real time on the example of Singapore (*Source: Siemen's Green Index; Frost & Sullivan*)

"Smart" logistics and production are more relevant for developing countries which are building up their industrial sector than for small developing countries with the little manufacturing sector. Nevertheless, the advantages of intelligent technologies apply to all countries and jurisdictions.

"Smart" technologies enhances competitiveness and for this reason they are relevant in the emerging market economy and any country that seeks to strengthen its industrial and manufacturing sectors, especially if they intend to compete on world markets, where "smart" technologies are increasingly being used, available and interact, in some cases, being controlled through the Internet.

'Smart' transport systems require significant investment. Nevertheless, the use of wireless applications such as WSN can make deployment decisions in intelligent transportation easier and more cost effective. For countries that cannot afford the investment in the whole range of ITS technologies, some sensory systems may be particularly attractive because of their low cost and ease of deployment. However, many of these technologies and their use in "intelligent" transport systems are in their infancy, and currently, are being experimented with their use. Municipalities especially need to stay abreast of the development of measures for the deployment of intelligent transport.

Countries do not have to implement the ITS fully, as is the case with Japan and the Republic of Korea. They can take specifically selected technologies, depending on the priorities and local needs and conditions. For example, the priority transit technology may be the only signal which is needed first. In this case, the transponder is mounted on the bus and will use wireless technologies for rationalisation of transport streams by assigning priority to bus signal lights and, on the other hand, thus speeding up the transit time.

The use of different kinds of terminals for collecting the toll can allow users to pay for the fare before boarding the bus. In New York, the use of payment services to the fare before boarding buses reduced delays by 30%, resulting in an increase in passengers by 30%, and 20% of the fees have reached a very high (98%) degree of satisfaction. Combining fare payments via mobile devices, a technology that is widely available in developing countries, could further increase the efficiency of transport, thereby encouraging more people to use public transport and, consequently, reduce emissions and energy consumption.

As part of ITS, particular interest will be 'smart' payment systems that facilitate and speed up processing of transactions at the time when the passenger enters the public transport. Up to 30% of the time is lost in the field of public transport services due to delays caused by an inefficient accounting system of the passenger fare. Combining smart payment terminals using mobile devices is one of

the ways to promote a transition payment system both for the Internet and mobile devices.

Mobile devices and smartphones, in particular, will contribute to the implementation of the ITS. There are some examples:

"Smart" mobile devices can be used to transmit data associated with advanced travel information systems, including information about the traffic in real time;

Taxi, public transport and other service providers, such as rickshaws can use smartphones with GPS support, connected to an improved public transport system. GPS-data may be combined to display traffic patterns and traffic congestions for determining to redirect vehicles, respectively;

"Smart" mobile devices can be used to pay for public transport, as well as other purposes, i.e. free travel, travel for disabled and elderly, travel associated with any event, etc;

Providing information relevant to the ITS using smartphones and devices associated with them can be applied in the development of a variety of other specialised products and services in the field of public transport, including the time of certain actions, to promote the route and so on;

With the increasing use of smartphones there appears a possibility to get data from passengers that allow transport services to react fast on the problems, accidents and technical issues. Passengers can provide crowd sourcing information which can facilitate the work of the transport system.

Consider the following from a policy perspective:

For the private sector, implementation of "smart" technology is the way to improve competitiveness and market allocation. For private-sector operators, as well as for their customers 'smart' technologies facilitate business. The promotion of business and foreign direct investment is the movement of a common policy, which can stimulate private sector investment in "smart" technology;

Countries should ensure that the private sector operators can invest in these 'smart' technologies, encouraging them to do so in the form of friendly business policy and attitudes, as well as by eliminating any policy or regulatory barriers that may stand in the way;

Countries should provide access to high-speed broadband network, which is the tool of the "smart" technology implementation;

"Smart" technologies require intelligent technicians and other specialists. At the same time, while encouraging investors to invest in "smart" technology countries need to modernise training and education, so that young people can explore the technology and management practices that will enable them to meet the needs of companies to use these technologies and methods in the staff;

The development of combined skills in order to promote "smart" economy is an important political consideration. Countries need to assess their interest and ability to improve the educational potential of the country. Different countries, such as China, Costa Rica, Egypt, India, Malaysia, Philippines, Singapore, and many others, have made development of highly qualified staff both experienced in

the use of ICT and modern management methods the cornerstone of its development policy. In all cases, it was important benefits.

Conclusion:

Use of ICT plays a key role in the optimisation of production and provision of services in the field of logistics and transport. Optimisation is the most efficient use of energy and natural resources in order to limit emissions, waste and pollution, and implementation of the timeliest and cost-effective manner;

Enabling policy environment for investment into 'smart' technology, strengthening human capacity and raising awareness in this area are key strategies for the adoption of "smart" technologies.

12.4 “Smart” motors and industrial processes

Industrial companies tend to invest millions in their infrastructure. In spite of these investments, many facilities are experiencing inadequate performance of monitors and control engine functions in order to maximise efficiency and power consumption, as well as complete control of operating costs.

Without the data provided by the integrated automation a manufacturer is like a rider in the race at 320 km / h that is simply using common data indicated on the instrument panel: motor fuel, speed and temperature data. Reduced visibility performance of the car production process and ways of their optimisation is only a part of problems that producers face. If the process breaks down and production stops, the loss of expenses for production and labour costs in the standby mode may grow by the hour.

An electric motor is a "muscle" that holds the material and the work performed in the production process. When an error occurs in the motor, the production may stop as long as the cause is not diagnosed and repaired, and the engine is restarted. These results can be put in jeopardy production, from the reasonable (restart in seconds) to expensive (restart takes hours or days).

Overload relays were invented in order to protect industrial engines from damage caused by overload conditions. These are specialised devices that can experience congestion or other adverse condition of the circuit, open circuit, and then provide some other control or operating indicator. In fact, the motor protective function of normal overload relays may expose the performance of process hazards, protecting the connected motor.

There are different types of relay, from simple overload relay thermal sensors to more complex solid state relay, which is referred to as intelligent engine management (SMM). They may include a wide range of programmed intelligence and the possibilities of the message. An important feature of this type of SMM device is its ability to take local control of the process, if the connection is lost. While overload relays have been designed to protect only the engine, SMM may help to protect the motor and the process, which stimulates it.

Over the past several decades, the production processes have become more and more complex. Rapidly changing market demand, including consumer expectations of a variety of products requires great production flexibility on the part of manufacturers. Competition among manufacturers demands answers.

Given the complexity and demands of production flexibility and responsiveness, technologists face a problem that needs to be maintained at a high level. No matter how complex their processes and monitor projects are, simple or catastrophic motor failure that occurred along the line can result in the production of related processes to a halt with many possible consequences.

A motor is “smart” when it can be controlled to adjust its power usage to a required output, usually through a VSD and intelligent motor controller (IMC), a piece of hardware controlling the VSD. Industrial activity is one of the largest contributors to global emissions, responsible for 23% of total emissions in 2002 (9.2 GtCO2e). ICT could play a significant role in mitigating global carbon emissions from motor systems and industrial process optimisation, up to 970 MtCO2e in 2020. These opportunities are not going unnoticed – initiatives such as Energy Smart in Australia, BC Hydro’s Power Smart in Canada and Motor Decisions Matter in the US are all working with businesses to identify optimal use of smart motors in their processes and the carbon and economic savings are substantial. Carbon emissions as a result of energy used by the growing manufacturing industry in regions such as China increase still further, as most of the electricity required will be generated using carbon-intensive coal-red power stations.

Smart motors have several advantages over conventional motors. For example, when the vehicle is stopped longer (for example at traffic lights or in a traffic jam) intelligent system automatically cuts the engine and re-launches it as soon as the driver releases the brake pedal. According to specialists, such a system must ensure reduction of fuel consumption and emissions in the urban cycle by about 10% (in the case of large movements’ difficulty saving up to 17%). This car will produce less noise and vibration; it should be like sitting in a car and others. Of course, the system can be forced to disable. In addition, Stop & Start function will not work when the engine is too cold, the battery discharged, seawater temperatures below -10 and above 30 degrees, heating switched glasses and reverse gear. For example, a car equipped with a 1.4-liter 16-valve 90-horsepower engine, automatic transmission and SensoDrive and "smart" system will consume 5.7 liters of fuel per 100 km in the combined cycle.

12.5 Monitoring with the help of 'Smart' devices (intellectual sensors, meters and etc.)

Smart Grid includes the following components:

- Virtual power plants;
- Smart meter;

- "Smart" home or intelligent buildings;
- Monitors and control software.

Virtual power plant combines electric power sources (block thermal power plants, gas power plants, biogas plants, solar panels or wind turbines), as well as necessary elements of the grid (transformer substations). It can cover a large geographical area and its individual components are connected to the central control system using information technology. One of such projects is implemented by Lichtblick company, German electricity provider, providing centralised management of distributed all over Germany block thermal power stations in accordance with the relevant requirements.

There are two aspects which are important for Smart Grid:

- network manages users and network elements;
- Smart Grid cannot function without a smart meter.

Smart meters implement interfaces to the network and consumers. It is not just about power meters, they can measure consumption of gas, heat or water. Being bi-component, such a counter supports remote readout and parameterisation, network connection and disconnection from her, the power consumption measurement (interval data collection), load management, and control of decentralised energy producers and management. Experts believe that these solutions have a large potential market. Currently, Germany is implementing a number of pilot projects, but lack of clear legislative wording complicates the work of manufacturers and energy supply companies.

On the one hand, smart meters send power supplies current information on consumption and on the other hand getting data on tariffs. Often such communication is implemented via a cellular communication interface, but you can imagine and the use of existing infrastructure of the Internet through a VPN (Virtual Private Networks, VPN) or the transfer of data on the power (Power Line Communication, PLC) (Fig. 12.7).

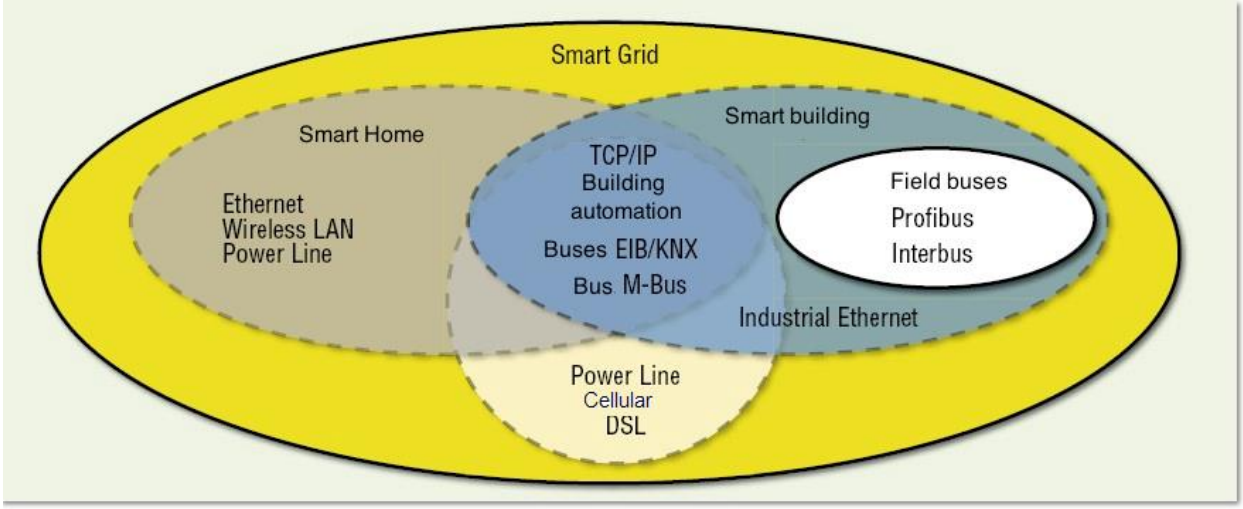

Figure 12.7 – The domain of the Smart Grid network, "smart" homes and intelligent buildings with a variety of communication infrastructure used by them (source: «Журнал сетевых решений/LAN», № 06, 2011).

In building different types of networks are available for communication which will be discussed in details later. Protection plays an important role in the transmission and processing of the data as no one wants the information to be obtained by an unauthorised person in such a simple way.

12.6 The Internet of Things

The term “the Internet of Things” (IoT) was first used in 1999 by a British technology pioneer Kevin Ashton to describe a system in which objects in a physical world could be connected to the Internet by sensors. Ashton coined the term to illustrate the power of connecting Radio-Frequency Identification (RFID) tags used in corporate supply chains to the Internet in order to count and track goods without the need for human intervention. Today, the Internet of Things has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors and everyday items.

At the beginning of 2016 the use of the Internet of Things technologies was oriented to the mass segments of the IoT, where the end user motivation to use IoT solutions and services are market-based incentives, such as:

Smart House, including:

- Solutions for creating smart security services
- Solutions for creating intelligent services to optimize the use of household resources.

Smart transportation, including:

- Fleet management class services for individual carriers (some analogue of Uber for freight transport);
- UBI-insurance services;
- Maintenance services for the actual condition.

Trade and financial services

- Solutions for automatic transmission and analysis of data with POS-terminals, including virtual ones;
- Management of the household reserves as a service.

Industrial segment

- Translation process control on the principles of IoT

IoT’s roots can be traced back to the Auto-ID Center at the Massachusetts Institute of Technology (MIT). This group was founded in 1999 and worked in the field of network radio frequency identification (RFID) and emerging sensing technologies. The labs consisted of seven research universities located across four

continents. These institutions were chosen by the Auto-ID Center to design the architecture for IoT. Before we talk about the current state of IoT, it is important to agree on its definition. According to the Cisco Internet Business Solutions Group (IBSG), IoT is simply the point of time when more "things or objects" were connected to the Internet than to people.

In 2003, there were approximately 6.3 billion people living on the planet and 500 million devices connected to the Internet. By dividing the number of connected devices by the world population, we find that there was less than one (0.08) device for every person. Based on Cisco IBSG's definition, IoT did not yet existed in 2003 because the number of connected things was relatively small and ubiquitous devices such as smartphones were just being introduced. For example, Steve Jobs, Apple's CEO, did not unveil the iPhone until January 9, 2007, at the Macworld conference.

The explosive growth of smartphones and tablet PCs brought the number of devices connected to the Internet to 12.5 billion in 2010, while the world's human population increased to 6.8 billion, making the number of connected devices per person more than 1 (1.84 to be exact) for the first time in history.

In January 2009, a team of researchers in China studied Internet routing data in six-month intervals, from December 2001 to December 2006. Similar to the properties of Moore's Law, their findings showed that the Internet doubles in size every 5.32 years. Using this figure in combination with the number of devices connected to the Internet in 2003 (500 million, as determined by Forrester Research), and the world population according to the U.S. Census Bureau, Cisco IBSG estimated the number of connected devices per person.

Refining these numbers further, Cisco IBSG estimates that IoT was "born" between 2008 and 2009. Today, IoT is well under way, as initiatives such as Cisco's Planetary Skin, smart grid, and intelligent vehicles continue to progress.

Currently, IoT is made up of loose collection of disparate, purpose-built networks. For example, today's cars have multiple networks to control engine function, safety features, communications systems, and so on. Commercial and residential buildings also have various control systems for heating, venting, and air conditioning (HVAC); telephone service; security; and lighting. As IoT evolves, these networks and many others will be connected with added security, analytics, and management capabilities (Fig. 12.8). This will allow IoT to become even more powerful so it can help people achieve what they want.

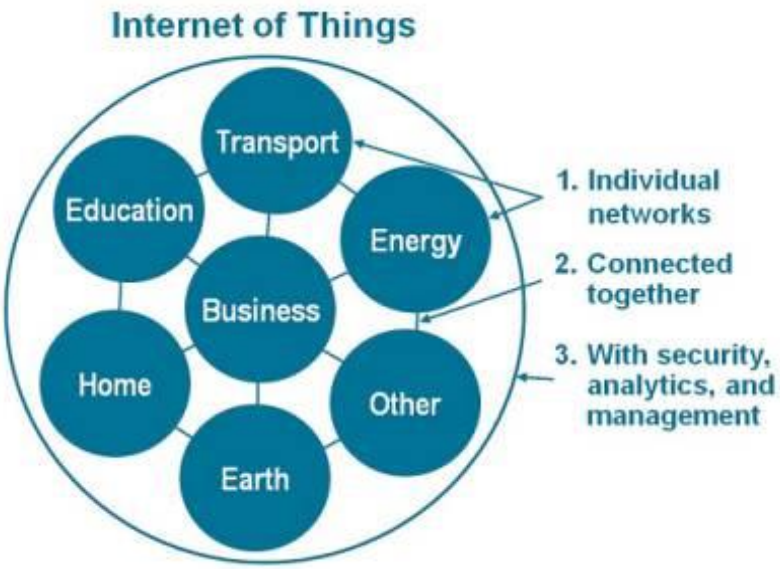

Figure 12.8 – The Internet of Things

Interestingly, this situation reflects what the technology industry experienced in the early days of networking. In the late 1980s and early 1990s, Cisco established itself by bringing disparate networks together with multi-protocol routing, eventually leading to IP as the common networking standard. With IoT, history is repeating itself, albeit on a much grander scale.

12.7 Big Data

Introduction of the term ‘Big data’ refers to Clifford Lynch, an editor of the journal Nature, who on September 3, 2008 prepared a special issue for magazine with the theme "How can the future of science technology open up the possibility of working with large amounts of data?", where the materials of the phenomenon of the explosive growth in the volume and diversity of data was processed and technological prospects in the paradigm of a possible leap from quantity to quality were collected. The term was proposed by analogy with the conventional wisdom in the business environment of English metaphors as big oil and big ore.

The category of large data (Big Data) includes information which is no longer possible to process by conventional methods, including structured data, media and random objects. Some experts believe that in order to work with them the traditional monolithic systems are replaced by new massively parallel solutions.

12.7.1 Methods of big data analysis

There are many techniques that are being used to analyse datasets. In this article, we provide a list of some techniques applicable across some range of industries. This list is by no means exhaustive. Indeed, researchers continue to develop new techniques and improve existing ones, particularly in response to the

need to analyse new combinations of data. We note that not all of these techniques strictly require the use of big data—some of them can be applied effectively to smaller datasets (e.g., A/B testing, regression analysis). However, all of the techniques we list here can be applied to big data and, in general, larger and more diverse datasets can be used to generate more numerous and insightful results.

A/B testing: A technique which determines what treatments (i.e., changes) will improve the given objective variable, e.g. marketing response rate. This technique is also known as split testing or bucket testing. An example application determines what copy text, layouts, images, or colours will improve conversion rates on an e-commerce Web site. Big data enables huge numbers of tests to be executed and analysed, ensuring that groups of sufficient size detect meaningful (i.e., statistically significant) differences between control and treatment groups (see statistics). When more than one variable is simultaneously manipulated in the treatment, the multivariate generalization of this technique, which applies statistical modelling, is often called "A/B/N" testing.

Association rule learning: a set of techniques that discover interesting relationships, i.e., "association rules," among variables in large databases. These techniques consist of a variety of algorithms to generate and test possible rules. One application is market basket analysis, where a retailer can determine which products are frequently bought together and use this information for marketing (a commonly cited example is that many supermarket shoppers who buy diapers also tend to buy beer). It is used for data mining.

Classification: a set of techniques that allows us to predict the behaviour of consumers in a certain segment of the market (making purchasing decisions, the outflow volume of consumption and so on). It is used in data mining.

Cluster analysis: a statistical method that classifies the objects into groups by identifying their unknown common features in advance. It is used in data mining.

Crowd sourcing: a method that collects data from a large number of sources.

Data fusion and data integration: a set of techniques that allows us to analyse the comments of users on social networks, and compare the results of sales in real time.

Data mining: a set of techniques that allows us to determine the most susceptible promoted product or service category of consumers, identify the most successful features of employees and predict the behavioural model of customers.

Ensemble learning: this method has operated a set of predictive models thereby improving the quality of predictions.

Genetic algorithms: in this technique the possible solutions are in the form of chromosomes, which can be combined and mutated as in the process of natural evolution where the strongest survives.

Machine learning: a direction in computer science (artificial intelligence), which aims to create self-analysis algorithms based on empirical data.

Natural language processing (NLP): natural human language recognition techniques that was borrowed from computer science and linguistics.

Network analysis: a set of links analysis techniques between nodes in the networks. With regard to the social networks it allows us to analyse the relationship between individual users, companies, communities and etc.

Optimisation: a set of numerical methods that redesigns in the complex systems and processes to improve one or more indicators. It helps to make strategic decisions, such as output product line, conducting investment analysis, and so on.

Pattern recognition: a set of self-elements methods that predicts consumer's behaviour models.

Predictive modelling: a set of techniques that allows us to create a mathematical model of previously given scenarios. For example, the base of CRM-system data analysis encourages subscribers to change service provider.

Regression: a set of statistical methods that identifies changing patterns in dependent and one or more independent variables. It is often used for forecasting and prediction. It is used in data mining.

Sentiment analysis: technology recognition of natural human language lies in the heart of the consumer sentiment valuation techniques. They allow you to isolate the general flow of information messages related to the subject of interest (e.g. consumer product), estimate the polarity judgment (positive or negative) and the degree of emotion.

Signal processing: borrowed from the radio set of techniques it aims to signal recognition of noise and its further analysis.

Spatial analysis: a set of statistics that was partly borrowed from spatial data analysis techniques as the topology of the terrain, geographical origin and the geometry of objects. The source of big data often performs geographic information system (GIS).

Statistics: is a science of collecting, organising and interpreting data, including developing questionnaires and conducting experiments. Statistical methods are often used to value judgments about the relationships between certain events.

Supervised learning: a set of machine learning methods based on technologies that can detect functional relationships in the analysed datasets.

Simulation: simulation of the behaviour of complex systems is often used to forecast, predict and study different scenarios when planning.

Time series analysis: a set drawn from the statistics and digital signal processing methods that analyze series of data repeated over time. Some of the obvious applications are tracking market securities or morbidity of patients.

Unsupervised learning: a set of machine learning methods based on technologies that can detect hidden functional relationships in the analysed datasets. It has similarities with the Cluster Analysis.

Visualisation: methods of graphical representation of the large data analysis that are given in the form of diagrams or animated images for understanding the interpreted and facilitated results easily.

12.7.2 Analytical instruments

Some of these approaches described in the previous allow you to put the analytical engines of big data into practice. Free or relatively inexpensive open systems that analyze Big Data are:

- 1010data;
- Apache Chukwa;
- Apache Hadoop;
- Apache Hive;
- Apache Pig!;
- Jaspersoft;
- LexisNexis Risk Solutions HPCC Systems;
- MapReduce;
- Revolution Analytics.

Appache Hadoop is an open source software. Once Yahoo opened Hadoop to the community as an open source code, entire field products were created based on Hadoop. Almost all modern big data analysis tools provide integration with Hadoop. Their developers act as start-ups and well-known global companies.

12.8 Blockchain technology

The Internet today connects billions of people around the world. It is great for online communication and collaboration. It was just built for moving and storing the information, so it has not changed the way we do business. When you send someone information by email, PDF, PPT, or JPG, you are really sending a copy, not the original. They may be able to print a copy of these files depending on the rights granted to the recipients.

We have to rely on powerful intermediaries to establish trust to the information on the Internet. Banks, governments, and even social media companies like Facebook work to establish our identity and ownership of assets. They help us transfer value and settle transactions.

Enter the blockchain, the first native digital medium for peer to peer value exchange. Its protocol establishes the rules in the form of globally distributed computations and heavy duty encryption that ensures the integrity of the data traded among billions of devices without going through a trusted third party. Trust is hard-coded into the platform. That is why we call it the Trust Protocol. It acts as a ledger of accounts, database, notary, sentry and clearing house by consensus.

Every business, institution, government, and the individual can get benefit in profound ways. The blockchain is already disrupting the financial services industry.

Blockchain is a string of data blocks, where each block is connected with the previous one. The block contains a set of records. New blocks are always added strictly to the end of the chain (Fig. 12.9).

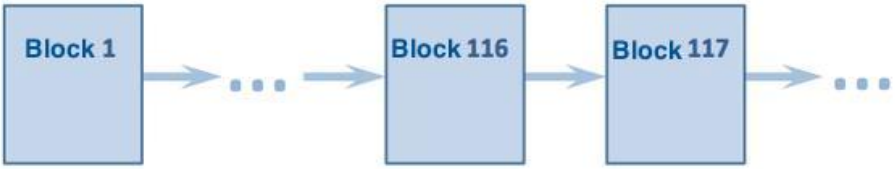

Figure 12.9 - Blockchain

However, this is a very difficult chain which is based on three important principles:

- distribution;
- openness;
- security.

All users of blockchain create a network of computers, each of which contains a copy of blockchain data. It is usually a complete copy of all blocks, but in principle, only necessary data can be stored on a particular computer. This eliminates the chance of turn off or breaks of the blockchain because it requires shutting down or breaking down of all computers. Blockchain works as long as there is at least one user. Each new user expands and strengthens the network. Moreover, all computers are equal; there are no organisers, moderators, supervisors and managers. Everyone is responsible for himself.

All blockchain data, blocks and their contents are always open for all users. You can easily read any block and see all the entries in this block. You can see the chain and keep the track of changing information. All data in blockchain is easily verifiable, and therefore, you do not necessarily trust other participants in the network, because you can always check them and get a guaranteed reliable answer. Blockchain widely uses encryption to protect data and users. So you get the openness and reliability at the same time with complete mistrust to other participants, and perhaps even their malicious intent.

In blockchain anyone can see that someone has a million, but the owner will not be shown until he shares with a special key.

Reliability and security in blockchain is held on cryptographic keys, with the help of which you can easily verify the authenticity and correctness of the data.

In fact, the key is just a number, a big number, for example 1173161954235709850086879078532699846656405640394575840079131296399 35.

It is calculated using an algorithm called hash function. The trick is that hash function gives exactly one key for a given set of data that has two very important properties:

- You cannot find the original data set with given key;
- It is almost impossible to find another set of data by giving the same key.

Having a key, you will, by and large, not know anything and cannot do any harm. But, by seeing the raw data you can easily check that they comply with the provided key. Here you have openness and protection in one set.

There are another important feature keys that should be mentioned. The key changes completely even with the minimal change in the initial data.

All data in blockchain is stored on users' computers. All network users are equal in their rights and, in general, can do anything they want, including unsuccessful attempt to deceive other users. No one can forbid them, because all users are equal, have equal rights, equally enforce and even violate their duties.

Thus, the user of blockchain-network does not need any intermediaries, such as banks, state agencies, auditors, inspectors, insurance companies or registrars. There is nobody to ask permission and drawing comfortably occupied position does not give any additional rights or opportunities, no one's authority protects you more than you can protect yourself. A blockchain-network user connects to other computers to exchange data: blocks and records. It is important that this network is not tied to geography, i.e. the user from Moscow can simultaneously connect to users from Beijing, London, New York and Buenos Aires. And this also protects it from any regional peculiarities (Fig. 12.10).

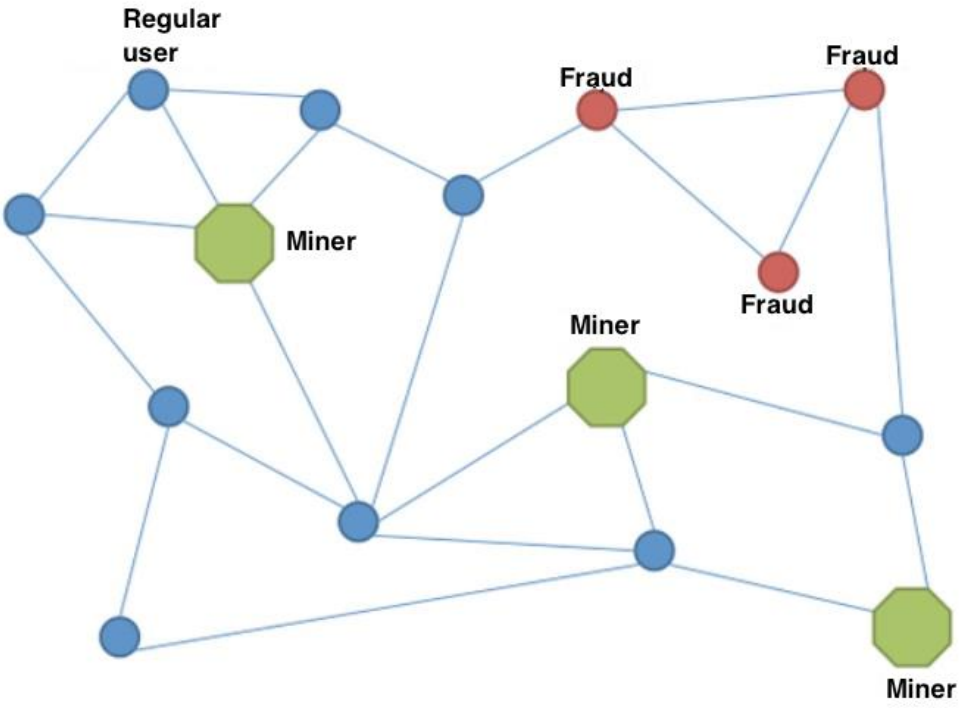

Figure 12.10 - Blockchain-network

Each user checks the correctness and ensures the reliability of new data when he receives it. Then he saves it, but also passes it to the network. The network can run two types of data: real and fake. They are distributed as malicious and respectable participants. Each respectable party finds fake data which is not transmittable. As a result, fake data wanders between malicious parties and respectable participants when they are exchanging the correct data.

