Conception of New Generation Computer Systems – The Last Large-Scale Initiative in Computers of the COMECON Countries: A Glance after Twenty Years

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Abstract. The conception of a new generation of computer systems was developed by a team of scientists from USSR Academy of Sciences, academies of USSR republics, academies of COMECON countries in 1984-85. The conception contained main directions of computing technology and informatics development in the socialist countries. Additionally, it prescribed the main directions of research and development that should be performed to obtain new qualities of information and computer systems. The conception was supposed to be implemented within the framework of ten integrated scientific projects performed by the international research teams. The structure of these projects and the main results of their implementation are presented. A glance on these projects from today positions is also presented.

Keywords: New generation computer systems, scientific project, research team, COMECON countries.

1 Introduction

In December 1983 in Sofia, the capital of Bulgaria, according to the recommendation of the meeting of the Academies of Sciences of the Socialist Countries representatives, the First Meeting of the Coordination Council for Computing Technology and Informatics of the Academies of Sciences of the Socialist Countries (CCCTI) took place. Academician Evgeny Velikhov, vice president of the USSR Academy of Sciences, headed this council. The representatives decided at this meeting to organize the Provisional Work Team (PWT) for working-out the "Conception of a new generation of computer systems" in the socialist countries. The proposals provided for directions of fundamental and applied research in computing technology and informatics.

Representatives of eleven Academies of Sciences of the socialist countries participated in PWT. They included the People's Republic of Bulgaria, Hungarian

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People's Republic, Socialist Republic of Vietnam, German Democratic Republic, Korean People's Democratic Republic, Republic of Cuba, Mongolian People's Republic, Polish People's Republic, Socialist Republic of Romania, Union of Soviet Socialist Republics, and the Czechoslovak Socialist Republic. Note that only three of these countries exist now with the same names (Vietnam, Korea, and Cuba). The director of the Institute of Informatics Problems of the USSR Academy of Sciences, Boris Naumov (at that time a corresponding member of the USSR academy, elected in 1984 a full member of the USSR academy), was appointed as the Chairman of PWT.

During 1984-85, a team of scientists from the USSR Academy, the academies of the Soviet republics, the academies of COMECON countries, after intense common activity, developed the "Conception of a new generation of computer systems" (CNGCS), which was approved in June 1985 in Prague on the third meeting of CCCTI [1]. That conception represented in some sense the answer of the socialist countries on the ESPRIT program of EEC and on the Japanese program of the fifth-generation computers. The conception contained main directions of computing technology and informatics development in the socialist countries for the period up to 2010. Additionally, it prescribed the main directions of research and development that should be performed to obtain new qualities of information and computer systems. The conception became the important component of the Integrated Program of Scientific and Technical Progress of the COMECON countries, the base for carrying out unified technical policy in academies of sciences and industry of the socialist countries.

The conception was supposed to be implemented within the framework of ten integrated scientific projects (ISP) performed by the international research teams. They included:

"Systems of knowledge processing" (ISP-1)
"Image processing and computer graphics systems" (ISP-2)
"CAD for computer systems" (ISP-3)
"Computer Networks" (ISP-4)
"Systems of personal computers" (ISP-5)
"Fault-tolerant systems" (ISP-6)
"New external storage devices" (ISP-7)
"Software engineering for new generation computer systems" (ISP-8)
"New algorithms and architectures for information processing" (ISP-9)
"Informatics for education" (ISP-10)

To guide the realization of the conception, CCCTI had arranged as its work institution the Commission on the New Generation Computer System (CNGCS) and academician Boris Naumov was appointed its Chairman. The main task formulated for CNGCS was to provide a practical realization of all projects using all efficient forms of international collaboration such as establishing international institutes and laboratories, arranging international conferences and symposia, creating a special

journal, and publishing proceedings. Due to these decisions, in 1988 they launched the publication "Journal of new generation computer systems" by the "Akademie-Verlag Berlin" publishing house at the Central Institute for Cybernetics and Information Processes of the Academy of Sciences of the G.D.R. The course of the Conception fulfillment appeared in the issues of this journal. This journal was edited up to 1991 when the activity on the conception realization was practically terminated due to the well-known events in most of the participating countries; fourteen issues of the journal were published.