Network participants are divided into two groups: regular users who create new records, and miners who create blocks. The fact is that the creation of the unit is a very resource-intensive and complicated process, and therefore not all participants can do it.

Ordinary users create and distribute a recording in the network, for example, "a user with the key A transfers money to the user with the key B" or "A person took the car loan with the key X". As you can see, all the records are open but encrypted. If you know the key of the car, then you can find out whether it is the loan, but you do not know the name of the owner or the name of the bank-mortgagee.

One person can have more than one key.

Then miners collect records, check and record them in the blocks and then send out the blocks on the network. After that, a normal user can get the blocks and keep them at home, so that he can check other people's records.

If the new record is not included in any unit, it is not reliable. Any member of the network can use it and there is a possibility that it is an incorrect or even fake account. Therefore, participants usually send new entries, so they sooner or later reach miners, who will include them into the block. And when the record is stored in the unit, you can be sure that it is checked and corrected. So it operates in Blockchain.

12.9 Artificial intelligence

Artificial Intelligence is the research area where the hardware and software problems are formulated and solved by stimulation of human activities. Today, due to the advances of artificial intelligence there was created a large number of scientific research which greatly simplifies the lives of people. Speech recognition or a scanned text, the solution is computationally complex tasks, and also other things are becoming available with the development of artificial intelligence.

Artificial intelligence as a scientific discipline is a good example of integrating various scientific fields. Experts in the fields of natural sciences and computer sciences study the properties and functioning of living systems by using similar methods.

Replacement of a human expert with artificial intelligence systems can significantly speed up the process and reduce the cost of production. Artificial intelligence systems are always objective and the results of their work do not depend on the number of subjective factors which are inherent to a man. But there

are dubious illusions and hope that artificial intelligence will be able to replace human's labour work. Experience shows that artificial intelligence systems achieve the best results if function together with a man. After all, people can think outside the box and they are more creative than artificial intelligence, which allow artificial intelligence to grow and move forward throughout its era.

Methods and means of artificial intelligence (AI) are able to solve a lot of problems in different fields such as industry, medicine, construction, energy and everyday life.

We can construct a new type of economy by using mathematical models that are based on the principles of AI. If there is a sufficient computing power and a giant automated system, we can release and create industrial goods and other services on the Earth.

12.10 Green technologies in ICT

Nowadays, the effectiveness of "green" technology is an urgent problem in the field of ICT. This trend came to Kazakhstan from the West, where the population is really concerned about the preservation of the environment. Western people save water, electricity and other recoverable or non-recoverable resources as their daily hygiene. Our mentality is not inclined to feel sorry for natural resources, which are national treasure. We consider them as endless, or at least sufficient. So, if you conduct a survey among local companies, most of them will say that they have rarely thought about the safety of the used technologies.

Green technology is closely linked to the "green economy". "Green" economy is a new global area of innovative anti-crisis development of the world economy. New course suggests a real improvement of human's well-being. It aims to build a modern infrastructure and increase the comfort of living, implies a massive reproduction of high-paying jobs, and facilitates the transition of finance, taxation, education and revolutionising science to new principles.

"Green" technologies in the ICT offer solutions for the use of computer technology and communication facilities with the least environmental damage and maximum positive effect on the environment. They include the reduction of specific energy consumption, insurance of longer service life, features of recycling and saving disposals of the individual devices and network components, transition to alternative energy sources for the operation of data storage and processing centres.

On the other hand, potential contribution of ICT to the "green" economy is not limited. The widespread use of digital technology provides a unique opportunity for "greening" the economy in general. The direct effect of ICT development that we are witnessing today is the dematerialization and miniaturization consumption and virtualization of many activities through the introduction of electronic document management, the development of electronic media and the market of e-books and music, the expansion of e-commerce and

online banking, the usage of e-mail and video conferencing for meetings and the transition to the remote operation.

"Green" technologies like ICT trend appeared in early 2000 to find alternative sources of energy. Subsequently, this trend has become more widespread and its addition to the ICT sector has joined agriculture to resource-saving technologies. Some analysts connect the concept of "Green Technology" with all solutions which promote ICT environmental exploitation. Some restrict the "green" technology by creating a new data centre. In fact, the definition of "green" can be given to any technology, as each of them involves replacement of old equipment with more efficient one, which reduces the time of operations and the amount of consumed energy. "Green" technologies in the ICT offer solutions with the least environmental damage and the maximum positive effect on the environment.

Another issue is recycling of old equipment. For example, if you throw away an old system unit it may remain until it decomposes completely. It can take up two hundred years. "Two years ago it was estimated that the average Englishman in his life emits about three tonnes of electronic junk" – wrote Stein Ramsli, the head of the TANDBERG representative in Russia and CIS countries, in the magazine "Technologies and means of communication", №1, 2010. If you update these calculations, the picture is even more dismal.

In fact, the vast majority of the company does not give value for "green" technologies. According to the recent informal study of TANDBERG, European management puts "green" on the last place of technology importance. Perhaps, it is the consequence of the crisis. Despite the fact that ICT has not been observed in the atmosphere as carbon dioxide emissions, it consumes electricity generated by power plants, and it certainly does not contribute to the improvement of the ecological situation, which is already a cause for serious concern. The growth of electricity consumption in the world is shown in Table 12.3.

Table 12.3 – Energy consumption (billion kilowatt / hour) source: Koomey J. Growth in Data Center Electricity Use 2005 to 2010, August 2011, [Available from: http://www.analyticspress.com/datacenters.html]

Server classification /Year	**2000**	**2005**	**2010**
Massive	19,7	50,5	67,2-81,5
Medium	6,7	6,7	5,1-7,3
High-performance	2,8	4,4	7,8-13,0

Despite the growth of servers' performance, supercomputers are significantly ahead of the growth of their energy consumption. The increase of data is accompanied by the growth of energy consumption. According to George Kumi, in 2010 the world's data centres consumed 203 - 271 billion kilowatts/hour electricity, which is 1.1-1.5% of global electricity consumption (in 2000 it is about 71 billion

kW/hr., or 0.5% respectively). In the US, the corresponding figures were 67-86 billion kW/h (1.5 - 2.2%) in 2010 and 28 billion kW/h (0.8%) in 2000.

Many scientific facts prove that acceleration of global climate change process is associated with strengthening of the greenhouse effect by 80%, caused by emissions of carbon dioxide (CO2) from the combustion of fossil fuels: coal, oil and gas. This can lead to the fact that sooner or later humanity will be able to use the "green" technology.

The post-crisis period forces to reconsider the relation to the "green technology." The impact of the crisis will force the company to restructure the business model and resort the energy-saving technologies. However, without planning and careful calculations the cost of electricity that ICT uses and the damage that they cause to the environment remain at the same level or even increase. It raises the necessity to determine the measure of IT damage to the environment.

The use of ICT not only improves economic and social indicators but it also has an impact on the environment due to the increased energy consumption, air emissions, accumulation of e-waste. According to Gartner, CO2 emissions are about 2%, which is comparable with the level of aviation emissions. According to forecasts, by 2020 this figure will increase by 6% annually. At the same time, ICT can be used to improve the environment. They are effective cross-cutting tools that can help to limit and reduce GHG emissions in the other sectors of the economy, mainly due to the development and introduction of more energy efficient devices, networks and safe disposal of equipment at the end of its life cycle. Efforts should be focused on creating more standardised power supplies, batteries and smart devices.

The basic concepts of the "green" office, "green" standards and "green" economy

Green Office is an environmental management system for offices. With its help workplaces are able to reduce their ecological footprint and greenhouse gas emissions. And it also saves money (source: https://wwf.fi/en/green-office/).

With the help of relatively simple steps, you can reduce the use of natural resources and make a contribution to environmental protection. Saving resources is a small but real contribution to solve the problem of global climate change, which can be made using the Environmental Office.

Advantages and benefits of the approach implementation:

- High quality of the building (room) is confirmed and guaranteed by the presence of recognised international community (for labeling "Leaf of Life" is the GEN, IFOAM);
- An opportunity to ask for a higher rent due to the uniqueness of the offer and high-quality facilities;
- An ability to increase the office occupation rate;

- Attracting foreign tenants who are familiar with the approach and willing to pay for office efficiency and environmentally responsible company;

- Certification and eco-labeling are the basis for the marketing strategy of potential landlords;

- Saving the budget by reducing the costs of resources such as electricity, water, paper and plastic;

-Foundation of additional media and PR-strategy of the company;

- Implementation of the "green" office programs increase and effectiveness of collective management systems;

- The program "green" office is a simple and necessary step towards implementation of environmental policy;

- Environmentally responsible image of the company is a real market advantage among its customers and partners;

- Improving the staff efficiency.

"Green" office or eco-office is not just a business premise in the decor which uses a lot of greens; the whole philosophy of prudent management of the organization is aimed at maximum reduction of negative impact on the environment by the rational use and saving both the planet's resources and human and financial resources of the company.

The following recommendations were provided by Greenpeace Russia, which became one of the first non-governmental organisations in the CIS to introduce "green" principles in Moscow offices, thereby reducing the administrative office expenses by 12%.

Ecological and economic advantages of "Green" offices

Environmental benefits of "green" office consist in significant reduction of the consumption of energy, water, heat, supplies, and the resources required for the production. The main concerns of the business are income and economic feasibility. This financial gain of the "green" office attracts many organisations. Reputable organisations like Intel, SchneiderElectric, Johnson Controls, Google, Black Stone, KAMAZ, Optics, UPECO have already experienced the benefits of environmental management. This approach helps not just save significant resources of the company, but also improve the company's image.

Activities for implementation of energy-saving technologies in offices of Kazakhstan are based on the world experience.

Energy savings through the introduction of energy-saving technologies

1. Energy-saving lamps are used instead of incandescent bulbs which consume more electricity. Due to lower power consumption and longer service life their costs are high but fully repaid.

2. Electronic ballasts in fluorescent tube lamps reduce power consumption by 30% with the same brightness. The cost of electronic ballasts exceeds the cost of

electromagnetic ballasts, but the initial cost is offset not only by high efficiency but also gentle lamp operation prolonging their service by 50%.

3. LED lighting can be used in the office because it is cost-effective, and the lack of mercury greatly facilitates their disposal. LEDs are better that energy-saving lamps and their service life depends on the specificity of the lighting transition.

4. Offices can be equipped with automatic lighting control systems: motion sensors, photoelectric relays, timer switches and etc. All these devices allow you to adjust the illumination of different areas and switch off electrical appliances and lights in offices automatically. Light used in the office (corridors, halls, bathrooms, stairs and facades) is variable. Implementation of auto-control systems can reduce energy consumption and reduce lighting costs by 25%.

5. Installing multi-rate counters in offices allows paying for electricity with different rates, depending on the time of the day.

6. During the time of reduced tariffs, conscious reorganisation of office work with "loading" office equipment and other electrical appliances is beneficial to the organisation and to the operation of power levels.

Saving energy on the collective level:

1. turn off the light where it is not currently in use;
2. clean the dust from lampshades and lamps;
3. use local lighting and try to reduce the level of ambient light;
4. use natural light;
5. configure the computer to support the sleep mode;
6. do not leave the charger plugged in without the rechargeable device;
7. turn off the office equipment, surge the protectors and other electrical appliances when you leave the office.

Saving heat:

1. equip radiators, thermostats to halve the heat consumption. Place the control on the lower temperature regime in non-working hours;
2. set Heat Reflector for radiators that reduce heat loss through exterior walls of the building;
3. insulate the room, replace windows with modern double-glazed windows (not containing PVC), and conduct comprehensive measures to further isolation facilities;
4. do not clutter furniture and battery, do not cover them with thick curtains;
5. install heat consumption metering devices and use them for testing the heat supply of organizations.

Water Saving:

1. equip offices with water metering devices and inform the employees about it and explain the need of rational use of water. Pay actual costs on the basis of performance counters;
2. keep taps and plumbing in serviceable condition;

3. use water-saving shower heads and equip faucets with dividers;
4. use sensor faucets or taps;
5. use the dishwasher;
6. equip toilets with two flush modes;
7. replace conventional soap to liquid.

Rational choice and use of paper:

1. use recycled paper;
2. use paper produced without chlorine bleaching and FSC certified, obtained from environmentally and socially responsible forest management. The cost of such securities does not exceed the cost of the ordinary;
3. print on the reverse side of the paper and use double-sided printing;
4. use correspondence e-mail and print out email letters when it is absolutely necessary;
5. try to introduce an electronic document management system.

Additional recommendations:

1. collect the waste by organizing sites for temporary storage of recyclable materials and, if possible, by concluding contracts with companies involved in its reception;
2. rely on environmental rating of electronics of manufacturers when you choose the office equipment and other appliances;
3. do not use disposable plastic products and replace them with reusable goods;
4. use safe household products that do not contain organochlorine compounds, chlorine, phosphates and phosphonates;
5. try not to use the stationery, interior, electronic and household appliances from polyvinyl chloride if there are alternative products on the market;
6. Do not buy products containing GMOs.

Environmental policy in the office

All these measures will have much greater effect if the initiative comes not only from directors but also directly from the team who daily work in the office. Making employees as an important part of the "green" office helps to support environmental initiatives and innovations strongly. You enhance the result by explaining the benefits of the company's participation in the project and their role. You can expect universal understanding and instant changes. In order to explain correctly it is required to use facts and figures. You can post the information about saving electricity, water supplies and describe the project, its aims and further results, so it helps you to improve the comprehension among staff.

Case study (source: http://www.ecostandardgroup.ru/cert/ecopro/)

1. Project "Green Office" Greenpeace-Russia was launched 2.5 years ago;
2. Project "Living Office" the WWF, which also involves a number of Russian companies, in particular, "M-Video", was launched a year ago;

3. GreenUp Agency launched a project "Eco-office" in September 2010. Also, St. Petersburg Ecological Union joined this project. They are developing a system of certification and eco-labeling "Leaf of Life. Eco-office" corresponding to the requirements of ISO 14024 recognized by the Global Ecolabelling Network (GEN);
4. Company EcoStandard group together with NP "National Bureau of environmental standards and ratings," have developed a program for certification of green offices.

12.11 Teleconferencing

Teleconferencing is a meeting through the telecommunication medium. It is a generic term for connecting people from two or more locations by electronics. There are at least six types of teleconferencing: audio, audio-graphic, computer, video, business television (BTV) and distance education. The methods used are different, but common factors contribute to the shared definition of teleconferencing:

1. Use of telecommunication channel
2. Connecting people from different locations
3. Providing two-way interactive communications
4. Requiring users' active participation
5. Types of Teleconferences
6. Audio Teleconference: Voice-only; sometimes it is called conference calling. It connects people from the remote locations via telephone lines. Audio bridges tie all lines together. Meetings can be conducted via the audio conference. Preplanning is necessary. It includes naming a chair, setting an agenda, and providing printed materials to participants before they can be reviewed.

Distance learning can be conducted by the audio conference. In fact, it is one of the most underutilized, cost effective methods available in education. Instructors should go to trainings and find out the best ways of using audio conferences to discuss other forms of distance learning.

1. Audio graphics Teleconference: It uses narrowband telecommunication channels to transmit visual information such as graphics, alpha-numeric documents, and video pictures as an adjunct to the voice communication. Other terms are the desk-top computer conferencing and the enhanced audio. The devices include electronic tablets/boards, freeze-frame video terminals, integrated graphics systems (as part of personal computers), Fax, remote-access microfiche and slide projectors, optical graphic scanners and voice/data terminals. Audiographics can be used for meetings and distance learning.

2. Computer Teleconference: It uses telephone lines to connect two or more computers and modems. Anything that can be done on a computer can be sent over the lines. It can be synchronous or asynchronous. An example of an asynchronous

mode is an electronic mail. Using an electronic mail (E-Mailyou can send memos, reports, updates, newsletters to anyone on the local area network (LAN) or wide area network (WAN). Items generated on the computer which are normally printed and then sent by facsimile can be sent by E-Mail.

Computer conferencing is an emerging area for distance education. Some institutions offer credit programs completely based on the computer. Students receive texts and workbooks via mail. Through the common files assigned to a class which each student can access, teachers upload syllabi, lectures, grades and remarks. Students download these files, compose their assignments and remarks off-line, and then upload them to the common files. Students and instructors are usually required to log on for a prescribed number of days during the week. Interaction is a large component of the students' grades.

Through computers the faculty, students and administrators have an easy access to the database resources provided through libraries. Academic resources of libraries and special resources can be accessed on OCLC, ERIC, and on the Internet.

Administrators can have an access to student's files, retrieve institutional information from central repositories such as district or system offices, government agencies, or communicate with one another. Other resources can also be created as updates on the state or federal legislation.

3. Video Teleconference: It combines audio and video to provide voice communication and video images. It can be one-way video/two-way audio, or two-way video/two-way audio. It can display anything that can be captured by a TV camera. The advantage is the capability of displaying moving images. In two-way audio/video systems, a common application is used to show people who create social presence, so face-to-face meetings and classes enable participants to see facial expressions and physical demeanor of participants at remote sites. Graphics is used to enhance understanding. There are three basic systems: freeze frame, a compressed, and full-motion video.

Video conferencing is an effective way to use one teacher for several sites. It is very cost effective for classes which may have a small number of students enrolled at each site. In many cases, video conferencing enables the institution or a group of institutions to provide courses which would be canceled due to low enrollment or which could not be supported because of the cost. Rural areas benefit particularly from classes provided through video conferencing when they work with a larger metropolitan institution that has a full-time faculty.

Teleconferencing allows institutions to serve all students equally.

12.12 Telemedicine

Telemedicine (also referred to as "telehealth" or "e-health") allows health care professionals to evaluate, diagnose and treat patients in remote locations using telecommunication technology. Telemedicine allows patients who are in remote

locations to have an access to medical expertise quickly, efficiently and without travel. Telemedicine provides more efficient use of limited expert resources that can "see" patients in multiple locations wherever they are needed without leaving their facility. In developed and developing countries telemedicine offers a reduced cost solution to deliver remote care when and where it is needed. Telemedicine also reduces isolation that clinicians can experience in small medical facilities in distant locations. Telemedicine allows local practitioners to consult with their peers and with clinical experts when it is needed. Telemedicine allows them to participate in the grand rounds and bears education opportunities.

The first large-scale application of telemedicine was held under the auspices of the Soviet-American working group on space biology and medicine, where more than 300 clinical consultations, victims of the earthquake in Armenia in 1988 and the gas pipeline explosion in Ufa in 1989 took part. It included the simultaneous audio, video and fax communication between the disaster areas, Moscow hospital and four leading medical centres in the USA. During 12 weeks 34 videoconferences were held with the duration of 4 hours. Specialists from Armenia, Bashkiria, Moscow and the United States took part in these videoconferences. There were reviewed 209 clinical cases in 20 specialities. And these cases were typical of the more than four thousand patients who were under the supervision of the doctors participating in the videoconferences.

Telemedicine Objectives:

- Preventive maintenance of the population;
- Low cost of medical services;
- Maintenance of the remote entities and elimination of isolation;
- Improvement of the service level.

Telemedicine is an area that connects several fields such as medicine, telecommunications, information technology and education. This is a new area, especially in Kazakhstan.

The need for information standards in medicine.

Today a computer system which collects, processes and analyzes medical information is relevant for all the health structures in Kazakhstan. At the same time, lack of standards about the methods of storage, conversion and transmission of medical data is a significant barrier to effective health information. As a result, there is a contradiction between the ever-growing information needs and the level of information support for the healthcare institutions. Today, we should recognize that in medicine standardization plays a key role in the implementation of the information technology. In recent decades, the greatest efforts of medical information specialists have been concentrated in two main subject areas: standardization of medical terminology and standardization of medical data transmission.

The concept of functional standards involves a solution of the following main tasks of medicine:

1. Medical information systems, which would include only components developed by the same manufacturer, cannot be created. This is explained by the fact that at present a large amount of medical equipment is filled with computers with their software. These programs either do not have an ability to communicate with other components or can communicate in a particular format or support a particular information exchange standard. The introduction of common information exchange standards will help to solve these problems within the health information system.

2. Currently, autonomous medical computer systems which are created independently by individual medical departments solve these problems. There is another period, the period of interacting with medical computer systems. Standards of health information technology allow sharing information not only within the systems but also with external systems. This will ensure an interaction of regional medical institutions with major centres, as well as Kazakhstan's institutions with foreign institutions.

3. Standards help to facilitate the introduction of up-to-date information technologies into medicine. Medical institutions should gradually introduce information systems to individual departments, and gradually establish a system of a large scale by using the software that supports the standard.

4. The software that supports the standard can be easily upgraded and updated, and be more stable in work. Besides, it is cheaper, since the introduction of standards causes a surge of competition in the software market.

Review questions

1. What is the basis of smart technologies?
2. What opportunities can an intelligent network provide?
3. What is the advantage of smart grids?
4. What is a distributed network?
5. What is the Smart Grid concept?
6. What directions are identified by the "Smart City"?
7. How does the use of ICT promote energy conservation?
8. How many directions does the "Smart City" Astana project have?
9. What is the purpose of ITS in the "Smart City" Astana project?

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CHAPTER 13. E- TECHNOLOGY

13.1 E-business: basic models of e-business

13.1.1 Concept of E-business

The introduction of information technology has brought dramatic changes in all spheres of business activity and resulted in the appearance of its separate branch - e-business. E-business (e-commerce) is a form of business transaction where the interaction of the parties is carried out electronically: via computer networks, via exchange of electronic documents.

E-commerce may involve different types of transactions: wholesale and retail trade; supply and distribution of products; delivery, provision of information and other services; investments; insurance, banking services, etc. The objects of e-commerce are goods, manufactured products, securities, currencies, services, etc. The subjects of e-commerce are financial organizations, entreprises, individuals - consumers of goods and services. The basic models of interaction between the subjects of e-commerce are:

- **B2B** - Business-to-Business focused on the business partner;
- **B2C** - Business-to-Consumer focused on the end-user;
- **C2C** - Consumer-to-Consumer focused on the end-user.

B2B is a business model in which the interaction between the companies is done via computer networks. The basis of the B2C business model is retail trade, i.e. interaction between companies and consumers on the Internet.

C2C is a model of selling goods and services by one consumer to other consumers, i.e. consumers' interaction with other consumers on the Internet.

In addition, there are a number of business models (B2A - Business-to-Administration, involving the interaction of companies with administrative authorities; C2A - Consumer-to-Administration, involving the interaction of consumers with the administration, etc.).

13.1.2 Information Technology Infrastructure for e-Business

The importance of information transparency in ensuring the functioning of markets and the overall sustainable socio-economic development is significantly growing nowadays, with the economy becoming a kind of an information network. The new economy, the economy of information, reflects a network behaviour. It is based on a system of relationships between subjects that produce different types of knowledge, and control the flow. Connections between the structural elements in the networked economy are made by information infrastructure objects, providing the general conditions of the functioning of the information society. In the context of the general economic trends in the development of society the basis of any enterprise activity is the availability of a particular infrastructure. E-business is based on the use of specific elements of the complex communication software and

hardware. The Internet becomes the main environment of doing business in the XXI century. E-business is an important structural component of information and network economy.

The B2C e-commerce sector is represented by online stores engaged in the retail sale of products aimed at the end consumer. An online store allows the buyer to choose, buy and pay for the goods without leaving home. An entrepreneur online store provides additional distribution channels and advertising of products, additional trade places without the rental of retail space, increase the number of buyers from other regions, ensure rapid feedback from the buyer. The structure of the online store includes the following components: storefront (front-office), a trading system (bask-office), the payment system, the delivery system of goods. At the storefront the buyer performs registration, gets access to the catalogues of goods and the price lists, chooses interesting goods, works with the electronic "basket" and checks out by choosing a method of payment and delivery. The storefront transmits data about the customer, the order and the selected payment and delivery methods of goods in the trading system. The trading system controls the operation of the entire store: organizes a dialogue with the buyer, checks the goods in the warehouse, controls the payment of goods, provides its delivery to the buyer. These functions, depending on the organizational and technical forms of the store can be carried out by managers of the company or special programs, built on the basis of CGI-scripts. The online store payments can be performed in off-line and on-line modes. Payments which may be made in the off-line mode are: cash to the courier upon delivery of goods, payment by bank transfer to the online store bank account, payment on delivery against receipt of goods in the post office the postage (wire) transfers. Payments in the on-line mode are carried out by a special hardware and software, which is called the online store payment system Goods can be delivered to the buyer from the online store by a private courier service shop, special courier companies, by "self collection" or post. If a good is information or software, e-mail or FTP service can be used as a delivery vehicle.

Unlike B2C, the B2B system first emerged in the 60s of the last century, when the use of the Internet for commercial purposes was not possible. It was based on the use of expensive private computer networks that were not available to medium and small businesses. Further Internet usage as an environment for information exchange significantly reduced the cost of B2B commerce systems and has made it possible to involve medium and small entrepreneurs. Furthermore, the Web-technologies of Internet have expanded the possibilities of B2B e-commerce systems and led to the emergence of a new class of systems, called electronic trading platforms.

Electronic trading platforms are special sites, the purpose of which is to unite entrepreneurs and enable them to conduct transactions in real time. Trading platforms can be intra-sectoral (vertical) and cross-sectoral (horizontal). They can be created by organizations-customers in order to optimize the procurement process, expand trade relations and the supply chain ("supply chain" or B2B

procurement); organizations-sellers in order to expand the market ('marketing system, "or B2B distribution); a third party in order to bring together buyers and sellers ("sale provision system and supply," or e-marketplace).

The use of electronic trading platforms provides the following benefits to entrepreneurs:

- Receiving market data in real time;
- Expansion of the consumer market and opening of new channels of procurement (goods);
- The possibility of increasing the number of customers without increasing costs for their maintenance;
- Reducing the costs of harmonization of conditions of sales - purchases between buyers and sellers;
- Optimization of the sales process - procurement of products (goods).

An electronic trading platform not only allows of direct interaction between suppliers and consumers, it can become an element of integration between the automated enterprise management systems of the supplier and the consumer.

In the C2C sector a web-site acts as an intermediary between buyer and seller. Consumers make a deal and expand their operations with the help of a third party - provider (which provides exchange services). Around the web site there develops an online community of people united by specific interests, their number is directly proportional to the efforts of the project participants and the organization of the necessary services.

The C2C direction allows to make deals at any convenient time, reduce overhead costs and increase savings of the final consumer. The C2C sector includes online auctions, or e-sales when there is a single seller and many buyers. To participate in an auction, it is enough for buyer or seller to become a customer of one of the auction servers and expose a product for sale or express a desire to purchase it through the Internet. The Internet allows one person who became a client of the auction, to participate simultaneously in multiple electronic trading and it is enough to have an electronic bank account for registration.

Banking structures use the technology of electronic auctions for foreign exchange trading. Sale of goods at the highest possible price is called direct auction. In this structure there is only one seller and two or more buyers. Conversely, in the Reverse Auctions there is only one buyer and several sellers. All the auctions of government procurement work using this structure. Auctions implement natural pricing schemes, they are therefore used for the study of market opportunities.

Bidding at auctions is conducted under the following schemes:

1) standard or English auction – there are used open format offers when all customers are aware of each other's offers. The seller assigns the starting price and the buyers indicate the price of a 3% more;

2) the Dutch auction - it starts with obviously inflated prices, also uses an open form of proposals and continues until one of the buyers accepts it;

3) simultaneous auction offers - all buyers set their prices at the same time and the winner is the buyer who offers the biggest price;

4) double auction - when the proposal comes from the seller and the buyer at the same time. As a result, the equilibrium price is set - electronic exchanges operate on the principle of the electronic auction;

5) the auction of closed offers - when the buyer and seller do closed (secret) proposals within a fixed time span. The winner buys the goods at the previous maximal price.

On-line auction is an information database which contains the description of the goods admitted for trading. There is a system of rating auction bidders. It will conclude that the winner of the auction and the seller put up with each other's evaluations, reflecting their attitude to the counterparty. Setting this assessment is mandatory.

Thus, the infrastructure of the information economy is a system of interconnected resources that enables communication between electronic devices, the network space, as well as the identification of Internet-based and other services for all subjects.

13.2 Types of e-business

E-business is represented by a big number of various companies that have moved to the Internet and now work there. A company is regarded as a type of e-business not due to the technology used, but because of the specifics of the company activity. Over time, many more companies will switch to the electronic format, though today it seems unthinkable. As technology is improving rapidly, what is hard to imagine today will be possible in the future.

The activities listed below are selected because of their proven viability. There are also other types, but in order to succeed, they must interact with the mentioned ones. For example, commerce does not make sense without marketing and information exchange. These phenomena must go hand in hand in both online and traditional forms of business.

13.2.1 Electronic auctions

Organization of auctions on the Internet differs greatly from the traditional ones. When holding a traditional auction some people come to the auction hall and others are allowed to bid by telephone. To attend an auction or get the permission to participate by phone, one has to pay a fee the amount of which sometimes exceeds the price charged for auction items. No wonder that the number of auction participants is very limited.

The Internet has made auctions more democratic, allowing everyone who has access to the global network to bargain for any exhibited items. One can get into "the auction hall" with a click of the mouse, regardless of the server's physical

location. Moreover, the Internet speeds up the bidding process. In the usual auction the final price determination takes quite a lot of time, as the auctioneer registers the proposed bids and participants, until the highest price is suggested. Online bids are available within seconds.

Large sites may participate in an auction both as buyers and sellers. On their web pages electronic auctions give everyone an opportunity to display any kind of property for sale. Such private auctions are held constantly: buyers bid on Web pages until the seller receives the desired price or until the time deadline, after which the product is sent to a new owner. Each user with the Internet access may not only take part in different auctions as buyer or seller, but also organize private mini auctions.

Such websites as eBay (http://www.ebay.com/), QXL (http://www.qxl.co.uk/) and Ricardo (http://www.ricardo.de/) offer roles of 'buyer' and 'seller' on their websites. The sites also provide the infrastructure for goods exchange based on the auction model, in which the price is set based on demand.

The Internet is gradually replacing the concept of fixed prices for dynamic prices. In several years all websites will be suggesting prices of products, information or services based solely on consumer demand.

13.2.2 E- banking

E-banking is one of the most prosperous electronic ventures. E-banking allows customers to access accounts and perform various financial transactions using a simple website. No special program is required, just a Web-browser; in many banks these services are provided for free. E-banking saves time and money of individual clients and companies.

Electronic bank transfers a part of responsibilities to the consumers and provides clients with self-service opportunities. This online service allows users to have full information about their accounts, including history (record of all the receipts), to transfer money and order checks, to pay bills and contact the Customer Service Department if necessary. The only operation unavailable on the Internet is getting cash, but banks are already working on a solution to this problem.

To become a client of a virtual bank, the consumer must have a computer or other device with an Internet connection and browser. Depending on the e-bank safety strategy, one will need to install an additional software module or Java support. A plug-in or a Java applet is used to increase the level of encoding to ensure the security of financial transactions. More advanced systems use smart cards to provide customers with secure access. Another way to improve security is to use, along with the ID and login, a list of transaction numbers (TAN) that is a set of one-time passwords.

Many people use special computer programs like Quicken as systems for personal financial management. The main difference between personal finance management and electronic banking is that the former is the program installed on

the user’s computer to manage financial affairs and all transactions are carried out through the mediation of a third party, reducing the security level of electronic banks. Electronic banking is one of the digital services which allows users to perform the same bank functions as Quicken, with one difference: users can access their accounts directly via the Internet.

13.2.3 E-commerce

In the previous years, before the advent of the Internet, trading opportunities were rather limited, compared with the opportunities that appeared due to the new technology and information infrastructure. The main restricting factors were time and space. Even if a shop worked 24/7, it was available only for buyers living nearby. Moreover, a shop could offer a limited assortment of the goods because any store is physically limited.

The Internet shop is not limited in space or time. The range of products offered by such a shop is also unlimited. For example, Amazon.com offers more than 4.7 million books. Imagine a shop warehouse with so much literature! The comparison is not perfect as Amazon.com does not store books in stock but orders them as needed. However Amazon.com provides information about each individual book.

Retailers (sometimes called electronic sellers) also offer more products than traditional vendors, as well as a wider range of services for each product. Online books, CDs and tickets are sold better than in conventional shops because the customer value of these goods lies in their content rather than design. The physical look of a plane ticket is of no importance as the buyer is mostly interested in price and level of service. New technologies also make the Internet a great place for sale of goods that are bought based on emotions, because of their outward looks, rather than content (the so-called spontaneous purchases).

The Internet is changing the traditional model of selling, tactical in nature. The companies produce what is easily sold, whether it's a product, service or information, and base their efforts on four key components of marketing (price, product, promotion and distribution). E-commerce is becoming strategic. If most companies regard their goods as a means to meet the demand, the Internet allows to observe the whole sales cycle (development of the market, creation of demand, satisfaction of demand, customer service and consumer retention). In a tactical model all these sales cycle stages are sort of inevitable stages preceding or following the sale. In the strategic model, on the contrary, they are the most important components of a commercial interaction.

Many believe that e-commerce and e-business are the same, but, according to the definition, e-commerce is only one component of e-business. Only end users, who purchase the company products, may think that e-commerce and e-business are the same. E-commerce is a type of e-business, which first appeared on the

Internet, but the Internet can offer much more than just buying and selling goods and services.

13.2.4 Electronic pointers

Pointers are necessary to search for goods and services. Both private "white pages" and public “yellow pages” telephone directories help to find the right person or company. Phone companies publish telephone directories, and offer special reference numbers for additional information.

These two functions were slowly transferred to the Internet. The entire database is in one place, providing a centralized functioning which makes it possible for anyone to get any information any time anywhere.

The Internet gives the opportunity to replicate telephone directories. One can find the name of the person by his surname on the Internet. Moreover, very soon new telephone directories of individual Web-pages and e-addresses of companies will be available on the Internet.

The Internet both simplifies and complicates the process of getting the information, as powerful digital tools make the search simple, but the growing volumes of information on the Internet hamper the search.

13.2.5 Electronic Research Projects and Development Projects

Over the past few years, the style of research projects, development projects, especially those related to the creation of complex software systems has been changed dramatically. Just two or three years ago, it was necessary for experts who are working on the project to meet daily. If the project had to be sent to another city, it was required to print the drawings or reports, and send them by post. Then the project was checked, modified or transmitted for production. The whole process was very costly, that is why things went slowly and were accompanied by constant errors and corrections.

The Internet has influenced the speed of project development. It has provided such assistance, which even powerful computers were unable to provide. Location of specialists no longer plays any role. Anyone who has an internet connection can participate in the project.

Through the Internet, the technical development can be improved, by offering participation to specialists from different countries. Open engineering design and software products have proven themselves well (programs and projects that are free from the restrictions on further modification and distribution, preserving information about the primary authorship and modification). Anyone can take part in the project and add something to it.

13.2.6 E-learning

Continuous change of the Internet requires a review of the learning process. Over the past decade, the set of subjects and course content has been changed a little. Of course, the basic course cannot become different in just a few years, but compared with the development of new technologies, changes are implemented too slowly.

Nowadays, for example, it is not possible to work for 40 years at one workplace, for instance, at a steel plant. Anyone can radically change the scope of activities, and this situation requires a new approach to work. New technologies are related mainly to the Internet, thus all the processes inherent in it have to be studied continuously. Life-long learning is becoming a necessity, and teachers need to learn new subjects as well as students. Knowledge has become the most important factor of income, and it is no longer possible to wait until new subjects appear in the education programs. Computer-based learning was proposed a few years ago, bringing in an opportunity to learn with the help of a computer.

Special programs are used for learning and subsequent testing. This quite effective method of learning has a major drawback: if the learner does not understand something, he cannot ask anyone for clarifications.

E-learning, which is sometimes called Internet-based learning offers a fundamentally new approach to training specialists. Material is available online, not in the form of executable files used for explaining the material and testing learners. Tests are carried out in real time by all students simultaneously, the students have the opportunity to share ideas and ask questions. In addition, assistance can be performed by an interactive teacher, who acts in the role of a true teacher giving additional explanations to all the "students" no matter where they are. All this takes place in real time. Instead of waiting for the next lecture, students can optionally connect to the learning network. The educational process becomes more individual, so that each learner studies at their own suitable pace.

Education through the Internet can be offered to students before the course is completed. In this case, it starts with the most important topics and the others are obtained during the learning process.

13.2.7 E-mail

Information and data exchange make up the basis of any business. Internet has radically changed the traditional markets of the information exchange. Postal services and telecommunications companies concede their market shares to the electronic communications, especially to email. Email combines the advantages of the phone (direct contact) and the letter (information in the written form). Internet allows instant contact in both written via e-mail or oral communication (a chat).

More and more companies communicate with each other by exchanging electronic messages. Unlike the phone, an e-mail message contains not only text. Any file can be attached to an email such as a formatted document, a presentation,

images or sounds. The exchange of information has never been easier. Email has also changed the way of communication between people. Instead of writing everything at once in a letter, you can write several different letters dedicated to different topics.

The advantage is the immediacy of the reaction; In addition, e-mail assumes that you expect an immediate response to every e-mail you sent, and others expect an immediate response from you.

13.2.8 E-marketing

Traditional marketing focuses on the target groups and creates a positive image of a product or a company. Before the digital revolution transmission of information occurred via advertising and other media advancement only in one direction. The marketing department could not get an instant reaction from consumers. Before the information era all of these were acceptable, since it was possible, without haste, to conduct research and analyze the results, which influenced the long-term strategy of the company and its products.

In the informational society everything is in motion. Products strategy and prices all depend on the needs of customers. All aspects of the company are focused on the consumer. Client requests have a direct impact on the product design, marketing strategies and pricing. Since marketing traditionally involves direct communication with the consumer, information which is coming in real time from the user should be transferred to a specialized department of the company, which will respond to the changing demands in real time.

Internet allows companies to meet the needs of each individual customer. Every consumer can be treated as he likes. Individual marketing has become a standard way of referring to the consumers on the Internet. Mass marketing in the Internet era cannot be applied.

13.3 Legal regulation of e-business

E-commerce operates within the legal framework of the Civil Code of the Republic of Kazakhstan, the laws "On electronic document and electronic digital signature" and "On informatization". Thus, Article 152 of the Civil Code of Kazakhstan stipulates that a written contract may be concluded by drawing up one document signed by the parties, as well as through the exchange of documents by mail, telegraph, teletype, telephone, electronic or other communication that allows to reliably establish that the document comes from a party to the contract.

The laws "On electronic document and electronic digital signature", "On informatization " rule that the legal validity of the document stored, processed and transmitted by means of automated information and telecommunication systems may be confirmed by an electronic digital signature, which is equivalent to a handwritten signature in a paper document under certain conditions.

As a form of business, e-commerce should be on an equal footing with other forms of commercial activity. This means that a commercial transaction cannot be deemed invalid only because it was concluded electronically, except when it is required by law. Transactions requiring notary certification or state registration cannot be committed electronically.

Currently, in the Republic of Kazakhstan, there is a system of formatting legal and technical regulations in the industry of information and communication technologies (ICT), which regulates the development and formation of information systems of state agencies to provide electronic services to individuals and businesses. In accordance with the Concept of the formation and development of a common information space of Kazakhstan's segment of the Internet in 2008-2012 the main direction of the Internet public policy is to provide the conditions that ensure the exercise of citizens' constitutional rights to information. Within the framework of the Program on the Development of Information and Communication Technologies in the Republic of Kazakhstan for 2010 - 2014, the Government of the Republic of Kazakhstan has approved the "Model Rules of rendering electronic public services" and terms of ensuring the provision of electronic state services by state bodies within the range of their competence. In addition, changes were made in the "Model standard of the state services" regarding demands to the standards for describing e-government services.

The development of ICT raises significant socio-economic issues which need to be addressed based on the citizens' interests. The state is obliged to provide universal access to public e-services to all citizens, including national minorities, the poor, the homeless and people with disabilities. These vulnerable groups may need special assistance, support with information and advice on the procedure for the provision of these services. It is important to inform the population about the benefits of e-government services. The electronic forms of public services should be established taking into account issues of consumer protection.

In this regard, the measures for implementation of the Program on Development of Information and Communication Technologies in the Republic of Kazakhstan for 2010-2014, for the promotion of electronic services and "electronic government", include the development and approval of the "e-government services" curricula in the fourth quarter of 2014.

13.4 E-learning: the architecture, structure and platform

E-learning refers to the educational process, which is characterized by systematic and intensive use of modern information technologies and computer engineering. This concept is consonant with such terms as distance, multimedia, computer, virtual, online, Web-oriented, cyber education. The current state of computer technology and the wide spread of the Internet make it possible to realize the many benefits of e-learning technology: high interactivity, long distance, mass

scale, access to electronic libraries, creation of a common educational environment and others.

E-learning is a complex system that consists of software and hardware, distributed between servers and client computers. Such a system is usually built on a client-server architecture. Since the client and server are on different machines (which is natural in the Internet), the data transmission becomes one of the main issues. Data exchange is performed in the educational subnet, usually through the channels and Internet communications network.

There are two ways to solve this problem.

The first is writing the client and server applications. The server application is started and is constantly working on the server side, and the user starts the client program from his workstation every time, connecting to the server and working in on-line mode. There is a model when a student gets the task through the network, and performs it in the off-line mode. Such a model is rarely used because it does not meet the safety requirements, moreover, it does not give the teacher the ability to control the learning process. The main drawback of this approach is the need for installing and configuring client software on the computer from which a student plans to connect to the system. This makes it very difficult to work in an internet cafe or on another computer. Another drawback is the attachment of the program to a specific platform or operating system, which also reduces its flexibility. The advantages include the security of data transmission and enormous functionality of the languages in which such applications are written.

The second possible logical e-learning system architecture is a fully server-based program which is called a web-application. In this case, absolutely all information is stored on the server, and the client connects to the system via a web browser.

Multilevel hierarchical systems are managed with the help of special software platforms, which in English language publications are called virtual learning environment (VLE) or learning management systems (LMS).

The traditional e-learning platform or learning management system is a medium for the provision of training courses and management. They offer packages of tools that support the creation of online courses and the provision of their service, students' registration tools and operation control, the administration of the learning process and the generation of pupil's progress reports.

All LMS-platforms can be divided into two main categories:

- Open source initiatives, which include Moodle (www.moodle.org), Sakai (www.sakaiproject.org), ATutor (www.atutor.ca), Whiteboard (whiteboard.sourceforge.net), etc.;
- proprietary solutions, including WebCT/Black board (www.blackboard.com), Gradepoint (www.gradepoint.net), Desire2Learn (www.desire2learn.com) and Learn.com (www.learn.com).

Freely distributed solutions are usually based on the expandable shells that allow you to configure and modify the learning system in accordance with the

specific requirements. Despite the fact that this approach is not widely used in the category of proprietary systems, it has emerged through initiatives such as PowerLinks to WebCT and in the Blackboard Building Blocks, involving the provision of funds for the communications software with third-party LMS.

Kazakhstan's IT-companies are involved in the development and implementation of e-learning systems. In order to improve the competitiveness of education, human capital can be developed through providing access to quality education under the State Program for the Development of Education in the Republic of Kazakhstan for 2011-2020 launched by the Decree of the President of the Republic of Kazakhstan № 1118 of December 7, 2010. Implementation of the "E-learning systems" project is being implemented step by step since 2011 in the state organizations of secondary, technical and vocational education in the framework of the RK State Program of Education Development for 2011-2020.

Introduction of e-learning system is a large-scale state project implemented under the RK State Program of Development of Education for 2011 - 2020.

The aim of the e-Learning project is the development of high-quality educational resources and services, as well as ensuring equal access to the use of information using communication technologies. Thus, any student needs to be able to use digital educational resources and services of the information system at any time, from any point of our country.

The system is designed for three main categories of users:

- Users of educational organizations such as the administration of schools, teachers and students;
- Members of the RK MES such as the structural units of the Ministry and the regional Departments of Education, collecting educational statistics;
- External users, students' parents.

The system based on user roles implements the concept of a personal account. The e-learning platform of an educational organization automates the processes of managing, planning, learning, registration of students and teachers, school records and reporting in the education organization. The e-learning platform creates the conditions for a transition to the electronic document management and reporting in the education system inside the school.

Teachers have access to the platform for the preparation of lessons, e-library with additional materials in the form of digital educational resources for school subjects and academic disciplines. All electronic working and training calendar and thematic plans, the teacher training system, model curricula and programs are centrally loaded into the system. Students' journals are conducted electronically. Progress reports are automatically generated on the basis of class journals. If necessary, parents can monitor their children's learning through their private offices, give free alerts by email or by mobile phone SMS.

The National Education Database compiled through the online collection of data on all schools and colleges of the country is deployed and implemented for the purpose of automatic generation of statistical reports.

In general, 14 551 digital educational resources are placed in public access for secondary school subjects and college courses. This educational content covering 8 general education school subjects and 5 college subjects was established in 2013. It supports a cross-platform technology (html5 format) and allows users to access a variety of devices, including mobile ones, regardless of their operating system. Materials are divided into different classes, subjects and topics, and each student can find an interesting topic easily. Materials are presented in two languages - Kazakh and Russian, and contain 1 212 digital educational resources for 5 school subjects in English as well.

13.5 Electronic textbooks and intelligent tutoring systems

Nowadays, informatization of education urgently requires the creation of new learning tools. Foremost it should include electronic books. To date, the issue creation and application of electronic textbooks has become vitally important, as mostly the electronic textbook is perceived as a mere transposition of the content of traditional textbooks. This view is simplistic. It is rooted in underestimation of the potential impact of computer-assisted training on students' cognition.

The traditional learning technology is based on the transfer of information mainly in oral form. At the same time, in the human memory information is stored in a folded form as some universal visual-shaped or circuit representations, that are "built" over them. Due to the specific characteristics of computer technology it becomes possible to transmit shaped information. The problem of computer-based training software for developers is that we have not yet learned how to transmit scientific information in this way. It is necessary to create new methods of its transmission by means of visual representations.

An electronic textbook is not only complex, but also a holistic didactic, methodological and interactive software system. The electronic textbooks' software should be implemented with an eye to the most general didactic laws of the learning process and methodological aspects of teaching specific disciplines or groups of disciplines. It is impossible to consider any one of these aspects without taking into account others.

The spectrum of subjects that are studied in the higher technical educational institutions of Kazakhstan is very wide. Due to the global information processes, there is a new interest in earth sciences, nature, human and outer space. The scientific outlook of future specialists in many ways hinges on the fundamental disciplines of physics and mathematics. There is a considerable amount of technical disciplines in the technical colleges. The formation of specialists is the final responsibility of the departments providing training in technical majors.

The use of Information technology for training provides benefits, such as: the educational process intensification, freeing students from long-term calculations, freeing teachers from routine work on the formation of educational tasks and test results, regular control of students' academic performance. There is the possibility

of using computer-based training programs for methodological support of various types of training: for the study and analysis of theoretical material, practical, laboratory works and other integrated activities.

An electronic textbook which is used in class should provide an opportunity to use illustrative video materials, animations with audio accompaniment, resources of demonstrating the complex phenomena and processes by the lecture text, graphics and sound.

An electronic textbook used in laboratory classes, should contain automations in training, access to work, performance of experiments, processing of experimental data, presentation of results of laboratory work. Such electronic textbooks should include modeling components creating a virtual laboratory, allowing to study various phenomena or processes at an accelerated or slowed down time.

Electronic textbooks used in laboratory work should also include a built-in automated control of students' knowledge and skills. Electronic textbooks used in practical classes must provide students with information about the lesson theme, objectives and modalities; control each student's academic performance; provide students with the information about the correctness of the answer; present the necessary theoretical material or the method of problem solving; provide the "teacher - electronic textbook - student" feedback.

The history of computer-based training development dictates the need to distinguish between two types of training systems - traditional and intelligent. The main features of intelligent tutoring systems are the management of educational activities at all stages of learning and doing cognitive tasks, starting from setting principles and searching for solutions and ending with evaluation of optimal solutions; providing a dialogue interaction in a language close to natural. Discussed in a dialogue may be not only the correctness of certain student actions, but also the search for solutions, action planning, monitoring techniques, etc. In such systems, individual training is based on a dynamic model of the learner. Systems of this type provide the distribution of control functions between the computer and the students, enriching the latter, in with new independent learning features, thereby ensuring optimal transition to the doctrine of self-learning. An intelligent system can improve its training strategy by increasing the data storage capacity.

Unlike conventional computer systems, which operate on the basis of a pledged algorithm, intelligent tutoring systems organize the management of education and independent activities on a heuristic level according to pledged algorithms.

There were created a lot of computer programs and software systems that simulate the physical and chemical processes, economic and social aspects of modern society. However, their main drawback is the lack of system integrity and its fragmentation. They can be used in certain types of training (sometimes only

one or two classes), or cover the entire complex at any rate or in any subject only after the development of appropriate didactic recommendations.

The widespread usage and application of general software (word processing, graphics, spreadsheets, various reference and information systems, etc) can accelerate the preparation of documents: reports, essays, term papers (diploma) work and projects (for students); guidance, lectures, presentations, articles for teachers. Using expressive drawings or posters, visual details of the mechanism is not a minor detail in the learning process, it ensures the most rational, adequate perception of the presentation material. Due to the reduction of the time of searching, in creation and editing (as any works do not meet the firstly set requirements) there is an opportunity for a more detailed study of the issues.

Consequently, computer technologies have a significant impact on all the components of a holistic educational process, which in turn proves the computer influence on the content of training. At the same time, the computer allows you to add various heuristic tools for learning content and in dealing with educational and cognitive tasks. Furthermore, the thing of great importance is the fact that the computer creates real prerequisites for the creation of integrated training programs, developing the content of vocational-oriented education based on real-life research and manufacturing processes, making the object of study itself educational and informative for independent student work. Moreover, the student is freed from having to perform routine tasks and has the opportunity to obtain the required information without resorting to the teacher.

13.6 Social networks

Analysis of the social networks is based on the work with the data of online research and is well suited for understanding of online interactions. There are two key factors regarding online interactions that make them easy to succumb to network analysis: the nature of electronic interaction as well as the nature of digital information.

Online interactions almost always have a network structure. Groups of nodes (people, organizations or web pages) could be found even in the simplest social networks. World Wide Web is a series of unstructured pages and links between them. Therefore, electronic communication may be represented as a network of senders and recipients. Finally, even the simplest social networks have series of nodes (user profiles) and links between them (friendship, for instance).

The digital nature of information makes it easier to obtain information about networks. The concept of communication systems and relationships were formed long before the emergence of the Internet. However, the collection of personal data is a difficult and time-consuming procedure; people sometimes do not know well enough the people in their personal network (or how strong certain their relationship is). Thus, importance of gathering accurate data on interactions should not be underestimated by the researcher. These problems can be minimized by

online researchers, because the information in them is digital and encoded through the acts of sending a message, or by predefined functionality of the web page. In addition, in electronic social networks it is easy to copy messages for further analysis.

13.6.1 Social graph storage

Traditional relational model representations are ineffective for processing data for popular social networking services such as Twitter, Facebook and etc., which work with large volumes of data in real-time and with specific types of queries. Graph structures are very helpful for that purpose. They are used today in the search engines, for example, for processing graphs of knowledge, which collect information on the request and display the related information together with a list of found websites. Fortunately, the existing graph database management systems (DBMS) can cope with necessity to store and process large graphs. However, the choice of the most appropriate DBMS to satisfy specific needs of each service requires prior testing.

The graph structure employs named nodes, named edges and properties. Currently, the existing DBMSs work according to RDF (Resource Description Framework) specification which was developed by W3C (The World Wide Web Consortium). RDF specification is based on the form of subject–predicate–object expressions, which are known as triples. All data in RDF can be represented as a directed graph, where the object and the subject are given as nodes, and the predicate is given as an arc (edge) from the subject to the object. Data representation in the way which was mentioned above is suitable for storing social networking data and metadata. For instance, if user A is subscribed to the news feed of user B, then there a need to draw a directed arc (edge) from node A to node B with the "following" property (characteristics). In case when each user of a system is required to specify the city of his residence, it can be displayed as follows: "user" (subject) - "lives in" (predicate) - "city" (object). The presence of a two-way relationship allows to find people who live in the same city with a particular user, or to find all users living in a given city. These kinds of search requests are much easier performed by the graph structures, rather than by the relational databases because there is no need to perform operations in joining tables.

The SPARQL query language is used to work with data stored in the RDF format. During the query execution, the system looks through all triples which are suitable for given conditions and then retrieves data from them or from triples which depend on them. Modern graph DBMS are able to work with structures which exceed available RAM. This gives an opportunity to handle large data streams in real time by using clusters of relatively "weak" machines. In addition to support of the social networks and graphs of knowledge, these DBMS's can be used for projects with related data, such as DBpedia, which is designed to work

with structured information from Wikipedia. However, the testing results show that the graph DBMS are not able to deal with all types of requests within a reasonable time, and there remains a necessity for additional modification for performance of specific requests.

There is a wide variety of commercial products for the visual representation of the structure of social networks graphs, for example, products, such as i2 Analyst's Notebook, Sentinel Visualizer, CrimeLink, Xanalys Link Explorer and Tom Sawyer Software. Despite some differences in the details of their functionality and purpose, these imaging systems are very similar. Such software products as i2 Analyst’s Notebook, CrimeLink, Sentinel Visualizer иXanalys Link Explorer are designed for the analysis of systems of interconnected objects and study of the dynamics of successive events. Tom Sawyer Software is a set of libraries, which are used to create the visualization tools and to analyze the networks from a variety of subject areas. Most of the modern industrial systems have different shortcomings: the lack of platform-independent solutions, the lack of their own specialized storage systems, and their inappropriacy for working with large graphs.

Graph storages are focused mainly on the support of the replenishment operations, operations of union and intersection of the graphs, as well on finding of the shortest paths between the two vertex groups. Used data structures are designed to work with graphs which contain up to 100 million vertices and billions of connections, therefore it is not possible to store a graph in the form of an adjacency matrix.That is why the method of storing graphs as adjacency lists is taken as a basis. Moreover, a specialized file system is used as the base structure of repository. This system is implemented within certain file of a standard file system of the computer. Thus, it is considered that the logical file is the file which belongs to the given specialized system. It is assumed that each logical file consists of some records of variable length.

Visualization graphs are used in order to understand the structure of the social network. Jean Villedieu's blog describes the visualization process of Facebook. It is well known that Facebook owns information about the structure of the social network, which has more than a billion people. However, Facebook users have very limited resources to analyze their social ties. Let's consider how to visualize your social network in Facebook with the aid of several tools for data collection, such as the Neo4j graph database and the application called Linkurious.

Given below is the algorithm of collecting data about the Facebook social connections for the purpose of collecting, storing and visualizing data on Facebook:

STEP 1. Downloading your friends list

A powerful, but easy to use OutWit Hub application based on Mozilla and XUL can be used to collect such data. This application has a broad functionality, which includes detection of tables and lists, a tool for retrieving data from the source code of the web pages, macros and etc.

For this purpose, Python or another programming language can be used, but OutWit Hub is aimed at users who are not programmers, and is immediately ready to use.

Open your Facebook page in OutWit Hub and display the whole list of friends. OutWit Hub retrieves the data from the source code of a web page. The problem is that Facebook uses a lot of code written in JavaScript, which "contaminates" the web page code and makes it difficult for analysis. To solve this problem, the user ought to save a web page in the HTML format on their hard drive and then open it in OutWit Hub as a static web page. In the left pane, one should click on «links» in order to extract all the links which are present in the web page code.

Then the links are filtered out using a regular expression, which is shown in frame in the lower left corner. Selected References are exported to the CSV-file. The values in the column «Url Source» are replaced with the URL address of the user's profile. Columns «Url Source» and «Url Page» can be renamed into «Source» and «Target» respectively. Then this file can be imported to any graph rendering tool, for example Gephi, in order to get a graphical representation of the social graph. The result would be a graph that visualizes the list of friends. However, the result is not very interesting from the point of view of the analysis of social networks because of the lack of links between the nodes (friends).

STEP 2. Performing the necessary transformations and exporting the user's friends list into the HTML format.

An application called OpenRefine is used to handle the URL addresses. Facebook uses two types of URL addresses:

- The old type, which contains "profile.php";
- The new type containing only a nickname.

The columns «Source» and «Target» are not changed, but on their basis the third column is created, containing a special URL address that allows to get a list of mutual friends between selected users.

This opportunity is given with the concatenation function. After this it is necessary to convert the URL addresses given in column «URL» into HTML-links, to enable them to be handled with OutWit Hub. This will allow OutWit Hub to retrieve a list of mutual friends by visiting HTML-links.

Then, the resulting table is exported into the project, which is presented in the HTML format.

STEP 3: Data extraction

It is necessary to open the HTML file obtained from the previous step in OutWit Hub. The contents of the column called «URL» is seen by OutWit Hub as links. Then, a macro that handles all the links is created. In fact, these are the same operations which were performed in the first step, but automated ones. Depending on the quantity of your friends and the machine on which this work is launched, this process can take several hours. When the process is complete, the application creates a CSV-file with a set of data. Duplicate entries can be removed by adding

the original list of friends (Step 1) into the newly created file with the aid of OpenRefine. Thus, it can be concluded that getting a valuable set of data from Facebook is not that easy. However, it is quite possible to do, in case of using appropriate data collection and processing methods.

Then, the resulting CSV-file is imported into the Neo4j database.

It is difficult to analyze the social ties with the help of tools such as Excel. Neo4j database is a convenient tool compared to Excel. Code from a file facebook.cql can be seen on GitHub as a plain text or as a text with highlighted syntax. You can then visualize the graph of social ties. Neo4j has a built-in tool for visualization. It allows you to visualize the graph queries executed by using the Cypher (graph query language).

In case when the study of social networks requires a simpler and more powerful tool, one can use the app Linkurious. This app allows you to visualize social ties by simple typing one of any existing friends. In addition, you can also specify in detail certain parts of graph which are interesting for you. Moreover, you can select and hide nodes on the base of their properties. It is also possible to analyze the path between the two people. And all this can be done with a simple-to-use interface.

Graphs visualization allows us to understand the structure of a social network. It allows us to see and analyze social ties, see who has a lot of friends and who has not, observe presence of different communities in the test network. All this information can be obtained by visual analysis.

13.6.2 Community

Online communities have appeared at the dawn of the global network. Since that time their shape changed many times. Initially, they were in the form of imageboards, or chat rooms and forums, and then they were replaced by blogs. Then came the "finest hour" for social networks: LinkedIn was launched in 2003, Facebook in 2004, Twitter in 2006, Google+ in 2011.

Internet communities for the users

Nowadays, the social networks are leaders in the number of online communities. Internet forums continue to exist, but they are not that popular aswas the case in the past.

According to Peter Kollock, users are willing to join communities for three reasons (Communities in Cyberspace, 2005):

1. Waiting for mutually beneficial cooperation. By joining a community, people hope to obtain useful information in exchange for their contributions (e.g., participation in surveys).