We will now try to present in a short form the goals and content of the integrated scientific projects and give some comments about the confirmation and correctness of the ideas included to the conception, its achievements, and its hopes.

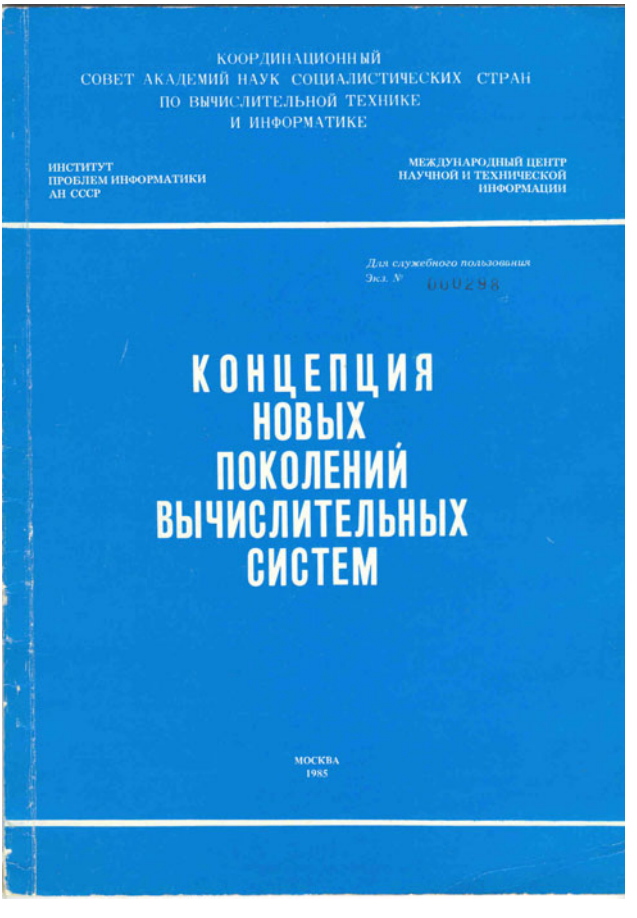

Fig. 1. Conception (photo of cover)

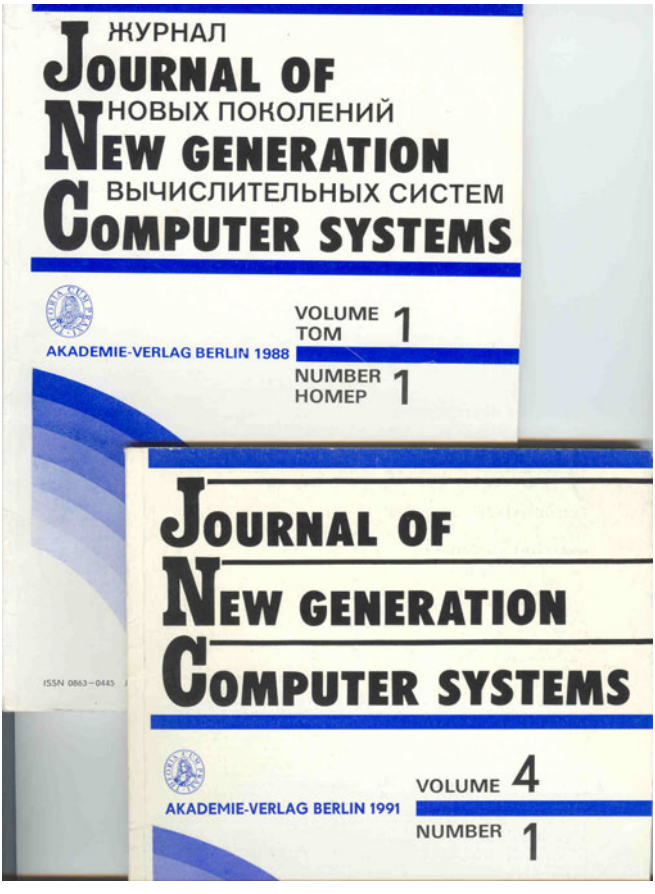

Fig. 2. Journal (photo of two cover pages of the journal)