2. Improving their own reputation. A community member shares a useful link with other members of the group. If he does it regularly, this is reflected in his reputation among the other members of this community.

3. Feeling utility (usefulness). Anyone who regularly makes a contribution to the common cause of community begins to believe that he is an indispensable member of this group.

Online communities for brands

1. Customer service and technical support. Within these communities the customers can discuss the advantages and disadvantages of a certain product, they also may suggest solutions to the problems associated with its use. One of the best examples of these communities is Twitter-accounts of brands such as Comcast.

2. Improving the reputation of the company. Online communities are a suitable place where brands can acquaint the audience with the results of research done on the industry, showing their leading positions.

3. Research. The community that exists around any brand, is an ideal focus group. This audience allows to test new solutions by getting an instant feedback.

4. Savings. Creating an online community can help the company to save money. Within the community, users can help to solve problems of other members, thus, the company will be able to decrease spending on the technical support. This does not mean that technical support should not exist at all, but the number of its employees may be reduced.

5. Increase of sales. For many, especially for small companies, creating of online community may be the most preferable way to familiarize a wider audience with their products.

There are many platforms which allow to do so, but most of the companies are focusing their attention on the following four:

Brand pages on Facebook are not just placing product information. They can be an excellent marketing channel, for example, in the propagation of "viral" content. In addition, a social network allows you to create a private group, which gives access to newcomers only with the approval of those who are already members of the community.

Communication on Twitter via hashtags is a great way to use social networks to bring people with common interests together. In a sense, these conversations are like mini-seminars or virtual conferences.

LinkedIn allows you to join groups depending on your interest, and to create your own public (open) or private (closed) groups.

Google+ allows to divide users into groups and selectively share your chosen content with them. Also, the network supports the video conferencing mode.

Added to this list in Kazakhstan should be VKontakte, Odnoklassniki, "My World". Moreover, there is a growing interest to such niche social networks asPinterest, Gogogbot, etc.

Choosing a social network for dialogue with the audience depends on the task that the company sets itself. Will it be just sharing of entertaining content or the company will conduct serious research and hold discussions within the audience of its customers? In which form will information sharing take place, as podcasts or

text? However, there is one important thing - the presence of the brand in the social media has a positive effect on awareness and loyalty among the audience.

13.6.3 Small world models

"Small-world" network is a version of the graph, which has the following property: if we take any two nodes A and B, then they are most likely not contiguous, but one node is accessible from the another one via a small number of hops or steps. "Small-world" network is defined as a network in which a typical distance L between two randomly selected nodes (the number of steps needed to reach one from another) increases proportionally to the logarithm of the number of nodes N in the network, as follows:

$$L \propto \log N \tag{13.1}$$

In the context of a social network, this leads to the phenomenon of "small world", i.e., strangers are connected by a small number of intermediate acquaintances. Many real-world graphs are well modeled through the "small world" graphs. Social networks, Internet connectivity, wikis such as Wikipedia, and gene networks are the examples of the properties of the "small world" network. In 1998Duncan Watts and Steven Strogatz identified a certain category of "small world" networks as a class of random graphs.They noted that these graphs can be classified according to two independent structural features such as the average distance from one node to another (also known as average shortest path length) and the clustering coefficient. Totally random graphs, constructed according to the Erdos-Renyi model, have a small average shortest path length (it increases with the logarithm of the number of nodes in the graph) and a small clustering coefficient. Strogatz and Watts found that most real-world networks have a small average shortest path length, however their clustering coefficient is significantly higher than expected at a random choice. After that Watts and Strogatz proposed a new model of the graph, which is now called the Watts and Strogatz model, which is characterized by (i) a small average shortest path length, and (ii) a large clustering coefficient. The intersection in the Watts and Strogatz model between a "large world" (e.g. a lattice graph) and a small world was first described by Barthelemy and Amaral in 1999. This paper was followed by a large number of subsequent studies.

13.7 E-government: concepts, architecture, services

The idea to create an electronic government in Kazakhstan was initiated by the Head of State, Nursultan Nazarbayev, and announced in his annual State of the Nation Address of the President of the Republic of Kazakhstan dated March 19, 2004.The first systematic plan of action in the form of a Policy document on the formation of e-government was approved on November 10, 2004.

Today, three access points were created on the principle of "one-stop" window for the public and businesses in Kazakhstan in order to obtain government services. Namely saying, it is the e-government portal, public service and contact center. Formed for the current moment the e-government infrastructure allows Kazakhstanis to receive through e-government portal more than 570 services. Every year the e-government system provides about 40 million electronic services. For a country with the 17 million population, it is a good indicator.

In 2013, 100% of socially important services were rendered in the electronic format via e-Government portal of the Republic of Kazakhstan.

Today, in addition to the e-government portal, public service centers provide 172 kinds of electronic state services.

Kazakhstan actively supports the initiative of "Open Government". Particularly, in 2013, there was launched an open data portal, dedicated to the accessibility of information disclosed by state bodies, national companies and other government agencies for the citizens of the Republic of Kazakhstan. Free access to government data of public character would make the governance process more transparent. Kazakhstan is in the process of transformation of both the public administration and the tools to ensure its effective operation. Such a tool is undoubtedly the electronic government and its next generation - Smart government.

E-government is the governance system, the system of interaction between the authorities themselves, with citizens and enterprises using information technologies (which should reduce red tape and increase the transparency of government activity).

E-government has several definitions, it covers the processes of management, in which information and communication technologies (ICT) play an active role in the delivery of related management products and services.

The use of ICT in governance can lead to one of the following key changes:

- Improving the quality and standards of existing management products and delivered services;
- Provision of new government services and products to citizens/users;
- Strengthening citizens'/users' participation in making decision on what kind of products and state services should be provided and how;
- Introduction of the new social classes into the sphere of public administration, including those that are more likely to remain out of the spotlight, namely the poor, the illiterate, the disabled, migrants and internally displaced persons.

Thus, e-government it is not just digitalization and automation of existing public services. Instead, the e-government is a tool aimed to transform government services so that they can be more effectively provided to all segments of society.

Today, the quality of public services is being improved by the development of two key tools: public service centers (PSC) and the "e-government" web-portal.

For the successful creation, development and modernization of automated public services, the development of e-government architecture is urgent and essential. This architecture consists of four levels: architecture of activities, architecture of data and information, architecture of application systems and architecture of technology.

Stages of maturity of the e-government are determined primarily by the stages of maturity of its architecture (EGA), namely: 1) the formation of the management bases for the development of EGA, 2) development of EGA elements, 3) completion of development of the EGA elements, 4) use of EGAs for changing the management system. The program provides for the transition to the second stage of EGA maturity - development of EGA elements. At this stage there will be set up concrete tools (the formal description of the system of administrative regulations, tool support configuration management), which are needed to form a complete EGA.

However, there are still a lot of problems in the implementation of approaches to e-government. Firstly, only few IT professionals are able to embody the idea of e-government in each state agency. Secondly, level of Internet use in the country is not high enough (as well as the level of computer use in general), and that is the essence of the government's program to reduce the digital divide. These are problems that are on the surface and are the result of other, more fundamental ones, such as the quality of secondary, vocational and higher education, people's living standards, poverty, unemployment, etc.

However, Kazakhstan is a dynamically developing country with a huge labor and innovative potential, to keep pace with scientific and technological progress. Therefore, the use of any new technologies that save time and money, is among the most important state tasks. E-government helps to save time, effort and to reduce corruption. Perhaps, that is why some structures are not in a hurry to implement it for fear of losing this source of income. In addition, e-government is more environmentally friendly: less paper waste, reduced load on auto transport - many operations can be done remotely.

Most of the explanations on this issue are currently available on the e-government portal of Kazakhstan - www.e.gov.kz, where there are sections containing information for different customers' services of e-government: "Power", "Citizens", "Business", "Foreigners". Each section has its own rubrics, which briefly describe almost everything about the provided services, legislation, political system, the procedure for obtaining services and so on. However, the qualitative transition from the level of providing information to the level of providing service is not being observed.

The e-government web-portal provides access to more than 730 services. The existing e-government infrastructure consists of an e-government gateway, payment gateway, infrastructure of digital signatures, unified transport environment, state database and information systems of state bodies. During the period of operation of the e-government there were provided over 97 million

electronic services, the number of registered users of the web portal reached the amount of 3.7 million people. The sum of transactions carried out through the payment gateway of e-government is more than KZT 6.8 billion.

13.7.1 E-government

E-government should be seen as a political process, which involves both political leaders and citizens in order to ensure good governance, and to implement continuous reforms in the governance processes. The management reform is a relatively slow process and changes can only happen in a few days, weeks or months, as they require the participation of different institutions and the adoption of constitutional amendments.

The development of the information society is pushing many organizations to adoption of the "e-government" concept to:

-*Provide services to the public in an integrated manner over the Internet.* In addition to simply provide services over the Internet, without forcing people to lose time standing in line, organizations can provide integrated services and additional features. Instead of visiting several different offices or several different websites in order to get any official permit, citizens and private companies can perform all operations at one place, access to which is open 24 hours a day, 7 days a week.

- *Overcome the digital divide.* The state can make new technologies more accessible to the less affluent sections of society as well as to organize the computer skills training , especially for the young and elderly people. This can be achieved in a variety of ways and through a variety of programs.

- *Give an opportunity to the people to learn throughout their lives.* The idea that learning does not stop at the moment when a person leaves school, can now be brought to life through the wide dissemination of e-learning. The society of the future consisting of "knowledgeable workers" will continue to use modern, personalized means of getting education over the Internet.

- *Rebuild the relationship with the population.* Instead of providing the same services to all citizens, government agencies can use the new information technologies, to take into account the individuality of people and provide personalized services. Citizens become more responsible for their relations with the state services. This leads to their regaining trust in the state sector.

- *Promote the development of the economy.*

Government agencies can help private companies get online, as well as to assist them in the use of electronic means. Sometimes this may require consultation or financial incentives. Private companies engaged in e-commerce, can not only take advantage of its proximity, for example, to local consumers, but also to grow and expand into new global markets. It also helps to increase the level of training and the level of local employment.

- *Develop reasonable laws and sound policies.* The information society poses many new challenges for legislators: identification of citizens, privacy and data

protection, questions regarding jurisdiction in cyberspace, e-commerce taxation, as well as cyber-crime and cyber-terrorism. The state should be flexible during the creation of a new legislation, by generating trust to all types of electronic transactions and keeping a balance between the need for economic development and ensuring the confidentiality of information.

- *Create new forms of governance with greater participation of citizens.* Automation of public services can lead to "direct democracy" (without intermediaries). At the local level, municipal authorities now support public debate, discussion forums and voting on the Internet, and it helps local authorities in decision-making (Fig. 13.1).

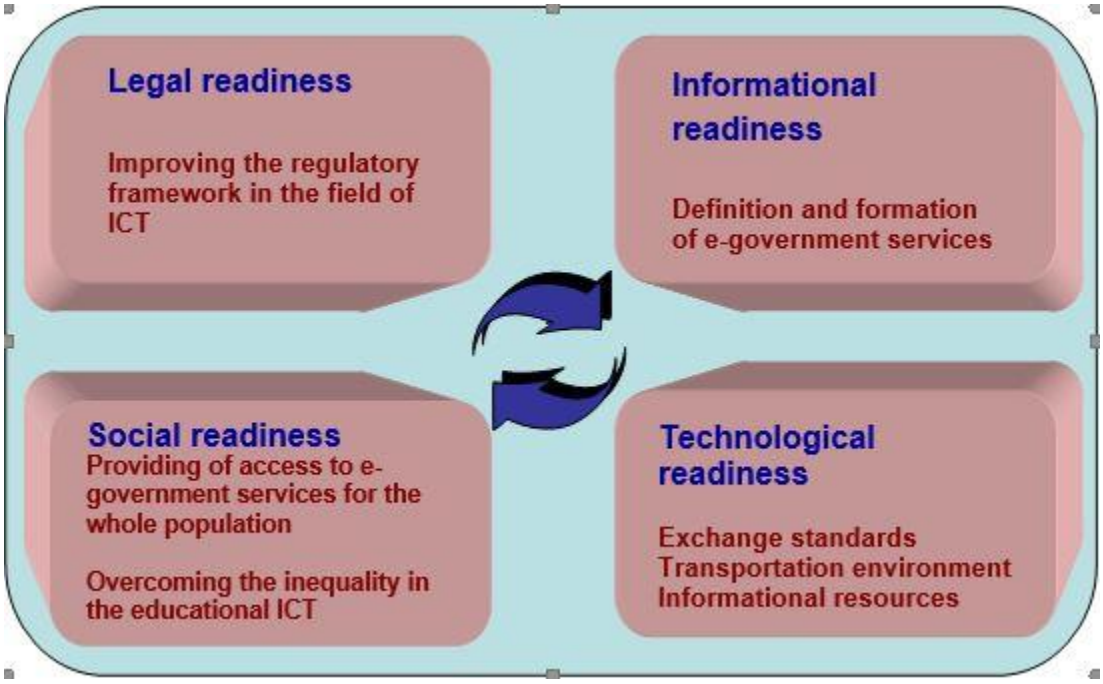

Figure 13.1 - The prerequisites for the implementation of EP

13.7.2 E-government architecture

E-government initiatives are implemented through the use of a structured, systematic approach to their planning and based on the development and realization of an unified e-government architecture.

Unified architecture of e-government (hereinafter UA) is a structure that reflects the relationship between all elements of the e-government, and should allow to identify and systematize existing needs of the ICT use in various ministries and departments, as well as opportunities to reduce the existing redundancy, and to identify areas, in which they have homogeneous requests for ICT investments.

The e-government UA of is seen as a reference model of the processes and governance structures, representing a methodological framework for implementing ICT projects and activities. UA is intended to provide:

- The correctness of the individual project objectives;
- Coordination between the projects;
- Assessment of the effectiveness of individual projects;
- Optimizing the use of resources by eliminating the duplication of work;
- Investing into promising technologies and compatible systems.

The key role of UA is clearly demonstrated in inter-agency projects, where UA acts as a single "framework", which is used as a set of project evaluation criteria, and as one of the mandatory regulatory and methodological tools for selection, implementation, and monitoring the effectiveness of projects.

UA gives a holistic view on what the state and the individual departments are doing, how they work, how ICT provide the necessary support to them. Without such a systematic approach the realization of e-government initiatives will inevitably be fraught with a lot of problems and inefficiencies.

General UA structure consists of the architectural layers, which are related to the requirements of the implementation of needs (activities architecture, system architecture, technical architecture) as well as two "perforating" architectural components that have their reflection in each of the previous three layers (architecture of continuity and security; performance architecture (architecture of efficiency)).

At the heart of the architecture activities lies a model which describes the activities of the state and local authorities in terms of the functions performed and the processes of fulfilling these functions. This model describes the mutual obligations of the state authorities, as well as their obligations to citizens and businesses.

System architecture reflects the main connections of services, which are offered by the state and local authorities with applied architecture components to support these services with ICT application layers. It contains standards and guidelines for the development of information systems of state and local authorities to ensure the performance of government functions, as well as the basic components and elements of the e-government that ought to be used centrally or repeatedly by many agencies: the e-government portal, certification authority, the national identification system (Fig. 13.2).

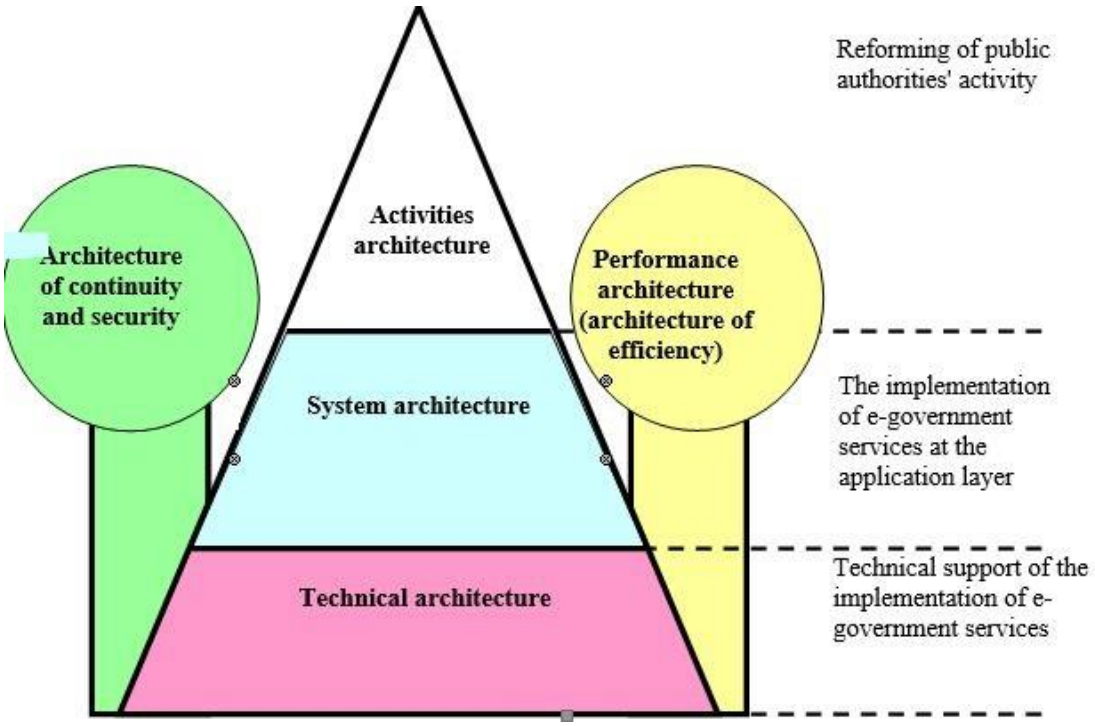

Figure 13.2 - Unified architecture of e-government

Technical architecture reflects the possibilities of basic ICT as a means of interaction between applied components of the system architecture, as well as with the data sources and with users of information systems. This architecture includes standards and recommendations for hardware and software which are used by the state agencies, communication means, technology standards and protocols, as well as methodology of description and standardization of governmental information systems and metadata standards.

Architecture of continuity and security is designed for planning, support and supervision at the architectural level of a set of actions and tools designed to ensure the information security and the continuity of the activities of the local authorities and the e-government system with the given values of parameters. Performance architecture of e-government and of its components is a system of balanced indicators and common metrics to evaluate the performance values, effectiveness and efficiency of e-government and its components. It allows to assess e-government on all levels - from the individual information systems and business processes to the main results of operations and their strategic impact (consequences).

13.8 Digital signatures

Documents which are circulating in the information society, ought to ensure not only the presentation of data in digital form for transmission over the network, but also ought to have certain validity. The paper documents for this purpose use personal signature and stamp, which is a legal guarantee of the authorship of the

document, and special paper with protective signs, which guarantees the authenticity of the document. In order to give legal power to electronic documents one problem had to be solved. This problem has mathematical, organizational and legal aspects. The mathematical problem was to find the electronic equivalent of a handwritten signature of the author, which will allow an unambiguous identification of the author of the document. In order to solve this problem, in the second half of the 70th of the last century mathematicians W. Diffie and M. Hellman had proposed to use the electronic digital signature. The legal challenge was to develop electronic signature regulations, containing the legal definition of the legal conditions under which the electronic signature in the electronic document can be recognized as equivalent to the handwritten signature on a paper document. As a solution to this problem in Kazakhstan there was adopted the Law "On Electronic Document and Electronic Digital Signature" of 7 January 2003.

As the mathematical basis, digital signatures employ asymmetric cryptography. The essence of this method is that a special algorithm generates two related keys, with the following properties: text, which was encrypted with one key can be decrypted only with a second key and vice versa. One key is declared public, and the other one is private. The private key must be selected randomly, for example, with aid of a random number generator. The public key ought to be calculated from the private key, to make it impossible to obtain the second from the first one. The public key is made available to all partners; the private key remains secret. The simplest example of an electronic signature is the document, which was encrypted with the private key of its author, and which contains information about him: the surname, first name, position and so on. Everyone who owns a public key will be able to read this information and identify the author of the document.

However, in order to protect an electronic document against counterfeiting, it is necessary to add to the information about the author of the document the document's digest to the electronic digital signature (EDS). Digest of the document is a unique sequence of characters, resulting from applying special hash-functions to the document. Electronic documents can have different size - from an empty message up to a large file including graphics. The algorithms of digital signature are designed for signing messages of a certain length. Therefore, the aim of a hash function is to get a unique character string of predetermined length for each document having an arbitrary length, which uniquely corresponds to the document. A uniquely corresponding digest of document in this case means that any change in the content of the document will necessarily lead to a change in the digest. After receiving the document, the host side verifies the digital signature, then handles the document with the same hash function as the sender, and after that compares the resulting digest with the one contained in the electronic signature. If the digests matches, then the document has not been subjected to unauthorized changes.

It should be noted that the public key cryptosystems are used not only for creating and verifying the digital signature, but also for encrypting documents (for

example, in e-commerce). In contrast to the electronic signature, which is encrypted with the private key of the sender, a document is encrypted with the public key of the recipient. The document encrypted with the recipient's public key can be decrypted only by using his private key. Mutual exchange of public keys between partners allows to create between them the exchange channels that are encrypted and signed with digital signature of electronic documents (SSL and SET protocols) protected against unauthorized penetration.

The Certification Authority that issues the signature key certificates is a legal person who has the necessary material and financial means to enable him to bear civil liability for damages in front of the users of signature key certificates, which may be incurred on them because of the unreliability of the information contained in the signature key certificate.

13.9 Formats of e-government in the developed countries

Based on the analysis of the experience of building e-government in different regions and countries of the world, it is decided to divide them into three main architectural models practiced in America, Europe and Asia. Conventionally, they can be called like this: the American model, which reflects the specifics of its formation in the United States; the European model, used in the development of e-government structures in most countries in Western, Central and Eastern Europe; the Asian model which is implemented with great success in Singapore and South Korea.

The European model is characterized by the presence of supranational institutions, such as the European Parliament, European Commission, European Court of Justice, whose recommendations are binding on all European Union countries. This model is focused primarily on the alignment conditions and coordination of e-government activities across all European Union countries.

The American model of e-government was developed in the US and Canada. The program of its creation in the United States, first of all, aims to simplify and reduce the cost of interaction of citizens and business representatives with government agencies, as well as to make possible their direct communication. The US government has gradually become the largest consumer of information technology in the country. Its high-tech solution costs are estimated as 40-50 billion of US dollars annually.

The US government currently pays particular attention to:

1) The supply of goods and services to meet the needs of the public on the basis of competitive electronic trading;

2) Public access to governmental and other administrative information;

3) The use of smart cards, including their use by the federal government;

4) Obtaining official documents through the government online resources, payment of taxes, the provision of statistical information on the work of the state apparatus to the public, etc.;

5) The use of information and communication technologies (ICT) in medicine and health care.

Government strategy includes the development and use of all kinds of electronic services, which means the possibility of providing services through the Internet, mobile communications, digital television, call centers.

According to the US e-government strategy, one of the main goals of e-government is reducing the scale, and ideally complete eradication of duplication of the same functions in the various government agencies in order to facilitate citizens to access them, and to reduce maintenance costs of redundant services and departments.

The Asian model is based on a particular management style, an Asian type of corporate culture and multi-layered system of governance, organized as a hierarchical pyramid.

A significant number of government services of Singapore are now available through the online system, some of which - through the program Singapore ONE. The government encourages citizens to access e-government services from home or work computers at any time convenient for citizens. One of the major e-government programs is the "e-Citizen", which provides a suite of integrated services previously provided by various government departments. Singapore's main priority is to integrate disparate systems into a single governmental portal of government services. The services provided previously by various ministries and agencies of the Government of Singapore, are now available under the "e-government" on a single Internet site of the government.

In pursuit of the development goals of Singapore's e-Government, it was decided to develop the government's action plan, which includes strategic objectives and strategic program of e-government. Nowadays there were identified six strategic programs to achieve the above strategic objectives of Singapore:

1) Knowledge-based working environment: public servants at all levels must be technically literate and have to use the benefits of ICT to improve work processes, service delivery and teamwork;

2) Electronic services: all government services, which technically can be provided in the electronic form, should be provided in the electronic form;

3) Technological experiments: they will contribute to a more rapid adaptation of public bodies to rapidly changing technical conditions and will aim to reduce the likelihood of a large investment into wrong decisions;

4) Improvement of operational efficiency: computer equipment must be modern;

5) Adaptable, but robust IT-infrastructure: rapid convergence of telecommunications, radio technology and information technology has opened the possibility for the use of government network at a lower cost. A sophisticated, well-developed, robust and expandable infrastructure is an essential element to support e-government initiatives;

6) Education in the field of ICT: educational programs in ICT provide knowledge not only in the study of computer systems and applications, but also in the use of ICT to improve business processes and in the provision of public services.

Within the framework of e-government development, Singapore is launching a private government cloud service, known as The Government Cloud (G-cloud), which is focused on supporting the new programs, the acceleration of the transformation of the state structures. In addition, there takes place the development of a unified concept of architecture for all state agencies in order to optimize and reduce costs of government information and communication technologies.

The main methodological approaches and practical experience of the developed countries (particularly the US and Singapore) for the formation of e-government have confirmed the idea that the success of e-government is possible. It requires the support from the public authorities of all levels, as well as the e-business subjects' interest in the implementation of this project.

Studying the experience of Western countries which are already implementing their programs is an important stimulus for the motion in the same direction for our country.

Review questions

1. What is e-commerce?
2. What are the main models of interaction between subjects of e-commerce?
3. What is a reverse auction?
4. List all types of e-business.
5. Specify the features of electronic banking.
6. What are the advantages of e-learning over the traditional one?
7. What are the main legal documents in e-commerce?
8. What is an electronic textbook?
9. In what way is the training system different from the electronic textbook?
10. Specify the features of an intellectual training system.
11. What are the advantages of information technologies in training?
12. What is e-government?
13. What kind of e-government services do you know?
14. What is a digital signature?
15. Where and for what purposes are digital signatures used?
16. List the conditions required for the implementation of e-government.
17. Give an explanation of unified e-government architecture.
18. What is the essence of the electronic digital signature method?
19. What are the differences between e-government formats of other countries?

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CHAPTER 14. INFORMATION TECHNOLOGIES IN THE PROFESSIONAL SPHERE. INDUSTRIAL ICT

Nowadays, information technology is being actively introduced in all spheres of human activity.

Accumulated information resources are one of the main sources of increase of welfare and economic growth. The information sector turns out into principal engine of step-by-step transition of traditional forms of managing into economic system of the information type. There is a concept of information asset. The information asset consists of technological, scientific and technical as well as social and economic information. The information asset is used for obtaining the income. The basis of information asset is information technologies. The information factor modifies the market mechanism of economy: competition methods are changed; the local, regional, national and international markets of information and telecommunication goods and services functioning on the new principles are created. The key sector of modern economy is the sector of information and communication technologies which provides creation, transmission, use and analytical processing of knowledge and information. Telecommunication infrastructure becomes the condition determining the level of competitiveness of production and services of the industry.

The following questions are discussed in this chapter:

- The software for solving problems of the specific professional sphere.
- The modern IT trends in the professional sphere: medicine, power engineering, etc.
- Use of search engines and electronic resources for the professional purposes.
- Safety issues in industrial information and communication technologies.
- Automated components of production processes.

14.1 Software for Solving Problems of the Specific Professional Sphere

Software for professional purpose is intended for solving problems of the specific professional sphere in different domains such as construction, architecture, music and motion picture art, etc. The main types of software for solving problems of different professional spheres are given in Table 14.1.

Table 14.1 - Types of application software for specific purpose (URL: http://infoegehelp.ru)

#	Types of application software for specific purpose	Purpose	Users	Software examples
1	Desktop publishing systems	electronic imposition of	employees of printing houses,	QuarkXPress, Adobe InDesign, Adobe

		newspapers, magazines, books, brochures (compilation of pages of a certain size from the text and illustrations for receiving a printing form)	editorial offices of magazines and newspapers, publishing houses, and also employees of advertizing agencies	FrameMaker, Corel Ventura, MS Publisher
2	Electronic encyclopedias, textbooks, dictionaries, reference manuals	acquiring of knowledge in a certain sphere	school students, students, scientists, experts of different spheres	"Encyclopedia of the modern technique. Construction", "Reference manual of the master builder", "The musical dictionary", interactive multimedia textbook "Organic Chemistry"
3	Machine translation systems (CAT software)	translation of professional texts with the use of knowledge bases of subject domains	professional translators	Trados, Deja Vu, Star Transit
4	Server DBMS (client-server)	management of creation and operation with databases of information systems	database administrators	mySQL, MS SQL Server, Sybase Adaptive Server Enteprise, Oracle Database
5	3D Graphics Editors	creation and editing three-dimensional graphics	3D artists	Autodesk 3ds Max (previous 3D Studio MAX), Autodesk Maya, Blender, Cinema 4D, ZBrush
6	Video editors (system of video-tape editing):	processing video records		
	- professional	mounting movies, telecasts	workers of a motion-picture and television	Adobe Premiere Pro, Grass Valley Ediu, Sony Vegas Pro
	- home	mounting home movies	non-professionals	Windows Movie Maker (included into OS MS Windows), Corel VideoStudio Pro, Pinnacle Studio
7	Audio Editors (audio editing	processing of audio materials		

	systems)			
	- professional	record of musical compositions, preparation of phonograms for radio, film scoring, computer games, restoration of old phonograms	sound producers on radio, sound recording studios, in the movie industry	Adobe Audition, Steinberg WaveLab, Sony Sound Forge. Audacity
	- home	record of amateur musical compositions, creation of own ringtones for mobile phones, etc.	non-professionals	CyberPower Audio Editing Lab, Akram Audio Editor
8	Musical editors	creation and editing the musical text with design, displaying the typed text	employees of musical publishing houses, musical educational institutions, musical theaters, philharmonic halls; composers, arrangers, conductors	Finale, Encore, Cakewalk Overture, Sibelius, MuseScore
9	Expert systems	solving problems of some subject domains (replaces experts)	employees who are engaged in diagnostics, constructioning, planning, management	Helthcare: MYCIN; military: ACES; electronics: ACE; computer science: CODES, chemistry: DENDRAL; geology:PROSPECTOR trade: PEMOPAMA
10	Computer Aided Software Engineering (CASE, CAD/CAM/CAE)	drawings, diagrams, 3D models, designer and technological documentation development on the computer	engineers, constructors and architects	Compas, AutoCAD, ZwCAD, nanoCAD Electro, BtoCAD, ConstructionExpert BASE
11	Geoinformation system (GIS):			
	- general and customized	creation, editing and analysis of electronic maps, information search of map objects: cities, roads,	GIS-specialists, GIS - operators, cartographic engineers, geologists, surveyors,	MapInfo, CREDO_DAT, ArcGIS, Arcview, GeoServer, GRASS, gvSIG, Apro, Poligon, Panorama, GIS Meteo

		buildings, streets, rivers, landscape, annual average temperature	hydrologists, meteorologists	
	-information and reference	viewing of neighborhood and city maps, search of the organizations, transport routes, journey search around the city	Non-professionals	2GIS
12	General systems for different enterprises and organizations:			
	- office-work integrated systems	support of the full cycleof the documents in the organization: creation of documents (documenting), organization of movement and accounting of documents (the document flow) and document storage (archiving)	clerks (workers who are responsible for guiding the documentation of the organization)	Business, LanDocs, Cinderella, Gran-doc
	- accounting systems	guiding the business and tax accounting	accountants	1C: Bookkeeping
	- financial analytical systems	guiding the analytical accounting of financial and economic organization activity (information systematization, calculation of analytical indices and report generation)	financial analysts	Alt – Finance, Audit Expert, INEK – Analyst, FinEcAnalysis, the module for MS Office Excel "Excel Financial Analysis"

14.2. Modern IT trends in the professional sphere

14.2.1 Modern IT trends in healthcare

Information technology allows the new horizons to improve the quality of

provision of the state services and the development of such directions as medicine, education, power engineering, etc. With the development of the information technology the new directions in medical sphere have appeared. Teleconsultations for patients, observation and monitoring in a real time mode have become possible, systems of distant fixation and transmission of physiological parameters have been developed. Many developed countries apply such systems in the regular practice in the health sector for a long period of time.

Technologies for the round-the-clock medical online consultations, monitoring of dynamic condition of patients, control over key vital signs of the patient and their emergency correction are widely used.

Nowadays, information technology is used in the field of health care for solving the following tasks:

- Carrying out the monitoring of physiological parameters of patients, for example, the arterial blood pressure, the sugar level in blood, etc.
- Increase in accessibility of medical services; help for people in geographically remote regions, physically disabled people, and also the patients who are in closed or organized groups.
- Support for the elder population with high-quality ambulatory observation. Control over physiological parameters for the purpose of support of prevention and treatment of diseases.
- Support of rehabilitation actions for patients after operations, and also rehabilitation and telemedicine services for women during the prenatal and postnatal periods.
- Carrying out rehabilitation of the patients who need psychological or mental health services. Carrying out a certain activity and rendering necessary support to patients by means of audio and visual communication.
- Conducting consulting support in the case of emergency by highly qualified specialists.
- Managing of the electronic database of all patients with complete history of requests starting with the very first visit to medical organization specifying the assigned treatment. Carrying out the fast information search in the database based on the context.
- Standardization and algorithmization of the description of the statuses and researches providing saving of time of the medical staff.
- Creation of electronic queues; guiding of electronic appointments to specialists.
- Automation of preparation of prescriptions, assignments, sick-lists and other documents for patients.
- Creation of unified information networks both within clinic and for interaction with other medical institutions and drugstores.

Nowadays, the staff of medical institutions gets access to the latest information in the field of health care and can establish professional connection with colleagues to exchange experience through the Internet.

Some of the listed items are already applied actively both in foreign countries and in Kazakhstan, and some of them are at the stage of implementation or development. Thus, information technology has already made the considerable changes in the medical sphere but a lot of them should be realized.

14.2.2 Modern IT Trends in Power Engineering

Information technology plays a special role in strategic branches of economy, one of which is the power engineering. The power engineering is difficult production and, therefore, needs bigger automation of the processes happening in it more sharply. Nowadays, the development of energetic branch has a set of serious problems that excludes effective operation of all electrical power processes.

In this regard information technology connected with the use of the modern tools of collection and data transfer allows new opportunities in the case of solution of issues of energy saving. The computerization of solving problems of technological processes optimization and minimization of losses are directly connected with saving energy resources.

The centralized monitoring of technical condition of energetic units and the other equipment, observation of rules of industrial safety are indispensable conditions of stable operation of thermal power plants and hydroelectric power stations. Creation of such centralized monitoring systems is possible thanks to the modern data exchange protocols allowing to connect territory remote monitoring systems to the head Data Processing Center (DPC). Further development and the growth of power of servers together with the use of virtualization technology will allow to solve important information problems of processing and reliable data storage in the central DPC.

Considering specifics of the energetic branch it is pertinent to mark that in the power industry along with high speeds of computation, reliability and fail safety of server and network equipment are important. Monitoring the aggregated conditions, energetic logistics, supply of the fuel and energy production are the processes proceeding continuously. The use of the blade servers, the newest fault-tolerant data storage systems and systems of backup of data, technologies of clustering (creation of clusters from servers) will allow to reduce quantity of failure points, duplicate and reserve the main parts of DPC to support the maximum fail safety.

14.2.3 Use of Search Engines and Electronic Resources for Professional Purposes

Information retrieval: basic concepts, types and forms of organization.

Information search (information retrieval) is one of the basic information processes. Objectives, features and character of search depend on the availability of information, its importance and accessibility as well as search tools organization.

Vast arrays of ever-growing variety of information are available and of interest in the broadest segments of society, characteristic of the late XX and early XXI centuries. In addition, Internet technologies, software and technical means available to the majority of people allow this process at any time, place and on any requests.

Search is a process in which sought is compared with each object stored in the array in a desired sequence. The objective is to search all requirements necessary or desired to find different types of information, relevant information, knowledge, etc. to enhance their own professional, cultural or any other levels of the person performing the search; creation of new information and acquiring of knowledge; management decision-making, etc.

The number of users who work online is growing. This makes it difficult to organize operational search and find the desired information for a large number of users. There are problems caused by a variety of features (types) of information retrieval, different ways of their realization in the information retrieval system (IRS), users' various levels of knowledge about the possibilities of such systems, especially in the area of query and data obtained as a result of these requests, etc.

It is expected that in the future the IRS will be created to be adapted automatically to reflect the level of knowledge and requirements of specific users, perceive queries in natural language, use the artificial intelligence and give them the relevant information. The creation of such IRS will require intelligence and knowledge of specific users or their intermediaries. Meanwhile, a fairly good knowledge of the subject area is required from a wide range of users of search engines.

There are different interpretations of the term "information retrieval".

The term "**information retrieval**" (eng. «Information retrieval») was introduced by the American mathematician K. Muers. He noticed that the motive of this search is the *information need* which is expressed in the form of information request. The documents and information on their availability and (or) location using factual information were taken by K. Muers as the objects of information retrieval.

The librarians are the first to solve the problem of factual research. They have developed means of information retrieval called "*reference-search device*" (catalogs, bibliographies, etc.). They define "information retrieval" as finding information in an array of documents corresponding to the information request of the users.

In terms of computer usage "information retrieval" is a set of logical and technical operations with the ultimate goal of finding documents, information about them, facts, data and the relevant request of the consumer. **Relevance** is conformity of the content of a document to information search or image search of a document to search prescription.

System to ensure implementation of information search is referred to as *search engines* (SE). The traditional technologies of the SE are card indexes and

catalogs, directories, indexes, encyclopedias, reference apparatus to the publications and other materials.

For the first time the issue about necessity of mechanization of information retrieval was widely raised by the American scientist and engineer W. Bush in 1945 in the article "A possible mechanism of our thinking." Since the 1960s, there are automated search engines working with information. From this period intensive work on the formation and implementation of the principles and methods of information retrieval has started.

The search system is used to search for the base or other machine-readable data array of documents that contain the specified keywords.

Electronic search systems allow users to perform search using formal elements and elements describing the content as well as special logical operators using conventional or intelligent terminals; they search documents among various arrays of machine-readable data that contain specific words. Search engines allow only searching procedures and related to them processes.

Information Retrieval Systems

SE with a large set of features and capabilities normally included in the database is referred to as information retrieval systems. They are also created and used by users for effective retrieval of the data they need including those ones in the Internet.

Information Retrieval System (RS) is a system for finding and storing information; software package that implements the processes of creating, updating, storage and retrieval of information in databases and data banks.

Information retrieval system is interpreted as a system that provides search and selection of required data based on the information retrieval language and related regulations, **the database** is a set of tools and methods for describing, storing and manipulating data, facilitating the collection, storage and processing of large data arrays. Arrangement of various databases differs from data objects and relations between them.

The function of modern IRS is based on two assumptions:

1) The necessary documents for the user united by the presence of some feature or combination of features;

2) The user is able to specify this feature.

Both of these assumptions are not performed in practice, and we can only talk about the possibility of their implementation. Therefore, the information search process is typically a sequence of steps that lead to some results and assess to its completeness. In this case the user's behavior as the organizing principle of management search process is motivated by the need not only the information but also a variety of strategies, technologies and tools provided by the system.

The user normally does not have comprehensive knowledge about the information content of the resource where he conducts a search. The user can assess the adequacy of the query expression as well as the completeness of the

result by finding more information or organizing the process in such a way that part of the search results could be used to confirm or deny the adequacy of other parts. At the same time the professional user is characterized by the resistance of thematic profile. When the professional users are "information-oriented" they want and have the ability to organize the information space of the problem. This means that the users create essentially new, "independent" problem-oriented, individually updated IR comprising Meta information, for example, the special terminological dictionaries, classifiers domains, resource descriptions, etc.

The peculiarity of the user's work in the "self-service" mode in the context of the task automation of combined activity means that the system should present environment that provides support for user's functions to process the found information as well as traditionally related to the functions of the information mediator (query interpretation, its translation into information search language, IR selection, an automated search and manual selection of materials), but also such "providing" functions as structuring information needs, lexical request adaptation, evaluation, systematization and processing of search results at the levels of a separate document and information resources in general. Technical capabilities of the user enable him to create an information resource, i.e. form arrays, organize and create the external representation of the content for their own or external use.

IRS is divided into: traditional (manual, mechanical, electro-mechanical) and automated (electronic) systems.

Automated Information Retrieval System (AIRS) uses computer software and hardware tools and technology and is designed to locate and release the information to users according to the specified criteria. The following two factors determine the search for an understanding of automation methods:

1) not only objects are compared but their descriptions i.e. so-called "search images";

2) the process is complex (composite and one-act) and is usually implemented in a sequence of operations.

The data are entered in AIRS based on a specially developed input formats. All information about one object in the IPA is presented in the form of systematic data forming one row of the table and is called a record. Moreover, if the IRS is an electronic catalog of the library, any bibliographic description (BD) of the document in it is one record consisting of fields that is equal to the number of BD elements. It is a set of records forming the database which is usually stored in one file. It represents the collection database united by the same database or database forms.

Because AIRS is a tool used by a person in the search (not intelligent machine to search for information representing ready solutions of problems of operating activities), the efficiency of its use depends on how well a person knows the nature of operating facilities and properties of the instrument by which he is working with these objects.

Information retrieval involves the use of certain strategies, methods, tools and resources. The behavior of the user managing the search process is determined not only by the information needs, but also by a variety of instrumentation systems, i.e. technologies and tools provided by the system.

Search strategy is a general plan (concept, preference, setting) of the behavior of a system or a user to express and satisfy the information needs of the user conditioned by the nature of the purpose and type of search and the system of "strategic" decisions, i.e. database architecture, methods and means of searching in a particular AIRS. The choice of strategy is, in general, an optimization problem. In practice, it is largely determined by reaching a compromise between practical needs and possibilities of the available funds.

Search method is a combination of models and algorithms for the implementation of individual process steps: constructing a search query image (SQI), selection of documents (comparison of search query images and documents) expanding and reformulation of request, localization and assessment of issuance.

Image search query is recorded in IRL (information retrieval language) text which expresses the semantic content of the information request and contains the instructions necessary for the most effective implementation of the information retrieval.

Search methods, i.e. allocation of subsets of documents, potentially containing a description of the decision problem of selection of documents, are a reflection of the process of finding a solution depending on the nature of the problem and the subject area.

Considering the search as an iterative process, methods of reducing the running space (viewing a subset) form a substantially methodological basis of the search strategy and can be divided into the following classes, i.e. search methods:

1) space (usually, topical);
2) hierarchically ordered space;
3) alternative space;
4) dynamic (changing in the search) space.

The implemented method for constructing posture should provide effective ways to build a query to achieve the objectives of different types.

Search engines are a collection of system models and algorithms in the process of delivery of documents in response to a search query.

Search engines, on the one hand, are an interdependent set of information retrieval languages (IRL) and the language of definition/data management providing structural and semantic transformation process objects (documents, dictionaries, sets of search results), and are the user interface objects that provide the consistent control of selecting specific operational objects of AIRS on the other hand.

Search technology is a unified (optimized within a particular AIRS) sequence of the effective use of certain means of research in the process of user’s interaction with the system for stable obtaining of the final and intermediate results.

Navigation, as the implementation of on-demand scanning process in the selected database, is a purposeful, determined strategy of using a sequence of methods, tools and technologies for specific AIRS and evaluation of results.

Navigation tools allow the user to manage the search process. They are provided to the users in the form of interface that allows them to organize more or less efficient process of interaction with the database. The "friendly" interface is characterized not only by ergonomics and apprehensibility, but by the availability and the choice of operating facilities. The process of searching for information is a sequence of steps leading through the system to some of the results to assess its completeness. Since the user does not usually have comprehensive knowledge about the information content of the resource, he can assess the adequacy of the query expression, as well as the completeness of the result. It can be based only on external assessments or interim results and generalizations comparing them, for example, with the previous ones.

The search process can be represented by the following major components:

1) Formulation of the query in natural language, the choice of search systems and services, formalizing the request to the appropriate IRL;

2) Conducting research in one or more search engines;

3) An overview of the results (link);

4) Pre-processing of the results (view the content of links, recovery and preservation of relevant data and pertinence);

5) if necessary, modification of request and conduction of repeated search and the processing of results.

To reduce the amount of selected materials, search results by source type (websites, portals), themes and other grounds are filtered.

According to the used search IP technology can be divided into 4 categories:

1. Thematic catalogs;
2. Specialized directories (online directories);
3. Search engines (full text search);
4. Metasearch tools.

In the Internet IRS is placed on one or more servers. The IRS collects, indexes and records the information on the documents available in the system serviced by a web server group. The documents are indexed by all meaningful words or only words from the title.

Thematic catalogs provide the processing of documents and classify them in one of several categories. The list of which is set in advance. In fact, this indexing is done on the basis of classification. Indexing can be performed automatically or manually with the help of specialists browsing popular Web sites and a short description of the documents, resume (keywords, abstract,).

Specialized catalogs or directories are created for individual sectors and topics, for example, news, city and e-mail addresses, etc.

Search engines (the most advanced means of Internet search) implement a full-text search technology. Indexed texts are located on the poll server. The index

can contain information about several million documents. For example, the index of the popular IRS «AltaVista» is more than 56 million of URL-addresses.

While using resources of metasearch inquiry is carried out simultaneously by several search engines. Search results are combined into a common list ranked by relevance. Each system handles only a part of the network nodes, thus, expanding the search base. "Personal search programs" which enable the development of their own metasearch tools (for example, automatically frequently visited sites) can be reffered to such class.

The data information base can contain almost any type of information. Information search is carried out both on the existing terms in the textual Electronic Information Resources (EIR) and the Special items included in the Information Retrieval Language (IRL). Special information retrieval languages are used for querying.

IRS found in the sample usually tries to locate documents in the order of "relevance", that is, close to the user’s request. Criteria of such closeness are a lot and identification of documents close to the meaning of inquiry does not solve the problem of getting information in the case of absence of a relevant document. This situation is fairly trivial because the user often looks for a document that is going to be written. It should be noted that as a result of the search conducted by the user there can be relevant, pertinent data subarrays as well as irrelevant and impertinent ones.

IRS is actually a system of information support, and it represents the databases and databanks. An organization, industry, region, etc. are objects of the individual act. The subject of information provision is an IT-specialist, any consumer of information.

Organization of search

The procedure of finding the necessary information is divided into nine main steps:

- Definition of the field of knowledge;
- Selection of the type and sources of data;
- Collection of the materials needed to fill the information model;
- Selection of the most useful information;
- Selection of the information processing method (classification, clustering, regression analysis, etc.);
- Selection of the laws of the search algorithm;
- Search laws, rules and formal structural links to the collected information;
- Creative interpretation of the results;
- Integration of retrieved "knowledge".

For the original search an interface with the appropriate database is loaded on the user's computer. This can be a local or remote database. Initially, we should

define the type of search (simple, advanced, etc.). Then, with a set of suggested search fields, IRS can send an offer to enter one or more fields. In the latter case it is usually in the following fields: author, title (title), the time period, document type, keywords, headings, etc. In forming the request virtually all the systems allow the use of logic elements "AND", "OR", "NOT".

Technologies of information search

The search engines and technologies used for implementation of information needs are defined by type and status of the user's task of primary activity: by a ratio of his knowledge and ignorance of the researched object. Besides, the process of interaction between the user and the system is defined by the user's level of knowledge of resource contents (completeness of representation, reliability of the source, and etc.) and the functional capabilities of the system as a tool. In general, these factors usually come down to a concept of "professionalism", i.e. information (prepared/unprepared user) and subject (professional/nonprofessional).

The information search process has usually an empirical character. It represents the sequence of the steps which in the case of system leads to some result allowing to estimate its completeness. At the same time the behavior of the user as the organizing start of search process management is motivated not only by information need, but also by a variety of strategies, technologies and tools provided by the system.

Usually, the user has no exhaustive knowledge of the information maintenance of the resource where he/she conducts search, therefore, he/she can estimate adequacy of expression of a request as well as the completeness of the received result having found additional data or organized the process so that a part of search results could be used for confirmation or denial of adequacy of another part.

The operational objects are directly participating in interaction of users with a search engine. They are a retrieval image of the document (RID) and the request (RIR) which compliance is set by the Automated Information Retrieval System' (AIRS) mechanism at the formal level. Adequacy of the image to the valid contents of the document is defined by the quality of process of the information convolution and the level of knowledge by the subject of means of reflection, i.e. the conceptual scheme of the subject domain and opportunities of Information Retrieval Language (IRL).

The retrieval image of the document is the document description expressed by means of IRL and characterizing the main semantic contents or any other features of this document necessary for its search by a request.

The majority of Retrieval systems (RS) initially offer users either BD or links to full or partial documents, their description, etc., stored in different AIRS. Modern retrieval systems (RS) allow to define and specify source of information the user is interested in.

Methods of Processing the Search Results

According to the nature of conversions (in the context of further use of results of processing) methods of processing the search results can be divided into two groups conditionally:

1. Structural and format conversions;
2. Structural and semantic conversions (information and analytical, logical and semantic).

Search Implementation

What does one usually look for in the Internet: personal data about individuals and the organizations; different address data; specific materials (articles, books, photos, handbook data, software, etc.) including place of their storage; where and how much those materials cost, services, products, etc.; information websites and portals, etc.

The organization of search according to initial fragments of a word is standard (search with truncation on the right), for example, instead of the word "library" it is possible to enter its fragment "librar*". At the same time documents which contain not only the word "library", but also "librarian" and other combinations will be found. In each case the user should understand what he wants to find because in the suggested variant will be found more documents than in the case when the given word is requested fully (without truncation). In this case it is possible to conduct the specifying search in the received array of information and as a result to obtain more relevant and

pertinent data.

Design of Results

From the point of view of the IRS the search result is the set (subset) of found documents or references to them. Usually, it is presented to the user in the list form. It is a list of links in the form of complete or partial BD found IR. Such kind of list can be printed or sent to any e-mail address immediately, if such opportunity is given to the IRS and the user is connected to the Internet.

Graphic and full-text EIR can be offered to the user only for viewing, copying in different formats and scaling fully or partialy. Graphic IR usually exists in the standard formats of JPG, GIFF, TIFF, BMP types, etc., for text materials one usually uses the TXT, DOC text formats and others, HTML and PDF are actually graphic formats in which both text and graphic data can be stored.

Criteria for Search Evaluation

Criteria of search result are obtained by the user. The list of documents or other parts of them are maximally fitting to his or her needs formulated in a search request. According to IRS it is accepted to create the list of documents on their relevance. Criteria of semantic and formal compliance between the retrieval instruction and the issued document are distinguished.

Completeness and accuracy of search are interdependent indices. An increase in one of them leads to the decrease of another one. In the modern IRS the balanced search of their value makes about 70%. It is necessary to consider a

situation when the list of the links issued by a search engine contains several, and sometimes tens of different addresses with the same text. Similar links are characterized as counterparts. In calculating the coefficients only one document is considered.

Assessment and Processing of Search Results

Considering that the ideal search result should meet requirements of uniqueness, completeness and consistency we understand that different types of search define different requirements to the functional capabilities of system regarding the estimation of the result. However, in the case of subject search the completeness proof is trivial: the nonblank search result confirms the fact of existence (or absence) of the object having required properties. At the same time the result of topic search is multiple and requires the subsequent systematization, i.e. one more procedural step for sorting received set of objects on values of the base which isn't defined obviously. In its own turn the problem search already presupposes two-tier systematization.

Development of search process is carried out by modification of the expression of RIR by reformulating a request and conducting the repeated search in the same data array or in the subarray received as a result of the implementation of the original search.

Interface tools of processing of result and the development of search use two types of operational objects, i.e. separate documents or collections of documents.

Internet search engines

In order to receive information in the Internet special search engines are created. As a rule, they are publicly available and serve users from all over the world where the Internet access is. Search machines, the number of which in the world is equal to several hundreds, are used for the immediate search. They are focused on certain types of queries or their combination (bibliographical, address, factual, thematic, etc.). Apart from this, there are full-text, mixed and other search machines.

For conducting search in the Internet (in WWW) some sites and search engines functions are necessary not only to be orientated in such systems but also to be able to execute an effective search, i.e. use corresponding technologies.

Search Technology denotes a combination of rules and procedures after using which a user gets an IP. During the search in the Internet it is recommended to pay attention to two components: completeness (nothing is lost) and proximity (nothing unnecessary is found). Usually compliance of the found materials with these criteria is called *relevance*, i.e. the correspondence of the answer with the question (query).

Search engines are also characterized by the time of conducting search, interface offered to users and the type of displayed results. While selecting a search engine attention is paid to such parameters as coverage and depth. *Coverage* is understood as the scope of basis of search machine measured by three indicators:

the whole volume of indexed information, the quantity of unique servers and the number of unique documents. The depth is understood as a presence of limits on the number of pages or on the depth of the directories enclosure on one server.

Every search machine possesses its own algorithms of sorting search results. The closer to the start of the list received after search the necessary document is, the more relevant and better is the work of the search machine.

Search machines use common principles of work focused on execution of two fundamental functions. *The first function* is realized by the robot programme which automatically views various servers in the Internet. Finding new or edited documents it conducts indexation and transmits to the basic computer of the search machine. "Robot" is an automated browser which loads a web-page, explores it and, if needed, moves to one of its hyperlinks. When it faces a page which does not have links the robot returns to one or two levels back and moves to the address indicated in one of the found links. The launched robot traverses vast distances in the Internet space (cyberspace) focusing on the development of web-net and changing its routes in accordance with it.

Indexing robots process only HTML files ignoring pictures and other multimedia files. They can detect links with non-existing pages, set the connection with the most popular nodes counting the number of their links on other web-pages; they register web-pages finding new exterior links in the explored documents. Their second function is identified by document processing. The content of all the pages (not only a full text, but also the presence of images, audio and video files, Java-applications) is considered. All words in the document are indexed which gives an opportunity to use search engines for the detailed search of the narrowest category. The developed gigantic index files which keep information about each word, its frequency of use and location in the document and server constitute a database to which users appeal in the search line typing RIR (combination of key words).

The results output is given with special subsystems producing intellectual ranking of results. Its calculation is based on the location of a term, frequency of its usage in the text, the percentage ratio of the term to the rest of the text on the given page and other parameters which characterize possibilities of the certain search machine.

"Robots" can be different, one of which is "*spider"*. It continuously "crawls over the web" going from one web-page to another to collect statistical data on Web and (or) to form some database with the indices of the web content.

Automatized agents, i.e. "spiders", regularly scan web-pages and actualize databases of the addresses (hyperlinks), the means of indexing information located on the indicated addresses. The received indices are used for the quick and efficient search according to a number of terms given by a user. In various systems this aim is achieved in different ways. Some automatized agents send "agents" to every web-page indexing all the words. Other automatized agents first analyze database of addresses determining the most popular ones (usually the number of

existing links to them is estimated). These web-pages are indexed in varying degrees (there may be only headings of web-pages and links, including automatic annotating of documents or the whole text).

More and more often *"intellectual agents"* are used, i.e. small programmes for self-study which act independently from their owner's name. Having connection with the computer of the user they act as the personal assistants which execute a number of tasks using the knowledge about needs and interests of the user. Intellectual robot-agents conduct an independent search in the net according to their own unique algorithms. Some of them do not solely view key words but conduct the semantic analysis of information in the Internet identifying the degree of its semantic relevance to the given task.

An effective access to information in the Internet is provided by such ***search engines*** as "AltaVista", "Lycos", "Yahoo", "Google", "OpenText", "Wais", "WebCrawler" and others. Their addresses in the Internet are www.altavista.com, www.yahoo.com, www.gogle.com, www.opentext.com.

"Aport" (JSC Agama), "Rambler" (Stack Ltd.), "Yandex" (CompTek Int), "Russian Search Machine", "New Russian search" and others are related to the search machines. Their addresses in the Internet: www.aport.ru, www.rambler.ru, www.yandex.ru, search.interrussia.com, www.openweb.ru, etc.

All these search engines allow keywords, subject headings, and even individual letters to find a network quickly, for example, all or nearly all the texts in which these words appear. In this case the user is provided with website addresses where are always found IP. However, none of them has an overwhelming advantage over the other. To conduct a reliable search for complex queries, experts recommend using varoious ISE in series or parallel (simultaneously).

Full-text search engine indexes all the words of the visible text for the user. Availability of morphology makes it possible to find the search terms in all declensions or conjugations. In addition, in the HTML language there are tags that can also be processed by a search engine (headers, links, captions to images, etc.). Some machines are able to search for words or phrases at the given distance; it is often important to get a reasonable result.

Despite the general principles of their structure/construction, the search engines differ in topics, volume, classification and interfaces. Some search engines use special section the "Map" for comfortable navigation through different sections.

The user often needs textual and cartographical information at the same time. In 80-ies of the XX century experiments of this issue were conducted in Canada. Thus, the first geographic information systems (GIS) have been developed, i.e. computer systems which allow working effectively with spatially-distributed cartographical information. GIS is a natural extension of the concept of a database that complements their clarity of presentation and the ability to solve problems of spatial analysis. They are used for land management, resource control, environmental protection, municipal administration, transportation, economy,

solution of social problems, and etc. Up to 80-90% of all information which users usually deal with can be presented in GIS. GIS is a stage of transition to a paperless technology of information processing.

During the search servers typically use the data stored on Web pages in the metadata tags: (title), (meta name = "keywords"), and (meta name = "description"). Information about the purpose of the site and its subjects should be reflected in these tags while creating your page.

It should be known that the less number of keywords is included in the tags, the greater frequency they can occur in the text pages, and hence, the higher is their relevance. The optimal frequency of such words is no more than 5%. The number of keywords should not be a lot, they increasingly have to consist of one or two words forming the frequently used terms. The more relevant keywords are, the more competitive they attach documents from the point of view of search engines.

The completeness and accuracy of the response depends on the accuracy of the request formulated by the user. As a result of research he is given much more information than he needs. It depends not only on the well-formulated request but also on the capacity of different search engines. The "forest syndrome" (due to the forest one cannot see the wood) is sufficiently shown, which demonstrates the fact that you can skip the main necessary information in the data. Obviously, no measures are exhaustive in terms of constant expansion of the environment and the emergence of new variety of IP which confirms the difficulty of search in the WWW.

Simple queries in the form of separate wide-spread terms lead to the retrieval of thousands (hundreds of thousands) of documents, the vast majority of which is not required (information noise).

An important aspect is also the possibility of such systems to support multiple languages, that is, the ability to handle requests in different languages. The users are offered bilingual dictionaries, electronic translators, and etc. In addition, systems carrying instant ("on the fly") translation of information resources found in the Internet and copied onto the user’s computer have been created.

The use of machine-readable thesauri is topical. Electronic Thesaurus, a dictionary used for text analyses and information retrieval, includes a wide range of semantic relations between its constituent terms.