2 Systems of Knowledge Processing (ISP-1)

Responsible Country: Czechoslovakia
Participating Countries: Bulgaria, Hungary, Germany, USSR
Supervisor: Academician Ivan Plander (Czechoslovakia)

2.1 Working Goal

A step-by-step creation of artificial intelligence systems providing efficient implementation of the knowledge processing functions and basing on architecture with high level of concurrency and distributed data bases. Development by 1995 a knowledge processing computer with special concurrency means. It was planned to perform main joint researches in the base laboratory on artificial intelligence in Bratislava (Czechoslovakia). The ISP-1 included six projects described below.

2.1.1 Project "Expert Systems"

Lead by Hungary with USSR and Czechoslovakia as participants.

Goal: Creation of a modular "empty" hardware system with a flexible architecture (expert meta-system)

Project Result: It created the universal environment for constructing expert systems for diagnostics and planning tasks.

2.1.2 Project "Main Tools for Knowledge Processing"

Lead by Germany with Hungary, USSR, and Czechoslovakia as participants.

Goal: A systematic creation of hardware and software means and specialized architecture models for knowledge processing.

Project Result: Development of the conception of the first release of a knowledge-processing computer.

2.1.3 Project "Systems of Knowledge Processing Computers"

Lead by Czechoslovakia with Germany, Hungary, and USSR as participants.

Goal: Creation of efficient implementation for knowledge processing functions on system architecture with high level of concurrency and with the use of relational data base facilities.

Project Result: Developed relational data base computer and knowledge base system of SIMD type; a sample of knowledge processing system (SOZ-1) was created.

2.1.4 Project "Distributed Knowledge Base Systems"

Lead by USSR with Hungary, Germany, and Czechoslovakia as participants.

Goal: Development of methods and tools for cooperative problem solving, using systems of distributed knowledge bases and mechanisms of distributed solutions of tasks.

Project Result: Created a "synthesis" knowledge integration system. Actively growing DATA GRID system represents in some degree an example of the tasks formulated in the project realization.

2.1.5 Project "Man-Machine Communication on Natural Language"

Lead by USSR with Germany and Czechoslovakia as participants.

Goal: Development of algorithms and methods for hardware-software implementation of input/output of natural language written texts and speech (partially, safe understanding of continuous speech without training on definite speaker).

Project Result: Developed a number of decent quality systems for output (pronouncing) of written texts. Understanding of written natural texts and especially continuous speech understanding happened to be too difficult tasks and are still not implemented in the full volume.

2.1.6 Project "Data Base Computer"

Lead by USSR with Germany and Czechoslovakia as participants.

Goal: Development of specialized computers for data base systems control.

Project Result: Limited progress on this effort.

2.2 Result of Performed Work

The projects developed a model of a database computer. Currently, a number of different companies in some countries are manufacturing database computers, which are operating within big information systems.

3 Image Processing and Computer Graphics Systems (ISP-2)

Responsible Country: Germany
Participating Countries: Bulgaria, Hungary, Poland, Romania, USSR, Czechoslovakia
Supervisor: Professor V. Vilhelmi (Germany)

3.1 Working Goal

The goal of this endeavor was the development of unified hardware and software facilities and standardized design solutions for the creation systems for image processing and computer graphics. The expectation by 1990 was the creation of a highly productive unified components and system of image processing with modular architecture. The ISP-2 supposed activity within three projects described below.