Systems allowing you to search the full-text database effectively are created. They are based on the use of technologies of syntactic and morphological analysis of text (split into elements recognized by the program) and the expeditious processing of texts into natural languages.

Developers of search engines are trying to adapt them to beginners and "average" Internet users, the number of which is growing steadily. In the Canadian system www.web-help.com users are offered a set of References prepared by employees of the internet company. In real-time mode the employee finds the user's request and attaches it to the user's screen which is an appropriate (in his

opinion) to the site. The method is useful for finding specific facts, statistics, and etc. that are not easy to find otherwise.

While organizing the same query on different search engines is possible to obtain a variety of content and breadth of materials. The art of building a query requires knowledge of the specific characteristics of each search engine and the availability of work experience with the Internet in general. Some search engines offer quasiintellectual means which allow less experienced users to ask questions traditionally in the natural language to get enough relevant data.

Typically, full-text search in the database is performed using morphological analyzers (usually Russian and English) to discover existing word forms by a fragment of a word, word, phrase automatically, even if there is the query of words there are some typographical errors.

Metasearch systems are used providing a search result to obtain summative data from a dozen search engines but the amount of information can be very significant. Part of this problem is solved by providing a general list at the begining of which there are the data relevant enough to the request. Another way to meet the needs of users is the creation of unidirectional thematic search engines on websites, i.e. **portals**.

The importance of information search in the Internet has spawned an entire industry which task is to assist the user in the navigation in the cyberspace. Specific search tools make this sector. Conventionally they can be divided into a reference type search tools or just directories and search engines in its pure form.

Metasearch systems. The increasing number of search engines in the Internet has led to the creation of "**metasearch systems**". They allow the user simultaneously to work with multiple databases in a single user interface using the codes of conventional search engines. "Metasearch system" does not yet allow realizing all the possibilities of individual search engines but for the most part it offers significant speed and the degree of coverage of Web-space that defines their ever-growing importance and popularity.

14.3 Security Issues in the Industrial Information and Communication Technologies

In reality, on the one hand the ICT market cooperates with modern information technologies and domestic industry of information including the industry of informatization means, telecommunications and communications, on the other hand - the state economic activity.

Information security means the security of the information and its supporting infrastructure from accidental or intentional exposure of natural or artificial character that would result in damages to the owners or users of the information and supporting infrastructure. The modern information technology, information resources and telecommunications are considered as the ICT infrastructure of the market. Therefore, we can say that the *information security of the ICT market* infrastructure is understood as a set of market conditions and protectionist

measures that provide the state of protection of domestic production of ICT and customer from damages of the use of foreign products with different tabs and malware.

The objects of information security of the ICT market are the participants in this market, i.e. the organizations and enterprises of credit and financial spheres, banking, financial and insurance companies, offices and agencies of the government, enterprises of oil and gas industry, enterprises of the industry of information technology and communications, enterprises and organizations of the nuclear and electric power, wholesale and retail companies.

In recent years our country has implemented a set of measures to improve information security. The legal base of information security has been formed, issues of hardware and software information security have successfully been resolved, the situation in the staffing of the information technology industry has been improved, and etc. However, looking at this or that aspect of information security, and in particular, at the ICT market, one can not bypass its economic aspects.

The economic component of the ICT market of information security is viewed as an important characteristic of quality of such economic system as the ICT market.

Safety in industrial information and communication technologies is often associated with the use of Internet resources of enterprises and organizations. Therefore, it is important to consider the management of the Internet.

14.3.1 Control Modes

There are four modes of regulation, namely:

- Legislation, i.e. through public and private sanctions and the use of force including self-regulation, especially, when it is delegated by the Government.
- Rules of social behavior in expectation, encouragement or censure.
- Market mechanisms, i.e. usually through pricing and accessibility.
- Architecture, i.e. through the possibilities of technology (it allows, prevents or prohibits).

14.3.2 Architecture

The term "architecture" refers to the development of the technology so that certain behaviors are encouraged or discouraged. For example, to deal with excessive speed the number of traffic police on the roads or "speed bumps" could be increased. In Singapore roads in residential areas are winding in order to slow down traffic and beautify the area. Similarly, manufacturers adopt a variety of locks and blocks to prevent copying of music and video.

In the Internet some people believe that the design of the Internet contributes to the greater freedom of expression. This means that anyone who wants to regulate the Internet content will find that very difficult to implement. In the Republic of Korea instead of trying to track down and catch hackers and those who

use botnets to attack the Internet the Safety Agency has developed a "network-trap» (honeynet) to fool the direction of botnet attacks with access to the false network.

14.3.3 Market Mechanisms

This method of regulation usually deals with pricing processes and availability of goods and services. Rules that market-based mechanisms use as a regulatory tool include rules of fair play, clear contractual terms, as well as the development of competition in the market. At a basic level it is the concept of trade, buying and selling.

Commercial sensitive information in the Internet, for example, giving someone your email address in exchange for the right to meet friends or receive any information content are examples of the use of the market mechanism as a form of regulation. The idea is that if someone appreciates their privacy more than the right to acquaint or receive any content then this person will never give your email address. In the US private such companies as Trust-e have appeared to give users the protection of private information. In the European Union (EU), on the contrary, it believes that privacy should be governed not by private agreement between an individual and a company but in accordance with the law.

Using social norms as a regulatory mechanism assumes that social pressure can dictate person's behavior. Netiquette or etiquette is an example of social norms as a regulatory mechanism. Etiquette requires reference of published messages in the forum to the discussion topic.

Using the rules of social behavior is eaasier in social groups because the groups act as a supervisory and executive body. Those who break the rules may be excluded from social groups. Such authorization may be effective when membership in a social group is considered important.

14.3.4 Laws including self-regulation

Laws are manifestations of policies and are accepted by Parliament or the National Assembly. In general, caution should be exercised with the adoption of laws in a rapidly changing environment such as technology. There are pioneer disadvantages. For example, the Digital Signature Act of Utah, the first such law in the world, soon became obsolete because there were new technologies as a result of which the technologically-oriented approach stopped working.

Singapore and the United States which adopted the first laws to immunize network operators (in the case of Singapore) and other intermediaries (in the US case) soon discovered that other countries had accepted their own laws and improved their possible superior ways.

Perhaps, the best advice is that laws should lag behind not ahead of technology, and a multifaceted approach with wide consultation before making laws should always be used. It should be taken into account that the Internet is still at a relatively early stage of development.

Self-regulation

In the Internet industry, as a rule, the concept of self-regulation is considered as a way to provide greater flexibility in the adoption and enforcement of laws. Originally, self-regulation meant industry regulating branch not a person or company regulating itself directly. In practice self-regulation is often a delegation of authority to the final rule of sanctioning that is still in the hands of the government. This means that the government has allowed the industry to take the lead in regulating the sector in this question.

Advertising is an area where governments, especially, in developed countries tend to use self-regulation. The government may serve as a lawsuit against the malign violators who ignore solutions of the industry for misleading or insulting advertising.

However, self-regulation needs a motivated private sector. It works in the advertising industry as well as the use of government intervention to approve advertising will slow down this fast-paced sector and very likely stifle creativity. Internet industry is less prone to self-regulation. Some people in the industry have even complained that self-regulation means that the industry performs the work of the government.

Questions overlapping with the real world

Internet has an impact on the real world. Should the offline world be modified so that it looks more like a virtual world? Or whether the rule applies to network offline world? The answer, of course, is somewhere in between.

14.3.5 Competitive policy

As far as possible the access to the Internet should be competitive. This means the liberalization of the telecommunications sector, particularly, if the sector is monopolistic or an entire monopoly. Liberalization in this sector, as experience has shown, improves the quality of service and at the same time leads to lowering of prices. Low prices lead to an increase in Internet penetration. In the case of broadband access to the Internet the reduction of the cost changes the circuit of its use. The game theory states that it is necessary to have at least three players to reach the effective competition.

Liberalization of the Telecommunication Sector and the Cost of Internet Services

One of the causes of development of the Internet in the United States is the liberalization of the telecommunication sector. The Internet ultimately depends on the extended International Telecommunication. Competition in current sector has reduced the prices. The most obvious impact of liberalization is observed in the United States where the telecommunication market has begun to be liberalized: it is cheaper to organize your web site in the United States than in the other countries. This leads to an effective cycle where the economy determined with grow of production scale, in turn, allows keeping low prices. Researches have shown that telecommunication demand is fairly elastic. That means that the fall of prices on the X percent leads to an increase in demand for more than X percent.

Moreover, researches have shown that stimulation of competition in the local loop of telecommunication sphere will contribute to a deeper penetration of the Internet.

France, Japan and the Republic of Korea have increased broadband access through competition policy. The Republic of Korea has the highest rate of broadband access in the world. This was aided by policy allowing free access to basic telecommunication sphere from the 1980s. In France and Japan there are more instructive cases as penetration rates were not so high until about 2005. Since then, the policy stimulating competition reduced prices and the spread of broadband access jumped up.

Since the middle -1980s to the middle -1990s in many books and articles the benefits of the liberalization of the telecommunication sector were discussed. Liberalization of the Internet sector is a continuation of the ideas discussed in the telecommunication sector. See E. Giovannetti «IT-revolution, the Internet, and telecommunications: the transition to a competitive industry in the European Union.", E. Giovannetti, M. Kagami and M. Tsuji «Internet Revolution: A Global Perspective.

14.3.6 Censorship and Freedom of Speech

Censorship by the government and the private sector exists all over the world. As noted before the question is to balance local interests with the international rules on the usage of little or absence of the Internet censorship. Full block of sites is condemned by the Internet community. The most practical and acceptable solution is filtering of some elements used by the user. The filtering of the software installed on the user's side is acceptable. But it has been found that parents are not often so quick-witted as their children in installing and using filters.

Voluntary self-assessment filter

In 1999 the Bertelsmann Foundation (Bertelsmann) assembled a group to develop a filtering system of Internet content that would be free, culturally sensitive, and does not violate the right of freedom of expression. This group comprised researchers, regulators, as well as defenders of freedom of speech. The final step was the formation of the Association for the Assessment of Internet content (Internet Content Rating Association, ICRA). Group imagined the following ideal outcome: a parent clicked on the country in which he or she is, and then clicked on the filtering system (one of the established by the Catholic Church), and then sites deemed to be inappropriate would be filtered out. Under the influence of the filtration system sites would label themselves on grounds of language, the presence of violence, nudity and inappropriate images (but legal) content such as alcohol. It is about 40 labels. In the end, however, ICRA did not come close to its lofty goal.

Firstly, there was opposition from the civil libertarians, such as the Center of development of Democracy and technological progress in the US. News sites which were initially agreed with self-labeled changed their minds when they understood that they would be perceived as inferior to the regime of censorship.

Second, to solve the problem of freedom of speech the websites had to be self-labeled. This prevented the development of a critical mass of websites that labeled themselves. Without critical mass of websites filter users should cease to use time filters from time to time. Third, the filters would work better if they were incorporated into browsers. At a time when the ICRA method was ready for action browser war was over, and Microsoft came out the winner. Until then Netscape and Microsoft added features into their browsers. In fact, in 2000 Microsoft browser had raw filtration system.

Finally, as it has been experienced with other similar labeling systems such as V-chip in the US which was supposed to filter obscene television content no actual demand from consumers has arisen, or consumers do not act on their verbal agreement on the need for such filtration scheme.

In 2007 ICRA was transformed into the Institute family of network security (Family Online Safety Institute). Since the author was directly involved in ICRA as a Board member the above mentioned details have been given for the first time. In the book "Organizing Chaos" in the chapter "Censorship and regulation of Internet content" some details about ICRA were given.

Another approach is to install filters at the server level which are sold as special additional services to the users. The fee is paid to upgrade and maintain the list of blocked sites. Such filter in fact is impossible to circumvent for the average user. Disadvantage of this approach is that sometimes blocking is worked out after which it was difficult to "unlock" the site that was mistakenly blocked.

14.3.7Defamation

With the freedom of speech in the Internet there is a greater chance for defamation. In general, the decision of issue about intentional false information requires balancing of competing interests: the interest of a person in his/her reputation and the public interest in promoting greater freedom of expression. In the Internet there are also additional problems of conflicting cultural values in the addition to the personal and public interests. One of the most instructive cases is associated with Joseph Gutnik, an entrepreneur from Melbourne, Australia. Barron's magazine owned by Dow Jones defamed Mr. Gutnik in the article. The magazine had 14 subscribers in Australia, five of which were from the state of Victoria. That was enough for the dissemination of the Australian High Court jurisdiction. The Barron's magazine had 1700 online subscribers who had paid by Australian credit card. Thus, the question is: if Gutnik won the case would it mean that all publications would have to be watched using as a yardstick the country with the most harsh defamation laws? Fortunately, the High Court ruled that the financial compensation to which Mr. Gutnik could claim would be limited to the damage of his reputation only in Melbourne, but not globally. It seemed that court took into account the fact of the actual damage that slanderous article may cause. Usually Commonwealth courts are not inclined to do so.

14.3.10 Copyright and other Intellectual Property Rights

For copyright it is necessary to ensure a similar situation immunity. This means that owners of websites and forums should not be responsible for the content posted by others which can lead to copyright infringement, subject to the rules of the host country "of reasonableness." More frequently many countries accept the American position "Notice and eliminate" provided for copyright. These provisions allow the notification to be contested. The person claiming copyright infringement can either stand back and allow the information to stay posted or the matter will be resolved in the court. Do I need to consider domain names as trademarks - a controversial area of the right to intellectual property? For multinationals such rule would ease the burden of having to register their names in each country. This rule means that anyone who uses the name of a multinational company as its domain name without permission violates the rules of intellectual property rights and will have to abandon the use of the domain name of this company. ICANN Uniform Dispute Resolution procedures can resolve this issue at the global level. But in each country the national rules are needed to clarify rights regarding ccTLDs country domain names.

14.4 Automated components of production process

The highest form of mass production is automated production which combines the main features of mass production with its automation. In automated production work of the equipment, assemblies, devices, installations will take place at a given program automatically, and control of their work, elimination of deviation from the predetermined process, adjustment of automated equipment are conducted by worker.

Methods of increasing the flexibility of automated manufacturing systems:

- Use of automated system of technical training of the manufacture (STTM);
- Application of rapid-changing automated production lines;
- Application of universal industrial computer-controlled manipulators (industrial robots);
- Standardization of the applicable instrument and means of technological equipment;
- Application of automatically re-adjusted equipment in automated production lines (based on microprocessor technology);
- Use of re-adjustable transport, warehousing and storage systems, etc.

However, it should be noted that any universalization requires considerable additional cost and its application requires a balanced economic approach based on information and research marketing.

The structure of the latest generation of automatic lines includes electronic devices:

1. "Intelligent supervisors" to monitor each piece of equipment and the central control unit. Their purpose is to warn the staff about the progress of the processes

occurring in the individual units and the system as a whole in advance, give instructions to proceed personnel (text on screen). For example:

- Negative trend of setting technical unit;
- Information about the backlog and number of pieces;
- Defects and its causes, etc.

2. Statistical analyzers with plotters intended for statistical processing of various parameters of the APL:

- Uptime and downtime (Downtime reasons);
- Amount of output (total, the level of defects);
- Statistical processing of each parameter of the workpiece of each automatically controlled operation;
- Statistical treatment of failure (failure, malfunction) of the system for each piece of equipment and the line itself, etc.

3. Dialogue systems of selective collection, i.e. selection of parameters relatively rough (inexact) of machined parts included in the assembly unit, a combination which provides high quality parameters of the assembly unit.

At the enterprises of mechanical engineering and instrumentation the automatic lines are applied which differ both in the technological principles of action and forms of organization.

Automation in the industry has become a familiar process for a long time. Smart controllers control technological processes in modern enterprises of all industries passing information to computers for analysis and human decision-making. To automate the management decisions by the controller is not possible, therefore, integrated systems are developed and successfully introduced around the world such as SAP which interconnects modules to control the production process.

In 1972 SAP company (System Analysis and Programs Development) was founded by five former employees of IBM corporation in Germany. Their goal was to develop a standard software that combines all business processes in the enterprise in real time. In twenty-five years SAP has become the leader in the automation niche of enterprise resource planning (Enterprise Resource Planning - ERP). Today, it is a corporation with branches and affiliated offices in all industrialized countries.

SAP ERP is an informative corporate system based on ERP methodology (Enterprise Resource Planning). It aims to achieve optimal business process. For large state-owned industrial giants the stable performance of the state order is strictly stipulated when terms are needed. In private industry the profit and payback of equipment are more important.

Projects implemented with the help of SAP help the state and private structures to optimize costs and achieve goals at every stage of the production cycle. At the same time individual methods and principles relevant only in the case are the basis of decision-making management.

Enterprise Resource Planning (ERP) is based on the concept of integrating various data and processes of the organization into a unified system. ERP-system

can use a variety of computer applications with a generalized database as a key factor for data storage of the organization.

Prior to the ERP concept the development of different departments of the organization could have their own computer systems for their own area. For example, the HR department could have its own data system for HR and reports; accounting department - to process and store data related to wages and salaries; Finance Department - for data on financial transactions; sales and marketing department – to store information about past, present and potential customers and related information. Each of these separate systems would have a core set of data, which would be made within the communication with other departments. For example, the department of personnel and accounting information would be exchanged on the basis of individual employee numbers which would have remained constant in all systems. This may require considerable effort with disparate systems. Any change or update may require immediate connectivity and instant synchronization, otherwise, the transaction can remain untreated (for example, a worker cannot get salary due to the lack of updated information payment).

ERP-system provides a solution based on the integration of all systems (which may have unique interfaces) through a single database. This allows you to make data available throughout the system and reduces the need for constant monitoring and updating data between different systems. It can also reduce hardware requirements in the sense that the application running on different servers can be configured to run on a single server (or pair of servers for reliability and/or scalability). It also reduces costs putting an end to the need for additional interfaces between two or more systems to exchange data.

14.4.1 The main modules of the program

Accounting and control are needed in any business. In business each percentage of the profit is on the account, so the implementation of information systems that reduces routine operations by more than 50%, shows the transparency of product manufacturing processes, and provides easy access to all the necessary information is the way to effective company's work.

The SAP architecture of new generation can effectively solve a variety of challenges which the company faces.

Key activities:

- rapid production management;
- accounting areas (accounting, finance, storage, transport);
- planning and control;
- personnel.

The system has not only extensive functionality but also full integration between modules.

Review questions

1. What types of special purpose application software do you know?

2. How is the search work in the Internet conducted?

3. What is special about the automated retrieval system?

4. To what extent does our country participate in international cooperation to address the problem of abuse in the Internet?

5. Describe the rules to enhance or promote the development of e-commerce in our country. If there are no such regulations, list down relevant rules which could contribute to the development and dissemination of e-commerce in the country.

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CHAPTER 15. ICT DEVELOPMENT PERSPECTIVES

In the Strategic Development Plan of Republic of Kazakhstan until 2050 the important factors of the rapid development and adaptation of ICT in the modernization of society are mentioned. It will impact on economic performance, as well as on people's lifestyle of modern Kazakhstan.

IT industry is the engine of the world economy. In the information age IT infrastructure contributes to the creation of new business models, products and services, new discoveries and inventions. In fact, it becomes the scientific and technological basis for fundamental restructuring of business models implementation, indirectly increasing the overall competitiveness of the economy.

The widespread use of IT is related to the dynamic trend of the development of innovations in this field. Today the Internet, "cloud computing", mobile and multimedia technologies, social technologies, "big data" and other technologies have become an integral part of the countries with a "smart" economy.

The ambitious goals of the Republic of Kazakhstan in joining the top competitive countries require the great efforts to build the new economy of the country. Competitiveness in modern world is possible only through IT development and implementation.

Education is one of the most important priorities of "Kazakhstan - 2050" long-term Strategy. The President of Kazakhstan N.A. Nazarbayev has set a goal to develop the country and become one of the top 30 the most competitive countries of the world. An important step in achieving this aim is improvement of the education system to ensure that all sectors of the economy will be provided with highly qualified personnel.

15.1 Prospects for the development of IT market: free software development

Free software is the software released under the terms of a free license agreement that gives the user the right to use the program in any purposes (not prohibited by law), access to the source code of the program in order to view, adapt, process, distribute the program (free or for a fee), modify and distribute the processed version of the program taking into account the requirements of possible license inheritance.

In opposite, the proprietary (non-free) software belongs to a certain company (developer). A monopoly of using, copying and modifying information in whole or partly is retained by the copyright holder.

There is also the concept of open source software (OSS). Unlike free software its license agreement may allow to explore the source code of the product without modifications and/or distribution of its copies.

Free software can be a powerful stimulus for the development of IT industry in Kazakhstan. Although, the assessment of the current state of software market segment and its immediate prospects are highly contradictory.

Modern IT industry of Kazakhstan makes no progress and IT business is developing chaotically, dependence on state order is not in favor of IT industry. Main prospects for real innovation development of the national IT market are associated with the creation of the national software industry.

In order to access the global markets Kazakhstan needs the software solutions and products created on the basis of available free software. Formation of strong domestic software companies requires the ability to work on the system and applied levels. Most products manufactured in Kazakhstan are not go into broad circulation although these products often appear before their analogues.

Free software in Kazakhstan is represented mostly by Linux-products. One of the widely used projects is Moodle – the software for distance learning and education process management deployed by UNESCO in 400 educational institutions in Central Asia. Supported by the presidential administration a software complex for scientific and pedagogical libraries Digital Library Green Stone (distributed under the GNU GPL available in the Kazakh and Russian languages) is widely distributed. Another example is Museums network in Central Asia which is open digital catalog of museums.

Free software implementation in Kazakhstan will allow to form the open educational and training resources and provide a basis for national knowledge system. Now free software industry in Kazakhstan is undeveloped and requires support at the legislative level as this technology is for the development not for the commerce. According to Alexei Smirnov, General Director of "Alt Linux", the open source software market of Kazakhstan is interesting for both local and international companies.

However, if the government wants to be not only the consumer of software products but also have its own infrastructure and inventions there are not so many choices.

All major inventions in IT are made on the basis of open source software products that allow to connect quickly to already existing international programs and continue to develop them for national IT segment. In addition, using proprietary software is the issue of civil liberties, and the possible dependence of the buyer from a foreign supplier. Using free software does not lead to such dependence.

There are several difficulties of free-software implementation. Firstly, development of single-piece product is costly and unprofitable. Software companies do not have enough resources to access foreign markets with their solutions. Another risk factor is the systematic "brain drain" and the low training level of young specialists. Also, the barrier may become commonplace habit of the users, the cost on the specification of data formats and the lack of government policy on the issue.

Education is the critical point where the user is addicted to different systems. School education should not be tied to any specific systems but free software provides greater choice and more fundamental education as a whole.

15.2 Formation of the IT entrepreneurship ecosystem and start-up support

Development of small and medium-sized businesses leads to the improvement of the economy efficiency, and it, in its turn, leads to the society welfare. Small and medium enterprises are gradually developing, gaining experience and taking its place in the structure of Kazakhstani economy.

Small and medium businesses (entrepreneurship) are the basis of any economy because they involve a huge cash turnover.

An important advantage of small and medium-sized businesses providing its effectiveness is the interchangeability of workers. In case of functions limitation among the staff of a small team it is distinctive to support each other mutually, have duplication and interchangeability when necessary.

A significant advantage is the high speed of data transmission. This is due to the smaller volume of information covered by direct communication between leaders and subordinates.

It should be noted that setting up the small and medium-sized businesses, as a rule, does not require huge investments in fixed assets. This benefit has attracted many business start-ups and has a positive effect on production costs.

At the same time, small and medium businesses have the following disadvantages:

a) high degree of risk, fear of bankruptcy because many things depend on the external environment;

b) low possibility of capital accumulation as its owners can allocate a small portion of their capital to expand the production;

c) scope of small and medium-sized businesses is limited, it is difficult to enter to the capital-intensive and science-based production;

g) difficulties for small enterprises consist in organizing their own marketing, dealer network, a limited range of products and competing with large-scale production, etc.

According to the Statistics Agency each year the information technology industry in Kazakhstan grows by 13-18%. This data is difficult to be compared with those of other countries because of differences in calculation methods. The number of IT-companies is difficult to estimate since the data from statistic agency does not reveal the number of operating ones.

The software is the important segment for the development of IT-industry where IT-companies can be divided into three groups. The first group is those who do business on implementation of solutions of vendors and other foreign companies. They employ the minimum number of workers and attract foreign experts for the implementation, respectively, the lion's share of their income goes abroad and is spent there. The second group is those who develop software or software products with available programming languages and tools. Third are those who develop programming tools and design the application (IT-projects) on the

basis of created platforms in order to improve labor productivity. There are few companies.

The second and third groups create local content and products, and they need targeted government support. Actually, they are an IT-industry of the country. Today, the first group is the dominating one, and the interest in activities of its members is greater because they are backed by vendors with their capital, the reason is lack of real government support to domestic software vendors. Although in recent years e-government with local content is actively implemented.

Recently, the word "start-up" is used quite often and mostly in relation to IT-projects. In fact, start-up projects can be implemented in any sector.

Startup is an early stage of the life cycle of the enterprise on which the entrepreneur moves from the business idea to the fundraising, building the foundations of the business structure and the beginning of business activity. The majority of startups build their business based on innovative ideas and technology, and, as a rule, they experience a severe financial constraints.

At the moment there is a huge amount of funds, business incubators, government agencies, and other auxiliary financial institutions to support start-ups.

Such organizations include the following public companies:

1. "Center for Engineering and Technology Transfer" JSC. The main objective of the Centre is to improve the competitiveness of the real sector of Kazakhstani economy by organizing the transfer of new technologies and promoting the innovation activities in the country.

2. «Corporation for Export Development and Promotion "Kaznex"» JSC which provides information and analytical support to the Government in the area of public policy including the development of entrepreneurship.

3. "Entrepreneurship Development Fund" Damu" JSC which promotes the quality development of small and medium-sized businesses, as well as microfinance institutions of Kazakhstan as an integrator and operator of financial and consulting services.

4. "National Innovation Fund" JSC which provides financial support to innovative entrepreneurial initiatives by attracting investment and financing projects.

5. "Investment Fund of Kazakhstan" JSC which provides financial support through investment in the authorized capital of enterprises that produce in-depth processing of raw materials using modern and advanced technologies.

6. "Kazakhstan Development Bank" JSC which provides financial support.

7. Technology parks, business incubators, industrial zones which provide logistical support to entrepreneurship at the stage of its formation and development.

Small and medium-sized businesses are an important phenomenon of economic life in a market economy. They are a guarantee of political stability and democratic development of society, creating new jobs they decrease

unemployment, and this is one of the ways of self-fulfillment gaining new experiences and revealing personal qualities.

15.3 Acceleration and incubation program.

Currently the lion's share of Kazakhstani economy belongs to big business, at the same time small and medium-sized businesses are growing fast. There are various accelerator programs for the preparation of startups: StartUp.kz, iStartUpSchool, Atameken Startup operating within Atameken Startup public fun. The club of business angels Atameken Angels unites successful businessmen from Kazakhstan willing to invest in start-ups. Examples of state programs for the development of start-ups are those that are implemented under the auspices of "National Agency for Technological Development" JSC (hereinafter - NATD) created by the state to support the business, first of all, innovative ones.

Basically Kazakhstani accelerators operate as training centers that help teams to create a project, prepare a business plan, study the market, access to an investors' audience. KazInno governmental program implementing by NATD operates according to this principle where the collection of projects is fulfilled in four areas:

- Agribusiness / biotechnology / pharmaceuticals / agriculture;
- IT-technology;
- Mechanical engineering;
- Renewable energy sources.

After the expert selection the projects are finalized by finalists together with mentors during two or three days, then the jury chooses the best in each sphere. The authors of the most promising projects get the opportunity to travel to the US to participate in the program of accelerated development, as well as to present their work to the US investors, entrepreneurs and mentors, establish contacts and partnerships. Study of the Kazakhstani accelerator sites has revealed the prevalence of IT-startups.

Before entering the market IT-startup goes a long way. The product can be created within a year or more. This is due to the fact that it serves as the basis to create, test, and modify the software which takes considerable time.

The idea of IT-products is not protected as intellectual property. There can be several products that will provide the user the same service. The exclusive right to object of copyright (dispose at own convenience) starts from the moment of its creation. The object of copyright is not subjected to registration in Kazakhstan, at the request of the copyright owner it can be registered with the authorized bodies responsible for the conservation and protection of intellectual property - the Office of Intellectual Property Rights of the Ministry of Justice of Kazakhstan. The original copyright holder of the copyright object including software is a natural person - the author of the created object.

In most cases the software of IT-product is developed by a group of programmers, co-authors. If the contract made between them does not consider other conditions, they have the exclusive right to the object. In order to avoid obstacles in the project implementation in the absence of agreement between the authors of the software product they need to agree on the use of intellectual property of created object. Software developer or development team can remain as copyright holder.

Each member of the startup team contributes to the joint activity: develops software, invests money, provides room, etc. Obviously, such situation takes place mainly in the early stages of the project when the company which will be engaged in its implementation is not registered yet. If the company that launches IT-startups has already been created, team members and investors are likely to insist on giving them the software which in this case can serve as a contribution to the authorized capital along with the finance. The rights to the software can also be assigned to a newly created company without making an intangible asset to the authorized capital. In both cases contract of assignment with the developer/software author or group of authors should be concluded.