3.1.1 Project "Development of Digital Image Processing Systems"

Goal: Creation of universal systems to be used as the experimental basis for algorithms and solutions development; creation of unified components for specialized peripheral devices; prototypes development of highly productive components basing on new algorithms and new architectural solutions.

3.1.2 Project "Development of Standard Applications for Automated Image Processing and Analysis"

Goal: Creation of real time image processing systems (for industrial automation and scientific researches); creation of systems for 3-dimensional scenes analysis using knowledge bases; creation of "turnkey" systems for selected applications.

3.1.3 Project "Creation of Computer Graphics Systems"

Goal: Development of efficient algorithms and basic components for three-dimensional graphics processing; development of standard solutions for CAD systems in mechanical engineering, aviation engineering and other industrial areas.

3.2 Result of Performed Work

Within the integrated project, the results included a search of efficient specialized hardware solution oriented on semi-custom and custom VLSI that came to nothing

more than experimental samples and models and they did not receive support from industry. Methods of software implementation were applied in some application systems based on general-purpose computers. Partially, it created a standard system for image processing on PC, a sample of intellectual controller for video databases, and a sample of system for images obtained from space processing.

Later, as a continuation of these works, the system for images analysis, understanding, and recognition named "Black square" came into existence in the Cybernetics Scientific Council of the Russian Academy of Sciences. Currently, powerful systems of 3-D graphics based on specialized graphical controllers are actively used in many applications.

4 CAD for Computer Systems (ISP-3)

Responsible Country: USSR
Participating Countries: Germany, Bulgaria, Poland, Czechoslovakia
Supervisor: Doctor of science, Efim Oihman (USSR)

4.1 Working Goal

The activity sought to create an integrated distributed CAD for computer systems, covering all stages of design from the level of system structure up to simulation, verification and testing of integrated circuits, image generators and testing procedures control, development of designer's documentation, control of manufacturing equipment and production planning. The system should allow describe and simulate IC's with the integration level up to 10^8 transistors on a chip using a high-level language of a "Silicon compiler" type that included a knowledge base and expert system. It was also to develop an experimental CAD system by 1990. ISP-3 included three projects described below.

4.1.1 Project "Systems for Description and Modeling Architectural Level of Computers"

Lead by Poland with USSR and Czechoslovakia as participants.

4.1.2 Project "VLSI and ULSI CAD Systems"

Lead by USSR with, Germany and Czechoslovakia as participants.

4.1.3 Project "CAD System for Computers"

Lead by USSR.

4.2 Result of Performed Work

A first version of a silicon compiler operating on 32-bit computer was developed and tested. Currently, there is a number of CAD computer systems, which include all functions described in the project. It provides all time parameters planned.

5 Computer Networks (ISP-4)

Responsible Country: Germany
Participating Countries: Hungary, Bulgaria, USSR, Czechoslovakia
Supervisor: Doctor of science, V. Heymer (Germany)

5.1 Working Goal

Development of methodology, standards on protocols, unified hardware and software components for the creation of local and global computer and data transmission networks, development tools for computer networks design, and tuning and exploiting automation. ISP-4 included four projects described below.

5.1.1 Project "Local Networks"

Lead by Bulgaria with Hungary, USSR, Czechoslovakia, and Germany as participants.

Supervisor: Professor Kiril Boyanov (Bulgaria).

Goal: Develop systems of protocols and create local networks providing transmission of data, sound, and images between different types of computers and devices, integrated into the united system; develop architecture of gateways between different networks taking into account upcoming international standards.

5.1.2 Project "Hardware and Software Components for Network Processors"

Lead by Germany with USSR and Czechoslovakia as participants.

Supervisor: Doctor of science, V. Heymer (Germany).

Goal: Create a profitable, efficient, and safe multiprocessor computer system to perform functions of package switching in global data transmission networks (parameters: up to 1000 communication lines, carrying capacity: up to 1000 packages/sec, full operating time: 5-10 years); perform research of hardware and software solution for connecting computers and intelligent terminals to global data transmission networks with the goal to create a family of communication devices.