The software, which is decided to invest in the authorized capital by the parties, is subjected to evaluation. Under the agreement of the founders and members an intangible asset cannot be valued for more than 37040000 tenge. If its cost exceeds the specified threshold, the assessment should be confirmed by an independent expert. Assessment of the intellectual property is a licensed activity; there is an institute of intellectual property appraisers in Kazakhstan.

The investment of intellectual property object including copyrights object in the authorized capital of the company is still rare avis for Kazakhstan. Mostly the intellectual property is simply passed to a company by the contract of assignment and money is invested in the authorized capital. The minimum amount of authorized capital should be a little more than 185 thousand, and for small businesses it should be even less.

Technoparks are the structures created mainly on the basis of higher educational institutions or scientific research institutions to use the scientific potential of universities and the commercialization of developed technologies through creation and development of small innovative enterprises located in the territory of industrial park.

The purpose of creation of technoparks is to organize the coordinator of innovative activities to ensure effective use of the results of research and development.

The tasks set by the state for technoparks are:

- Introduction of the latest achievements of local and world scientific and technological progress into production;
- Investment of scientific and technical research and innovative industries;
- Providing material and technical assistance in the creation and development of innovative entrepreneurship.

Business incubators are programs of assistance to businesses that provide entrepreneurs with necessary support and consulting. Typically, business incubators are located in special rooms where a few start-ups are located. They share not only the space and equipment but they also have equal access to all services provided by the business incubator including consulting on various business areas. The cost of some services may be included in the rental price, and other types of provided services are at a quite low price.

The goal of the business incubators is the creation of favorable conditions for business start-ups where the newly established enterprises gain experience and get assistance for the further growth and strengthening their market position. After reaching a certain level of development, usually after the third year, the company leaves the business incubator and begins an independent existence already having significant experience and capabilities that allow it not only to avoid bankruptcy, which is very frequent in the early stages but also grow further. The vacant place is taken by a new company which starts the business from scratch.

Almaty Tech Garden

Almaty Tech Garden is Kazakhstani «Silicon Valley" which lies in the foothills of the Trans-Ili Alatau. Tech Garden Innovation Cluster is a professional environment for the development of innovation demanded by the business on the basis of mutually beneficial cooperation between business, startups, investors, educational and research institutions. The purpose of the cluster is to consolidate orders, intellectual resources, the best foreign technologies, targeted measures of state support and stimulate private investments.

Executive authority of the Cluster is Autonomous Cluster Fund (hereinafter ACF) that has a financial instrument to support innovative activities of the participants from the fund recourses which are formed mainly from the contributions of subsoil users. Cluster members are participants of free economic area "PIT" as well as legal persons approved by the ACF.

The cluster aims to solve two main tasks: to increase the share of local content in the field of high technologies as well as to create an ecosystem of venture financing.

To solve the first problem there are provided acceleration and incubation programs supported by grants, seed investments and, if necessary the co-investment instruments; as well as the measures aimed at developing the competence and intellectual capital. To achieve the second objective the ACF applies a special system of investment incentives at each stage of funding, for example, it provides investors and subsoil users the right to choose the projects; and uses a set of specific financial instruments to support projects at every stage.

Basic technological directions of Cluster are focused on the rapid introduction and consolidation of the demand, and therefore are presented by complex sectors: smart environment, smart industry, environmental life, e-commerce and media.

15.4 Development of the necessary infrastructure for logistics and electronic payments

Electronic payment systems, which allow to pay for goods and services without leaving home, and even without a credit card, are actively developing in the world. This trend is relevant for Kazakhstan. According to the published data of National Bank in the Republic of Kazakhstan 15.2 million transactions in the amount of 266.7 billion tenge were carried out in 2013 through the Internet and mobile phones.

Electronic money is the real way of payment, real money that can be paid online. The issuing bank which has taken the commitment to their release ensures the financial security. There is fiat electronic money pegged to the currency of the country, and non fiat electronic units of non-state payment systems - PayPal, YandexMoney and so on.

Electronic payment systems are mechanisms for the implementation of remote transactions including banking and non-banking payment terminals and remote financial services.

Providing payment and other services through electronic terminals and remote access systems from an innovative method by the banks has gradually become one of the main factors of influence on the market of financial services. Thus, the bank with no limited service network branches can attract more customers providing services through the Internet, mobile banking and electronic terminals. Thus, the assessment of the current state and prospects of development of the financial sector including payment systems has to take into account infrastructure development of Internet operators, mobile communications, and the availability of electronic terminals and their access to the main part of the population.

With the ratio of quantitative indicators of electronic banking terminals with payment card holders, three terminals and one ATM amount to 1000 cardholders. At the same time ATM indicators are similar to those of developed countries. For instance, in Singapore 0.5 ATM amounts to 1,000 cardholders. Installed terminal indicators in Kazakhstan are lower than in developed countries, so in England 8 terminals amount to 1000 cardholders, 17 terminals in Singapore, about 10 terminals in Switzerland.

However, a large number of equipment is not yet the evidence of development and efficiency of the payment infrastructure. For example, in Almaty in the framework of a working meeting and evaluation of the payment infrastructure the representatives of the World Bank and VISA company highlighted ATMs concentration in some places which is not observed in the US and Europe. Thus, there is a problem of understanding between banks on the placement of equipment and rendering service for cardholders.

Development of payment infrastructure through remote access systems, the Internet, mobile phones etc. can be assessed considering the dynamic of changes

of transactions volume made through these systems. In 2012 compared with 2011 the growth of payments made via the Internet and mobile phones was amounted to 27.3% which demonstrates the interest of banks in e-business.

However, the advantage of doing business electronically is also its main drawback. As Western experts point that banks which develop the market of electronic banking services find that a significant portion of the population does not accept it, and some of them, refuse to use e-banking.

The main reason for such behavior of bank customers is the virtual impossibility to meet all their needs and their unwillingness to study procedures for the implementation of electronic payments and other financial transactions on their own.

Thus, despite all the conveniences of electronic banking services the population is not ready yet to abandon the traditional live communication in carrying out financial transactions including payments and money transfers. To a greater extent this refers to less progressive part of the society. One of the confirming factors for such conclusions is a noticeable differentiation of market indicators development of electronic banking services in the regions of Kazakhstan, i.e. high rates in large cities and the low rates in regions. The most advanced network performance in electronic banking terminals is in Almaty which amounts to 32.0% of all POS-terminals, 18.8% of ATMs and 17.8% of banking stalls. There are13,4% of POS-terminals, 10.1% of ATMs and 8.5% of banking stalls installed in Astana. Almost in all other regions the indicators are below 10%.

Today it should be focused on the following problems hindering the intensive development of the electronic payment segment in the country:

- Undeveloped payment service. The tool capable to enforce the development of the market is electronic money which allows the owner to use a transparent tool with convenient terms of the payment mechanism for both sellers and consumers.

- Undeveloped logistics - delivery of goods and services.

- Lack of clear incentives for organizations, entrepreneurs to transfer to the alternative on-line selling. But this problem will be solved soon, and many Kazakhstani citizens will pass to this type of service.

Solving these and other problems is a good opportunity to actively develop e-commerce.

Electronic money is not focused on conducting operations with large amount payments which amount to several tens of thousands of US dollars and more. The threshold of the maximum allowable amount of one operation has been defined by the working group during the development of the draft law with the participation of market participants. Payment for transactions that exceed this limit can be carried out with the use of other payment instruments including credit cards.

Kazakhstan could become a center of logistics and e-commerce for the countries of the Customs Union as well as to achieve the world's total share of e-commerce in 4% of the total retail market in the country. For that it is necessary to

reconsider the approaches to logistics, develop a delivery network and expand the range of banking services.

15.5 Prospects for multimedia development

Currently, multimedia technologies are widely used in various fields including education, art, advertising, science, trade, entertainment, engineering, medicine, mathematics, business, scientific research and space-time applications. In each of these areas application of multimedia opens up new possibilities that were not available during application of older technologies.

The main trends of development of multimedia technologies:

1. *The content of mobile phones.* People gradually turn off the TVs and refuse to buy newspapers because they are immersed in their mobile phones. Mobile advertising market has crossed the figure of $18 billion and continues to develop in this direction.

2. *Augmented reality* (augmented reality, AR) is an environment with the direct or indirect addition of the digital data to the physical world in real time with the help of computer devices - tablets, smart phones and innovative gadgets like Google Glass and their software.

3. *Virtual reality* is a world created by technical means in which a person feels like he/she is in the real world. The extent of how much a person feels and behaves in a virtual reality is the degree of immersion. Thus, the illusion of entry into the artificial (imaginary) world is created in real-time. The imaginary world is formed on the basis of computing and software. For representation of the volumetric visual information in such systems a variety of means of its three-dimensional display is used.

4. *User Interfaces*. Material user interface is a kind of user interface in which the human interaction with the electronic device occurs by means of physical objects and structures. Tactile Interface is a new generation of interface that allows controlling the movement of fingers on any surface: glass, human hand, etc (Fig. 15.1).

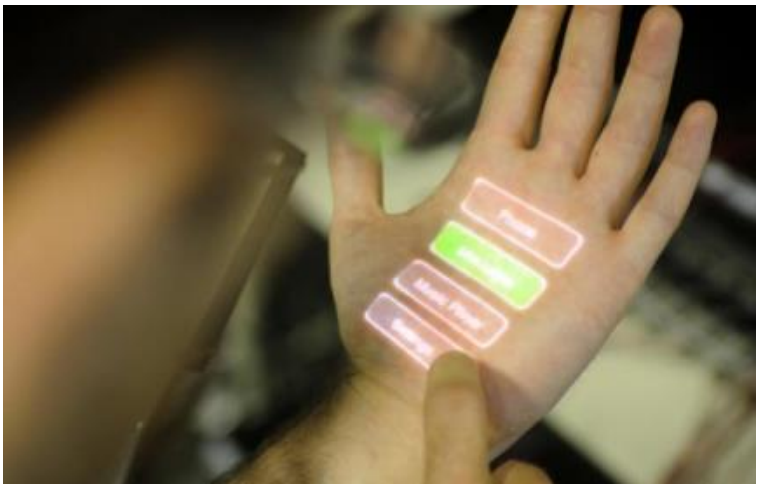

Figure 15.1 - Tactile Interface

Pen computing is a subset of the input system for a graphical user interface of devices equipped with special input devices that differ from the keyboard or touch screens. It allows emulating keyboard shortcuts (or key combinations) using gestures. The main motivation for the development of these interfaces is the improvement of the ergonomics of management and rejection of application menu common for computer programs (Fig. 15.2).

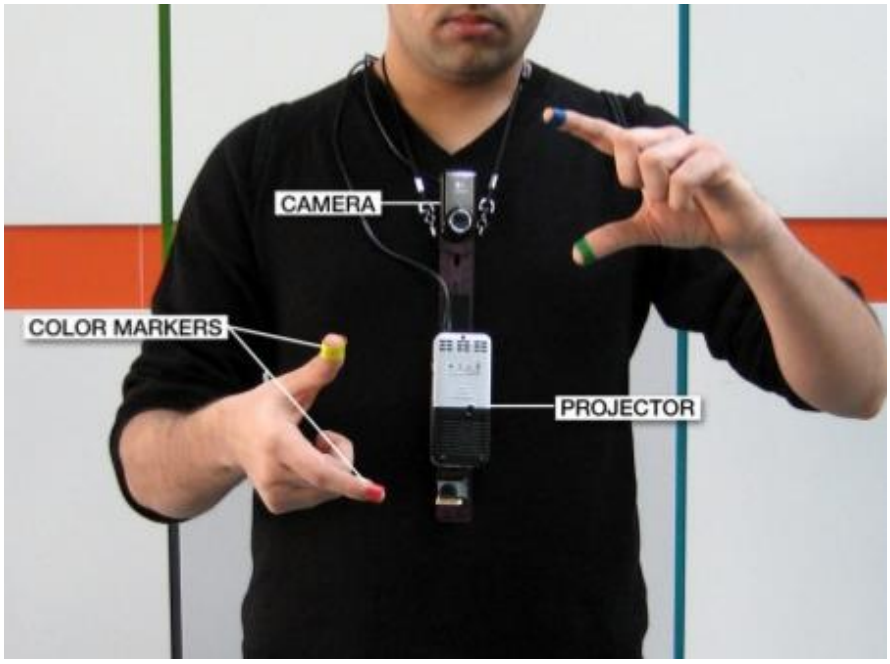

Figure 15.2 – Pen computing

5. The Internet of Things (IoT, Internet of Things) is the ability of people and things to interact remotely through the Internet anytime, anywhere thanks to the merger of different technologies. Now it is possible to identify objects, household items, equipment as well as people who use the Internet. In the future the "Internet of Things" (*IoT*) will mean the appearance of speaking refrigerators and self-driving cars but the devices that are connected to the Internet and able to communicate with other devices will also affect our lives outside the "smart home".

Multimedia Prospects are various, the media area will be expanded improving our world and opening up new worlds, providing information on a global scale, changing not only the equipment but also, above all, the human being and his perception of the world.

15.6 Prospects of development of E-technology

The information industry is moving to new qualitative and quantitative levels. Electronic media in Kazakhstan are the first to respond to the challenge of the time; they are changing their policy to meet the new increased requirements. Social and economic changes in Kazakhstan's society have determined the direction of

development of the mass media of the republic. Policy of openness and co-operation makes it possible to create new ways of communication and open new prospects for the broadcast in which the mass media play an important role.

The latest information and communication technologies (ICT) have allowed the large-scale transfer of information accumulated by mankind from the electronic to digital form. These different forms of presentation of audio-visual and multimedia information allow organizing production processes, storage and dissemination of information at a qualitatively new level.

Advanced ICT that provides a dynamic socio-economic and cultural development began to define the image of post-industrial states. New ICTs bring about changes in the life of Kazakhstan's society: they expand cable-satellite broadcasting, mobile Internet, mobile communication, digital broadcasting, gradually introduce elements of interactive TV and increase confidence in electronic means of mass communication as an important source of information about events in the country and the world.

The potential of ICT is already ranked among the state priorities. There is an increase in output of information products and services in the country. In the twenty-first century the business of information technology has become one of the most prosperous. Every year information technology industry is growing at 13-18% in Kazakhstan. Changes in the life of Kazakhstan's society caused by the spread of ICT are economical, social, political and cultural.

Socio-cultural nature of the impact of communication infrastructure on society is aimed to increase communication and collaboration capabilities, and resolve the issues and problems using a variety of information and knowledge. Different types of television, video information, computer games, CDs, laptops, ATMs, mobile phones, digital cameras, plastic cards, fax, telex, electronic protection and safety devices, remote controls, video surveillance, and a variety of multimedia products have become a part of our life. "Inclusion" into the world of ICT has become a real factor of social mobility, social security and protection.

Currently, digital, multimedia, and interactive communication technology expands the boundaries between countries, and becomes more accessible in different regions. MC sector becomes interchangeable and complementary. The integration of all kinds of communication on the basis of fiber-optic cables into the telecommunication structure is a kind of "central nervous system of the whole society".

The use of new ICT reinforces the convergence process and leads to the construction of a global information society. The free market of ideas in an era of global information infrastructure is increasingly defined by the business objectives which dictate the desire for liberalization. A number of characteristics that determine the transformations of the media market which show a causal relationship of emergence of convergent processes are revealed by the scientists of Kazakhstan. There is a change of mono-media to multimedia environment:

1. Change of the classification name of media - they are transformed from the media to the MC.

2. There is a new form of communication - interactivity.

3. The processes of globalization taking into account the use of modern digital technologies change the parabola of distribution of information products.

There is a fusion of computer, telecommunication and broadcasting technologies. Convergence and interaction change the communication system. This integration leads to the fact that the information industry is expanding, erasing the rigid boundaries between sectors of traditional media and creating new media systems. There is a "convergence" trend – integration and merging of communication technologies, markets, media, consumer and professional equipment into a single entity.

Printing, radio and analog TV are perceived as the "old" media in the expanding media space. New channels for delivery of information and the information itself based on digitalization are defined as "new media". Another proposed definition describes new media as "digital communication channels in which a text, graphics, moving images, and a sound are presented in a single "package". They have various forms of production, distribution, receipt and storage of the final product."

New media have facilitated the acquisition of knowledge, provided access to the funds of libraries, universities, museums, accelerated post-treatment as well as the national and transnational information and cultural services. Internet is gradually appearing in different parts of the world opening up new possibilities for the development of economy, culture, education, science, public life and business.

The program "Informational Kazakhstan-2020" puts a special emphasis on the development of broadcast media space, the manufacture of Kazakhstani content, and the increase of the level of satisfaction with domestic information and cultural product. As a result, in 2020 there must be an increase of volume of Kazakhstani own television productions up to 60% of the total broadcasting time. The number of Internet sites in kz and kaz domains should be increased by 50% compared with 2012. The volume of the TV production will include no less than 15 projects a year by placing an order among private channels on the condition of co-financing while the volume of the transferred state TV channels in outsourcing will be 60%. Kazakh TV channels will be available on the territory of 110 countries, and the number of media on the Internet will amount to 95% of their total number. By 2020 the number of subscribers of the national satellite network is expected to reach 1 million.

Internet, mobile telephony and cable-satellite TV are important components of the process of communication globalization. The information industry is expanding, blurring the boundaries between sectors of traditional systems of media and creating new means of mass communication (MC).

Kazakhstan is actively implementing new information technologies in the media space. The huge territory of the country also contributes to the development

of satellite TV – Television Without Borders. The Kazakhstani cosmodrome "Baikonur", a centre for the launch of space rockets, renders a great assistance in this direction. The first Kazakhstani satellite "KazSat-1" was launched in June 2006. "KazSat-2" was launched in mid-2011; it provides a republic with the satellite communications as well as the digital TV and radio broadcasting. This satellite is intended for domestic broadcasting and telecommunications. The launch of "KazSat-3" in 2014 made it possible for Kazakhstan to cease dependence on the foreign operators.

Modernization of the country can be successful in case of maintaining identity by the community in the conditions of information globalization which is achieved by the balance between external and internal circumstances, the impulse from outside and internal potential of society for improvement. The development of national policies in the field of information and broadcasting industry can be seen as an important component of the country's development and its entry into the international information space.

Not all members of the business community as well as the public authorities want to freely implement electronic innovations and get rid of papers but in practice and according to statistics all participants of the process will eventually understand and support the need of modernization of technologies.

The level of development of Kazakhstan is largely formed on the basis of the use of information and communication technologies, the active production and the use of information. Natural resources and material wealth as well as telecommunication infrastructure and information resources constitute the national wealth.

Review questions

1. What are the prospects of development of the IT market in the field of free software?
2. What is a startup company?
3. What are the technological parks?
4. What is the purpose of creating a business incubator?
5. What are the prospects for electronic payment systems?
6. List the modern electronic shops, electronic auctions and electronic payment systems.
7. What are the main trends of media development?
8. What are the prospects for the development of E-technologies?

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Glossary

3D computer graphics are graphics that use a three-dimensional representation of geometric data.

Access control is the selective restriction of access to a place or other resource.

Access Identifier is a standard way of identifying users who request access to a network.

Access means to read data from or write data to a mass storage device. A user can access files, directories, computers, or peripheral devices.

Access to information is the right to access to information and ensuring timely and reliable access to and use of information.

Accreditation is the process of certification by the specialized accrediting body for conformity to requirements.

Active threat is the threat of a deliberate unauthorized change to the system.

Administrative Safeguards are administrative actions, policies, and procedures to manage the selection, development, implementation, and maintenance of security measures to protect electronic information and to manage the conduct of the covered entity's workforce in relation to protecting that information.

Advanced Encryption Standard (**AES**), also known as **Rijndael,** is a specification for the encryption of electronic data. It supersedes the Data Encryption Standard (DES). For AES, NIST selected three members of the Rijndael family, each with a block size of 128 bits, but three different key lengths: 128, 192 and 256 bits.

Airgo Networks True MIMO (Multiple input, Multiple output) is a smart-antenna technique that uses multiple antennas to transmit and receive wireless signals. It transmits multiple signals on each antenna. True MIMO is the first technology to address the issues of coverage, speed and interference in larger homes and offices.

An afterburner or 125 High Speed Mode is an enhancement to the IEEE 802.11g wireless networking standard. Afterburner will only improve speeds when used with clients that also have the Speedbooster/Afterburner feature.

Animation is the process of making the illusion of motion and change by means of the rapid display of a sequence of static images that minimally differ from each other.

Application program interface (API) allows programmers to use predefined functions to interact with the operating system, instead of writing them from scratch.

Artificial intelligence (AI) is intelligence exhibited by machines. In computer science, an ideal "intelligent" machine is a flexible rational agent that perceives its environment and takes actions that maximize its chance of success at some goal.

Atheros Proprietary Extended Range (XR) Technology. The basic idea behind XR is to make longer range communication possible by sacrificing data throughput rates. Accordingly, the data rates used in XR mode are 3Mbps, 2Mbps, 1Mbps, 500Kbps and 256Kbps using OFDM.

Attack is any attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of an asset.
Attribute is a specification that defines a property of an object, element, or file. It may also refer to or set the specific value for a given instance of such. An attribute of an object usually consists of a name and a value; of an element, a type or class name; of a file, a name and extension. A labeled element of a tuple.
Audio editing software is software which allows editing and generating of audio data.
Authentication exchange is a mechanism to authenticate any logical object by exchanging information.
Authentication Mechanism is hardware-or software-based mechanisms that force users to prove their identity before accessing data on a device.
Authentication of electronic digital signature in an electronic document is a positive result of certification of an electronic digital signature using the signature key certificate in an electronic document proving that no distortion was made in the document signed.
Authentication Token is authentication information conveyed during an authentication exchange.
Authenticity is a property to ensure that the entity or resource is identical to the declared.
Authorization is the process of giving individuals access to system objects based on their identity.
Authorized access to information is an access to information without violating the rules of access differentiation.
Availability is the degree to which an object is in a specified operable and committable state at the start of a mission.
Basic input/output system (BIOS) is the built-in software that determines what a computer can do without accessing programs from a disk
Beacon Interval is one of the router settings. Beacon Broadcast interval is the time lag between each of the beacons sent by your router or access points. Most of the routers out of the box have the default Beacon Interval function value set at 100 ms.
Bit rate is the number of bits that are conveyed or processed per unit of time.
Block chain is a distributed immutable database that maintains a continuously-growing list of records called *blocks* secured from tampering and revision.
Blog is a discussion or informational website published on the World Wide Web consisting of discrete, often informal diary-style text entries (“posts”). The emergence and growth of blogs in the late 1990s coincided with the advent of web publishing tools that facilitated the posting of content by non-technical users who did not have much experience with HTML or computer programming. In the 2010s, majority are interactive Web 2.0 websites, allowing visitors to leave online comments and even message each other via GUI widgets on the blogs, and it is this interactivity that distinguishes them from other static websites.

Bridge is a device that is used to connect segments or networks.
Bus (computing). In computer architecture, a bus or buss is a communication system that transfers data between components inside a computer, or between computers. This expression covers all related hardware components (wire, optical fiber, etc.) and software, including communication protocols.
Business-to-business (**B2B**) refers to a situation where one business makes a commercial transaction with another.
Byte is a unit of storage capable of holding a single character. A byte is equal to 8 bits
Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) is a network multiple access method in which carrier sensing is used, but nodes attempt to avoid collisions by transmitting only when the channel is sensed to be "idle". In CSMA/CA, as soon as a node receives a packet that is to be sent, it checks to be sure the channel is clear (no other node is transmitting at the time). If the channel is clear, then the packet is sent. If the channel is not clear, the node waits for a randomly chosen period of time, and then checks again to see if the channel is clear.
Cascading Style Sheets (**CSS**) is a style sheet language used for describing the presentation of a document written in a markup language.
Certification centre is a legal entity or an individual entrepreneur, exercising functions for creating and issuing certificates verifying electronic signatures keys, as well as other functions stipulated by the law on electronic digital signature;
Certification is a third-party action to confirm (with a certificate of conformity) that the product (including software) or service that meets certain standards or other normative documents.
Channel capacity is the tight upper bound on the rate at which information can be reliably transmitted over a communications channel per unit of time. It is quantified using the bits per second unit (symbols: bit/s, kbit/s, Mbit/s, Gbit/s).
Cipher is conversion of plaintext to ciphertext through the use of a cryptographic algorithm.
Cipher is the algorithm used to encrypt or decrypt information.
Ciphertext is a series of transformations that converts plaintext to ciphertext using the Cipher Key.
Classified information is material that a government body claims is sensitive information that requires protection of confidentiality, integrity, or availability. Access is restricted by law or regulation to particular groups of people, and mishandling can incur criminal penalties and loss of respect. A formal security clearance is often required to handle classified documents or access classified data.
Client is a piece of computer hardware or software that accesses a service made available by a server.
Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centers that may be located far from the user–ranging in distance from across a city to across the world.

Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network.

Cluster analysis or **clustering** is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters).

Codec is a device or computer program for encoding or decoding a digital data stream or signal. *Codec* is a portmanteau of *coder-decoder* or, less commonly, *compressor-decompressor*. A codec encodes a data stream or signal for transmission, storage or encryption, or decodes it for playback or editing.

Color channels is the set of channels in a bitmap image representing the visible color components, i.e. Distinct from the alpha channel or other information.

Color gradient (sometimes called a **color ramp** or **color progression**) specifies a range of position-dependent colors, usually used to fill a region.

Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) is a challenge-response test that determines whether a user is human or an automated bot.

Computer hardware is the collection of physical elements that constitutes a computer system. Internal hardware devices include motherboards, hard drives, and RAM. External hardware devices include monitors, keyboards, mice, printers, and scanners.

Computer systems include the computer along with any software and peripheral devices that are necessary to make the computer function.

Computer virus is a type of malicious software program that, when executed, replicates by reproducing itself (copying its own source code) or infecting other computer programs by modifying them.

Computer-aided software engineering (**CASE**) is the domain of software tools used to design and implement applications. CASE tools are similar to and were partly inspired by Computer Aided Design (CAD) tools used to design hardware products. CASE tools are used to develop software that is high-quality, defect-free, and maintainable. CASE software is often associated with methods for the development of information systems together with automated tools that can be used in the software development process.

Confidentiality: The property that information is not disclosed to system entities (users, processes, devices) unless they have been authorized to access the information. Preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information.

Content management system (**CMS**) is a computer application that supports the creation and modification of digital content using a simple interface to abstract away low-level details unless required, usually supporting multiple users working in a collaborative environment.

Cookie is a small piece of data sent from a website and stored in the user's web browser while the user is browsing. Cookies were designed to be a reliable

mechanism for websites to remember stateful information or to record the user's browsing activity. They can also be used to remember arbitrary pieces of information that the user previously entered into form fields such as names, addresses, passwords, and credit card numbers.

Cryptanalysis is operations performed in defeating cryptographic protection without an initial knowledge of the key employed in providing the protection.

Cryptographic checksum is a message authentication code covering the original message.

Cryptographic Security is a component of COMSEC resulting from the provision of technically sound cryptographic systems and their proper use.

Cryptographic transformation is a series of data transformations that converts plaintext to cipher text using the Cipher Key.

Cryptography is the discipline that embodies the principles, means, and methods for the transformation of data in order to hide their semantic content, prevent their unauthorized use, or prevent their undetected modification. Cryptography concerns the methods for rendering plain information unintelligible and for restoring encrypted information to intelligible form.

Data center is a facility used to house computer systems and associated components, such as telecommunications and storage systems.

Data decoding is a process of converting encrypted data into readable one

Data integrity is the maintenance of, and the assurance of the accuracy and consistency of, data over its entire life-cycle, and is a critical aspect to the design, implementation and usage of any system which stores, processes, or retrieves data.

Data mining is an interdisciplinary subfield of computer science. It is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems.

Data security means protecting data, such as a database, from destructive forces and from the unwanted actions of unauthorized users.

Database normalization is the process of organizing the columns (attributes) and tables (relations) of a relational database to reduce data redundancy and improve data integrity.

Database system is a computerized system for the collection, organization, storage and communication of data.

Database management system (**DBMS**) is a collection of programs that enables to store, modify, and extract information from a database

Decryption is the process of transforming ciphertext into plaintext**.**

Device driver is a computer program that operates or controls a particular type of device that is attached to a computer. A driver communicates with the device through the computer bus or communications subsystem to which the hardware connects.

Digital signature is a bit string obtained as a result of the process of the signature formation. This string has an internal structure, depending on the specific mechanism of formation of the signature.
Digital signature is additional data or a cryptographic transformation of any data t that allows a data receiver to verify the authenticity of the sender and data integrity and protect it from distortion by, for example, means of the recipient.
Digital Signature is an asymmetric key operation where the private key is used to digitally sign data and the public key is used to verify the signature. Digital signatures provide authenticity protection, integrity protection, and non-repudiation.
Digital Signature is the result of a cryptographic transformation of data which, when properly implemented, provides the services of origin authentication, data integrity, and signer non-repudiation.
Digital Signature Private Key is the secret part of an asymmetric key pair that is typically used to digitally sign or decrypt data.
Digital signature verification key is a unique sequence of characters uniquely associated with the digital signature key to authenticate digital signatures.
Direct access is the ability to access an item of data at any given coordinates in a population of addressable elements.
Direct-sequence spread spectrum (DSSS) is a spread spectrum modulation technique. Spread spectrum systems are such that they transmit the message bearing signals using a bandwidth that is in excess of the bandwidth that is actually needed by the message signal. This spreading of the transmitted signal over a large bandwidth makes the resulting wideband signal appear as a noise signal which allows greater resistance to intentional and unintentional interference with the transmitted signal.
Discretionary access control (DAC) is a type of access control defined by the Trusted Computer System Evaluation Criteria "as a means of restricting access to objects based on the identity of subjects and/or groups to which they belong. The controls are discretionary in the sense that a subject with a certain access permission is capable of passing that permission (perhaps indirectly) on to any other subject (unless restrained by mandatory access control)".
Display resolution is the number of distinct pixels in each dimension that can be displayed.
Distributed denial-of-service (**DDoS**) is a distributed attack where the attack source is more than one. The aim is an attempt to make a machine or network resource unavailable to its intended users, such as to temporarily or indefinitely interrupt or suspend services of a host connected to the Internet.
Domain is a group of computers and users with a central authenticating domain-controller.
Domain knowledge is valid knowledge used to refer to an area of human endeavour, an autonomous computer activity, or other specialized discipline.

Driver is a program that controls a device. Every device, whether it be a printer, disk drive, or keyboard, must have a driver program.

Electronic commerce is the trading or facilitation of trading in products or services using computer networks, such as the Internet or online social networks.

Encapsulation is one of the four fundamentals of OOP (object-oriented programming). Encapsulation refers to the bundling of data with the methods that operate on that data.

Encryption is conversion of plaintext to ciphertext through the use of a cryptographic algorithm.

Expert system is a computer system that emulates the decision-making ability of a human expert.

Extensible Authentication Protocol (EAP) is an authentication framework frequently used in wireless networks and point-to-point connections. It is defined in RFC 3748, which made RFC 2284 obsolete, and was updated by RFC 5247. EAP is an authentication framework for providing the transport and usage of keying material and parameters generated by EAP methods including EAP-TLS, EAP-SIM, EAP-AKA, PEAP, LEAP и EAP-TTLS used for wireless networks.

Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

Field is a space allocated for a particular item of information. Data that has several parts can be divided into fields. Each record consists of several fields; the fields of all records form the columns. Examples of fields: name, gender, hair colour etc.

File is a collection of data or information stored in one unit and identified by a filename.

File Transfer Protocol (**FTP**) is a standard network protocol used to transfer computer files between a client and server on a computer network.

Filename extension is an identifier specified as a suffix to the name of a computer file. The extension indicates a characteristic of the file contents or its intended use.

Fractal is a natural phenomenon or a mathematical set that exhibits a repeating pattern that displays at every scale.

Frame is a digital data transmission unit in computer networking and telecommunication. A frame typically includes frame synchronization a feature consisting of a sequence of bits or symbols that indicate to the receiver the beginning and end of the payload data within the stream of symbols or bits it receives. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

Frequency Hopping Spectrum Spreading (FHSS) is a method of transmitting signals by rapidly switching a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver. It is used as a multiple access method in the frequency-hopping code division multiple access (FH-CDMA) scheme. FHSS parameters are defined in IEEE 802.11 standard.

Frequency is the number of occurrences of a repeating event per unit time.
Audio compact discs frequency is of the 44.1 kHz sample rate.
FTP server is a software.html application running the *File Transfer Protocol* (FTP), which is the protocol for exchanging files over the Internet.
Gateway is a network node equipped for interfacing with another network that uses different protocols.
Grid is a form of local networking.
Hash code is a bit string, which is the result of a hash function output.
Hash Function is a function that maps a bit string of arbitrary length to a fixed length bit string.
Hertz is the unit of frequency and is defined as one cycle per second.
Hotspot is a specific geographic location in which an access point provides public wireless broadband network services to mobile visitors through a WLAN.
Hub is a network hardware device for connecting multiple Ethernet devices together and making them act as a single network segment. It has multiple input/output (I/O) ports, in which a signal introduced at the input of any port appears at the output of every port except the original incoming.
Hyper Text Markup Language (**HTML**) is the standard markup language for creating web pages and web applications.
Hypertext Transfer Protocol (**HTTP**) is an application protocol for distributed, collaborative, hypermedia information systems.
ICQ is an open source instant messaging computer program. ICQ is one of the communication means in the Internet.
Identification is the process of verifying the identity of a user, process, or device, usually as a prerequisite for granting access to resources in an IT system.
Identification is the process of comparing a biometric data sample against all of the systems databased reference templates in order to establish the identity of the person trying to gain access to the system.
IEEE 802.11 is a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 mHz and 2.4, 3.6, 5, and 60 gHz frequency bands.
IEEE 802.11a standard uses the same data link layer protocol and frame format as the original standard, but an OFDM based air interface (physical layer). It operates in the 5 gHz band with a maximum net data rate of 54 Mbit/s, plus error correction code, which yields realistic net achievable throughput in the mid-20 Mbit/s.
IEEE 802.11b is an amendment to the IEEE 802.11 wireless networking specification that extends throughput up to 11 Mbit/s using the same 2.4 gHz band. 802.11b is a direct extension of the DSSS (Direct-sequence spread spectrum) modulation technique defined in the original standard.
IEEE 802.11g is the third modulation standard for wireless LANs. This works in the 2.4 gHz band (like 802.11b), but uses the same OFDM based transmission scheme as 802.11a. It operates at a maximum physical layer bit rate of 54 Mbit/s exclusive of forward error correction codes, or about 22 Mbit/s average

throughput. 802.11g hardware is fully backward compatible with 802.11b hardware, and therefore is encumbered with legacy issues that reduce throughput by ~21% when compared to 802.11a.

IEEE 802.11i is an amendment to the original IEEE 802.11, implemented as Wi-Fi Protected Access II (WPA2). This standard specifies security mechanisms for wireless networks, replacing the short *Authentication and privacy* clause of the original standard with a detailed *Security* clause.

IEEE 802.11n is a wireless-networking standard that uses multiple antennas to increase data rates. Sometimes referred to as MIMO, which stands for "multiple input and multiple output", it is an amendment to the IEEE 802.11-2007 wireless-networking standard. Its purpose is to improve network throughput over the two previous standards—802.11a and 802.11g—with a significant increase in the maximum net data rate from 54 Mbit/s to 600 Mbit/s (slightly higher gross bit rate including for example error-correction codes, and slightly lower maximum throughput) with the use of four spatial streams at a channel width of 40 mhz. 802.11n can be used in the 2.4 ghz or 5 ghz frequency bands.

IEEE802.11b+ is an amendment to the IEEE 802.11b wireless networking specification that extends throughput up to 22 Mbit/s. Texas Instruments (TI) has been trying to put its 22Mbs version of IEEE 802.11b (sometimes called 802.11b**+)** technology using Packet Binary Convolutional Code (PBCC). Vendors like D-Link and NDC are delivering Wireless Access Points and network interface cards (NIC)s that can both work with existing 802.11b equipment and double the throughput when used with compatible "b+" equipment

IEEE802.11e (QoS, Quality of service) is a networking term that specifies a guaranteed throughput level. One of the biggest advantages of ATM over competing technologies such as Frame Relay and Fast Ethernet, is that it supports QoS levels. This allows ATM providers to guarantee to their customers that end-to-end latency will not exceed a specified level.

Independent Basic Service Set (IBSS) is an ad hoc network when client devices are set up without a controlling access point. The network is ad hoc because it does not rely on a pre existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks.

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Industrial, scientific and medical (ISM) radio bands are radio bands (portions of the radio spectrum) reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications.

Information and Communications Technology (ICT) is the modern methods and means of communication which enable users to access, store, transmit, and manipulate information.

Information security (**infosec**) **threat** is a possible danger that might exploit a vulnerability to breach security and therefore cause possible harm.

Information security from unauthorized access is the measures to defend information from unauthorized access, use, disclosure, disruption, modification, perusal, inspection, recording or destruction.

Information Security is the protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide confidentiality, integrity, and availability. Protecting information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide

Information security system is a set of bodies and/or performers and information security techniques as well as security objects, organized and functioning according to the rules established by the relevant legal, organizational and administrative instruments for information security.

Information security threat is a set of conditions and factors that create a potential or actual risk for information security.

Information security threat model is physical, mathematical, descriptive representation of the properties or characteristics of threats to information security.

Information security tool is a technical or software tool, agent and/or material intended or used to protect information.

Information system vulnerability is a breach in the information system that makes information security threats possible.

Infrastructure as a service (IaaS) refers to online services that abstract the user from the details of infrastructure like physical computing resources, location, data partitioning, scaling, security, backup etc.

Infrastructure is a basic mode of operation. In infrastructure mode, a base station acts as a wireless access point hub, and nodes communicate through the hub. The hub usually, but not always, has a wired or fiber network connection, and may have permanent wireless connections to other nodes.

Instant messaging (**IM**) is a type of online chat which offers real-time text transmission over the Internet. Short messages are typically transmitted bi-directionally between two parties, when each user chooses to complete a thought and select "send". Some IM applications can use push technology to provide real-time text, which transmits messages character by character, as they are composed. More advanced instant messaging can add file transfer, clickable hyperlinks, Voice over IP, or video chat.

Institute of Electrical and Electronics Engineers (**IEEE**) is a professional association with its corporate office in New York City and its operations center in Piscataway, New Jersey, the USA. Today, it is the world's largest association of technical professionals with more than 400,000 members in chapters around the world.

Integrated circuit is a set of electronic circuits on one small plate ("chip") of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from independent electronic components.

Integrity means guarding against improper information modification or destruction, and includes ensuring information nonrepudiation and authenticity.

Interface is the junction between a user and a computer program. An interface is a set of commands or menus through which a user communicates with a program.

International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations.

Internet Control Message Protocol (**ICMP**) is one of the main protocols of the internet protocol suite.

Internet forum is an online discussion site where people can hold conversations in the form of posted messages.

Internet hosting service is a service that runs Internet servers, allowing organizations and individuals to serve content to the Internet.

Internet Information Services is an extensible web server created by Microsoft for use with Windows NT family.

Internet of things (**IoT**) is the internetworking of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.

Internet Protocol (**IP**) is the principal communications protocol in the Internet protocol suite for relaying datagrams across network boundaries. Its routing function enables internetworking, and essentially establishes the Internet.

Internet Protocol address (**IP address**) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication.

Internet Service Provider (**ISP**) is an organization that provides services for accessing and using the Internet. Internet service providers may be organized in various forms, such as commercial, community-owned, non-profit, or otherwise privately owned.

Internet is the global system of interconnected computer networks that use the Internet protocol suite (TCP/IP) to link billions of devices worldwide. The Internet carries an extensive range of information resources and services. The origins of the Internet date back to research commissioned by the United States federal government in the 1960s to build robust, fault-tolerant communication via computer networks.

IT security is software and/or hardware that detects and/or prevents the attack.

Javascript is a high-level, dynamic, untyped, and interpreted programming language. It has an API for working with text, arrays, dates and regular expressions. Javascript is also used in environments that are not Web-based, such as PDF documents, site-specific browsers, and desktop widgets.

Joomla is a free and open-source content management system (CMS) for publishing web content. Joomla is written in PHP and javascript, uses object-oriented programming (OOP) techniques and software design patterns, stores data in a MySQL and MS SQL. Joomla is widely used free software.
Key is a numerical value used to control cryptographic operations, such as decryption, encryption, signature generation, or signature verification.
Key Management is the activities involving the handling of cryptographic keys and other related security parameters during the entire life cycle of the keys, including their generation, storage, establishment, entry and output, and zeroization.
Lightweight Extensible Authentication Protocol (LEAP) is a proprietary wireless LAN authentication method developed by Cisco Systems.
Linux is a freely-distributable open source operating system that runs on a number of hardware platforms.
Local area network (**LAN**) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building.
Machine learning is a subfield of computer science that evolved from the study of pattern recognition and computational learning theory in artificial intelligence.
Macro is a rule or pattern that specifies how a certain input sequence should be mapped to a replacement output sequence (also often a sequence of characters) according to a defined procedure.
Mainframe is an ultra high-performance computer made for high-volume, processor-intensive computing. Mainframes can usually execute many programs simultaneously at a high speed. They are typically used by large businesses and for scientific purposes. In the hierarchy of computers, mainframes are right below supercomputers, the most powerful computers in the world.
Malware is a program that is inserted into a system, usually covertly, with the intent of compromising the confidentiality, integrity, or availability of the victim's data, applications, or operating system or of otherwise annoying or disrupting the victim.
Mandatory access control (**MAC**) refers to a type of access control by which the operating system constrains the ability of a subject or initiator to access or generally perform some sort of operation on an object or target.
Mask is data that are used for bitwise operations, particularly in a bit field.
Masking is the act or ability to simulate the appearance of another logical object.
Maximum transmission unit (MTU) of a communications protocol of a layer is the size (in bytes or octets) of the largest protocol data unit that the layer can pass onwards. MTU parameters usually appear in association with a communications interface (NIC, serial port, etc.). Standards (Ethernet, for example) can fix the size of an MTU; or systems (such as point-to-point serial links) may decide MTU at connect time.

Media access control address (**MAC address**) of a computer is a unique identifier assigned to network interfaces for communications at the data link layer of a network segment.
Media player is software that plays digital media. The most popular media players are Windows Media Player, Winamp, quicktime, GOM Player, powerdvd, Media Player Classic, VLC Media Player, bsplayer, realplayer etc.
Media are the methods that are used to connect computers.
Mesh network is a network topology in which each node relays data for the network. All mesh nodes cooperate in the distribution of data in the network.
Message Authentication Code (MAC) is a cryptographic checksum on data that uses a symmetric key to detect both accidental and intentional modifications of the data. Macs provide authenticity and integrity protection, but not non-repudiation protection.
Microphone is a transducer that converts sound into an electrical signal. Most microphones today use electromagnetic induction (dynamic microphones), capacitance change (condenser microphones) or piezoelectricity (piezoelectric microphones) to produce an electrical signal from air pressure variations.
Microprocessor is a computer processor which incorporates the functions of a computer's central processing unit (CPU).
Mixing console is an electronic device for combining, routing, and changing the volume level, timbre (tone color) and/or dynamics of many different audio signals.
Modelling is the process of imitating real objects, processes or phenomena; the acquisition of valid source information about the relevant selection of key characteristics and behaviours; the use of simplifying approximations and assumptions within the modelling.
Modem is a device or program that enables a computer to transmit data over telephone or cable lines.
Montage is the art, technique, and practice of assembling shots into a coherent sequence.
Motherboard is the main printed circuit board (PCB) found in general purpose microcomputers and other expandable systems.
Multilevel Security (MLS) is the concept of processing information with different classifications and categories that simultaneously permits access by users with different security clearances and denies access to users who lack authorization.
Multiple Input Multiple Output (MIMO) refers to the use of multiple antennas at the transmitter and the receiver. Specifically, it refers to a practical technique for sending and receiving more than one data signal simultaneously over the same radio channel by exploiting multipath propagation. The transmitted stream is divided before transmission, and is connected after reception. The first devices were presented by Belkin International, Inc. on August, 2004.
Multiplexing is a method by which multiple analog or digital signals are combined into one signal over a shared medium.

Netiquette is the rules of etiquette that apply when communicating over the Internet or social networks or devices. It is a social code of network communication.
Network attack is the use of software and/or hardware through a network protocol, aimed at unauthorized access to information and change of automated information system resources.
Network diameter is the longest cable distance between any two dtes.
Network node is an active electronic device that is attached to a network, and is capable of creating, receiving, or transmitting information over a communications channel.
Network operating system is an operating system oriented to computer networking, to allow shared file and printer access among multiple computers in a network, to enable the sharing of data, users, groups, security, applications, and other networking functions.
Network switch is a computer networking device that connects devices together on a computer network, by using packet switching to receive, process and forward data to the destination device.
Network topology is the arrangement of the various elements (links, nodes, etc.) of a computer network. A network topology describes the arrangement of systems on a computer network. It defines how the computers, or nodes, within the network are arranged and connected to each other. Some common network topologies include star, ring, line, bus, and tree configurations.
Networking hardware, also known as **network equipment** or **computer networking devices**, are physical devices which are required for communication and interaction between devices on a computer network.
Nitro XM nitro is a solution to increase the speed of Internet connection.
Node is any system or device with one or more IP interfaces that have a single IP address. A node is connected to a network and supports IP protocol.
Noise filters add or remove *noise*, or pixels with randomly distributed color levels.
Numeral system (or a **system of numeration**) is a writing system for expressing numbers; that is, a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner.
Open text is semantic data with available semantic content.
Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, used in applications such as digital television and audio broadcasting, DSL Internet access, wireless networks, powerline networks, and 4G mobile communications.
Palette window floats on top of all regular windows and offers ready access tools, commands or information for the current application. The palette window can be freely moved, minimized or expanded.
Passive threat is a threat of unauthorized disclosure of information without changing system conditions.

Password is a person's secret ID consisting of a string of characters to provide access.
Personal web pages are World Wide Web pages created by an individual to contain content of a personal nature such as résumés, family, hobbies, or information about a user's other interests.
Physical protection is the means used to ensure the physical protection of resources against deliberate or accidental threat.
Pixel is the smallest controllable element of a picture represented on the screen.
Platform as a service (**PaaS**) is a category of cloud computing services that provides a platform allowing customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app
Pooling is the grouping together of resources. Pooling IT (equipment and staff) resources involves virtualization of typical IT stacks server, storage and networking.
Preambles are specific patterns providing synchronization and identification of the subframes and blocks. Short and long preambles are used in wireless networking.
Private signature keys are the private keys of asymmetric (public) key pairs that are used by public key algorithms to generate digital signatures with possible long-term implications.
Process of signature formation is a process the source data of which is a signed message, validation key and digital signature and the result of which is (non-)/authentication of the digital signature.
Public key digital signature is a unique sequence of characters matching the digital signature private key, available to any user of the information system and designed to confirm digital signature in an electronic document;
Raster graphics image is a dot matrix data structure, representing a generally rectangular grid of pixels, or points of color, viewable via a monitor, paper, or other display medium. Raster images are stored in image files with varying formats.
Record is a collection of logically connected fields. Relational databases arrange data as sets of database records, also called rows.
Register is a special, high-speed storage area within the CPU.
Relation is a set of tuples that have the same attributes. A tuple usually represents an object and information about that object. Objects are typically physical objects or concepts. A relation is usually described as a table, which is organized into rows and columns. All the data referenced by an attribute are in the same domain and conform to the same constraints.
Relational database is a digital database whose organization is based on the relational model of data.
Repeater is an electronic device that receives a signal and retransmits it. Repeaters are used to extend transmissions.
Resolution is density of pixels, measured by the number of dots per inch..

Router is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the internetwork until it reaches its destination node.
Routing table is a data table stored in a router or a networked computer that lists the routes to particular network destinations, and in some cases, metrics (distances) associated with those routes.
Routing is the process of selecting best paths in a network.
Rx Rate is the rate at which data packets being received by your computer.
Scam is an attempt to defraud a person or group after first gaining their confidence, used in the classical sense of trust.
Scanner is an input device that scans documents and images, which can be imported into a computer.
Screenshot is an image taken by a person to record the visible items displayed on the monitor, television, or other visual output device in use.
Scripting language is a high-level programming language that supports scripts, programs written for a special run-time environment that automate the execution of tasks that could alternatively be executed one-by-one by a human operator.
Security administrator is a person who is responsible for protecting computer systems against attack
Security Controls are the management, operational, and technical controls (i.e., safeguards or countermeasures) prescribed for an information system to protect the confidentiality, integrity, and availability of the system and its information.
Security is a condition that results from the establishment and maintenance of protective measures that enable an enterprise to perform its mission or critical functions despite risks posed by threats to its use of information systems. Protective measures may involve a combination of deterrence, avoidance, prevention, detection, recovery, and correction that should form part of the enterprise's risk management approach.
Security kernel is hardware, firmware, and software elements of a trusted computing base that implement the reference monitor concept.
Security model is an abstract (formal or informal) description of software and hardware and/or organizational measures to protect against unauthorized access.
Security service is a service, provided by a layer of communicating open systems, which ensures adequate security of the systems or of data transfers
Serial Line Internet Protocol (also SLIP) is an encapsulation of the Internet Protocol designed to work over serial ports and modem connections.
Server is a computer program or a device that provides functionality for other programs or devices.
Service set identifier (SSID) is a sequence of characters that uniquely names a wireless local area network (WLAN). An SSID is sometimes referred to as a "network name." This name allows stations to connect to the desired network when multiple independent networks operate in the same physical area.

Shading is the process of altering the color by varying levels of darkness.
Shortcut is a type of file in some operating systems that points to another file, program or device.
Signature Certificate is a public key certificate that contains a public key intended for verifying digital signatures rather than encrypting data or performing any other cryptographic functions.
Signature key certificate owner is a person who has an electronic document used to prove ownership of a public key and the digital signature that has verified the certificate's contents are correct. If the signature is valid, and the person examining the certificate trusts the signer, then they know they can use that key to communicate with its owner.
Simple Mail Transfer Protocol (SMTP) is an Internet standard for electronic mail (email) transmission.
Simple XOR cipher is a type of *additive cipher*, an encryption algorithm. This operation is sometimes called modulus 2 addition.
Simulation is the imitation of the operation of a real-world process or system over time.
Slot is an opening in a computer where you can insert a printed circuit board.
Smart technology is information environment of smart solutions.
Social networking service is an online platform that is used by people to build social networks or social relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections.
Software as a Service (**SAAS**) is a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted. SAAS is typically accessed by users using a thin client via a web browser. SAAS has become a common delivery model for many business applications, including office and messaging software, payroll processing software, DBMS software, management software, CAD software, development software, etc. SAAS has been incorporated into the strategy of nearly all leading enterprise software companies.
Sound card (also known as an **audio card**) is an internal expansion card that provides input and output of audio signals to and from a computer under control of computer programs. Sound processing hardware is also present on modern video cards with HDMI to output sound along with the video using that connector; previously they used a SPDIF connection to the motherboard or sound card.
Spoofing refers tricking or deceiving computer systems or other computer users. This is typically done by hiding one's identity or faking the identity of another user on the Internet.
Spyware is software that is secretly or surreptitiously installed into an information system to gather information on individuals or organizations without their knowledge; a type of malicious code.
Storage area network (**SAN**) is a network which provides access to consolidated, block level data storage.

Structured Query Language (SQL) is a standardized query language for requesting information from a database.
Subnetwork or **subnet** is a logical subdivision of an IP network. The practice of dividing a network into two or more networks is called **subnetting**. Subnetting enables the network administrator to further divide the host part of the address into two or more subnets.
Super G is Atheros' proprietary frame-bursting, compression, and channel bonding technology to improve IEEE 802.11g (Wi-Fi) wireless LAN performance. The throughput transmission speed limit when using Super G is claimed to be up to 40 Mbit/s-60 Mbit/s at a 108 Mbit/s signaling rate, which is achieved through the bonding of two 54 Mbit/s 802.11g channels.
Syntax of a computer language is the set of rules that defines the combinations of symbols that are considered to be a correctly structured document or fragment in that language.
Technology information security is information security tools, information security effectiveness tools, monitoring tools, management tools and systems designed to protect the information.
Telnet program runs on your computer and connects your PC to a server on the network.
Temporal Key Integrity Protocol or TKIP was a stopgap security protocol used in the IEEE 802.11 wireless networking standard.
Threat is a possible cause of an unwanted incident that could harm a system or organization и.
To verify is defined as to ascertain the truth or correctness of, as by examination, research, or comparison
Token is a special three-byte frame that travels around a logical “ring” of workstations or servers.
Track is a recorded piece of music.
Trade secret is compilation of information which is not generally known or reasonably ascertainable by others, and by which a business can obtain an economic advantage over competitors or customers.
Traffic is the flow and the amount of data on a communications network. Web traffic is the amount of data sent and received by visitors to a web site.
Transformation is modification of the selected area (move, scale, rotate, perspective, warp). In a scatter graph, transformation is usually called distortion (see p. 24).
Translator is a computer program that performs the translation of a program written in a given programming language into a functionally equivalent program in a different computer language, without losing the functional or logical structure of the original code (the "essence" of each program).
Transmission Control Protocol (TCP) is one of the main protocols of the Internet protocol suite.

Trojan horse is the malware program that writes over certain parts of your hard drive, corrupting your data.
Tx Rate is the rate at which data packets being sent from your PC.
Unauthorized access (UA) is an access to or manipulation with information that violates the rules of differentiation of access using regular tools provided by computer means or automated systems.
Unauthorized access to software is an access to programs stored in computer memory or various storage media gained in violation of the established rules.
Uniform Resource Locator (**URL**) is a reference to a web resource that specifies its location on a computer network and a mechanism for retrieving it.
Unix is a popular multi-user, multitasking operating system.
User Datagram Protocol (UDP) is one of the core members of the Internet protocol suite.
Vector graphics is the use of polygons to represent images in computer graphics. Vector graphics are based on vectors, which lead through locations called control points or nodes.
Verification is confirmation, through the provision of objective evidence, that specified requirements have been fulfilled (e.g., an entity's requirements have been correctly defined, or an entity's attributes have been correctly presented; or a procedure or function performs as intended and leads to the expected outcome).
Video clips are short clips of video, usually part of a longer recording. The term is also more loosely used to mean any short video less than the length of a traditional television program.
Video editing is the process of manipulating video images. Video editing includes cutting segments (trimming), re-sequencing clips, and adding transitions and other Special Effects.
Video editor is a computer device controller that controls video machines to mechanically put pieces of a film together.
Video editing software is an application software which handles the post-production video editing of digital video sequences on a computer non-linear editing system (NLE).
Video is an electronic medium for the recording, copying, playback, broadcasting, and display of moving visual media.
Virtual machine is an additional operating system (OS) that runs on top of the main OS through virtualization. Virtual machines are based on computer architectures and provide functionality of a physical computer.
Virus is a computer program that can copy itself and infect a computer without permission or knowledge of the user. A virus might corrupt or delete data on a computer, use email programs to spread itself to other computers, or even erase everything on a hard disk.
Visualization is any technique for creating images, diagrams, or animations to communicate a message.

Vulnerability is a breach in monitoring and management tools that can be used as a threat.

Web browser (commonly referred to as a **browser**) is a software application for retrieving, presenting, and traversing information resources on the World Wide Web. An *information resource* is identified by a Uniform Resource Identifier (URI/URL) and may be a web page, image, video or other piece of content. Hyperlinks present in resources enable users easily to navigate their browsers to related resources.

Web server is a computer system that processes requests via HTTP, the basic network protocol used to distribute information on the World Wide Web. The term can refer to the entire system, or specifically to the software that accepts and supervises the HTTP requests. The primary function of a web server is to store, process and deliver web pages to clients. The communication between client and server takes place using the Hypertext Transfer Protocol (HTTP). Pages delivered are most frequently HTML documents, which may include images, style sheets and scripts in addition to text content. Web servers are not only used for serving the World Wide Web. They can also be found embedded in devices such as printers, routers, webcams and serving only a local network. The web server may then be used as a part of a system for monitoring and/or administering the device in question. This usually means that no additional software has to be installed on the client computer; since only a web browser is required (which now is included with most operating systems).

Web service is a service offered by an electronic device to another electronic device, communicating with each other via the World Wide Web.

Web template system uses a template processor to combine web templates to form finished web pages, possibly using some data source to customize the pages or present a large amount of content on similar-looking pages.

Website is a collection of related web pages, including multimedia content, typically identified with a common domain name, and published on at least one web server. A web site may be accessible via a public Internet Protocol (IP) network, such as the Internet, or a private local area network (LAN), by referencing a uniform resource locator (URL) that identifies the site.

Wide area network (**WAN**) is a telecommunications network or computer network that extends over a large geographical distance.

Wi-Fi is a technology that allows electronic devices to connect to a wireless LAN (WLAN) network, mainly using the 2.4 gigahertz (12 cm) UHF and 5 gigahertz (6 cm) SHF ISM radio bands.

Wi-Fi Protected Access (WPA) is one of two security protocols and security certification programs developed by the Wi-Fi Alliance to secure wireless computer networks. The Temporal Key Integrity Protocol (TKIP) was adopted for WPA.

Wireless access point (WAP) is a networking hardware device that allows a Wi-Fi compliant device to connect to a wired network. Most WAPs support the

connection of multiple wireless devices to one wired connection. Modern WAPs are built to support a standard for sending and receiving data using these radio frequencies. Those standards and the frequencies they use are defined by the IEEE. Most WAPs use IEEE 802.11 standards.

Wireless Bridge is a computer networking device that connects two wireless networks together over Wi-Fi.

Wireless local area network (WLAN) is a wireless computer network that links two or more devices using a wireless distribution method (often spread-spectrum or OFDM radio) within a limited area such as a home, school, computer laboratory, or office building. This gives users the ability to move around within a local coverage area and yet still be connected to the network. A WLAN can also provide a connection to the wider Internet.

Wireless network interface controller (WNIC) is a network interface controller which connects to a wireless radio-based computer network, rather than a wired network.

Workstation is a special computer designed for technical or scientific applications. Intended primarily to be used by one person at a time, they are commonly connected to a local area network and run multi-user operating systems.

World Wide Web (**WWW**) is an information space where documents and other web resources are identified by URLs, interlinked by hypertext links, and can be accessed via the Internet.

Xspan is the product that Qualcomm Atheros offers as wireless connectivity solutions.

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INFORMATION AND COMMUNICATION TECHNOLOGIES

Textbook

1st edition

Editor: A.Sholakhova
Proofreader: A.Zhaparova
Technical editor: A.Ospan

Подписано в печать 20.01.2017 г.
Тираж 1000 экз. Формат 60x84x 1/16. Бумага офсетная.
Усл. п.л. 31. Заказ №___. Цена договорная.
Издание АО «Международный университет информационных технологий»