5.1.3 Project "Network of Intelligent Terminals"

Lead by Czechoslovakia with USSR and Germany as participants.

Supervisor: Doctor of science, Miroslav Novak (Czechoslovakia).

Goal: Create an integrated network of terminals, independent on types of included hardware devices, which permit simultaneous connecting a great number of intelligent terminals (different types of personal computers, mini-computers, special processing devices for telecommunication equipment, for experiment control and so on) to mainframes and computer networks via communication processors.

5.1.4 Project "Distributed Data Processing"

Lead by Hungary with Bulgaria and Germany as participants.

Supervisor: P. Bakoni (Hungary).

Goal: Develop principles of task distribution between elements and create distributed data processing systems in computer networks on the principles of ISO open systems; implement as the experiment a teleconference system.

5.2 Result of Performed Work

Some basic researches on conceptual level were performed, a number of LANs and package switching devices, network of intellectual terminals with communication processor were designed and provided for manufacturing.

6 Systems of Personal Computers (ISP-5)

Responsible Country: USSR
Participating Countries: Bulgaria, Hungary, Germany, Korea, Mongolia, Poland, and Czechoslovakia
Supervisor: Doctor Igor Landau (USSR)

6.1 Working Goal

Develop architectural and software solutions for prospective personal computers (PC) and their peripheral devices oriented on artificial intelligence tasks processing – both in the role of intellectual terminals of computer systems and as stand-alone intellectual workstations.

The project was based on the forecast about occurring everywhere usage of PCs and possibility of their connection to information and computer networks providing access to general use data and knowledge bases. Methods providing software portability have been investigated. They developed: tools for architecture description; structure and components of software for new generation PC; new man-machine interfaces providing input of tasks and requests to a system on language close to natural one.

6.2 Result of Performed Work

Models of 32-bit PC with microprocessor compatible with I80386 have been developed and delivered to the plants for manufacturing; microprocessors with RISC architectures and transputers were also developed. They also developed such software as a universal operating system UOS (those time it exceeded all existed on market OS for PC in some characteristics), a portable OS of UNIX type, standard packages of application programs for PC.

Passed time confirmed the correctness of the estimation regarding the role and place of the PC in new generation systems and surpassed the most audacious forecasts about the scale of PC expansion and applications.

7 Fault-Tolerant Systems (ISP-6)

Responsible Countries: USSR, Germany
Participating Countries: Bulgaria, Czechoslovakia
Supervisors: Academician Boris Naumov (USSR) and professor Dieter Hammer (Germany)

7.1 Working Goal

Develop experimental samples of new generation fault tolerant computer systems, with ability to reorganize automatically, practically without breaks in operating their structure with quick replacing of fault components after faults detecting. Develop methods to achieve "absolute" (during all system life period) reliability alternative to traditional methods of dubbing, tripling, etc. Expected ways of solving these problems include usage of self-timed schematics on the LSI and VLSI, fault-tolerant interfaces and system software supporting functions of failure parrying on the structural levels of complexes and systems.

7.2 Result of Performed Work

A number of works on the level of resolving conceptual items had occurred. Actuality of the formulated problem did not disappear up to present time. The investigations in self-timing technology only recently achieved practical stage – samples of simple microprocessors in chip designed within self-timed schematics were manufactured and tested. They demonstrated the correctness of theoretical proposals regarding considerable expansion of the operating environment area and efficiency of fault-tolerant systems creation basing on self-timed schematics.

8 New External Storage Devices (ISP-7)

Responsible Country: Bulgaria
Participating Countries: Hungary, Germany, USSR, Czechoslovakia
Supervisor: Professor J. Kasabov (Bulgaria)

8.1 Working Goal

Development of new methods for recording and storing information on external storage devices (ESD), providing increase of capacity and reliability. Development of the methods for information protection in ESD and implementation of these methods in VLSI set. ISP-7 included five projects outlined below.

Project "External storage devices based on multi-layer medium with optical writing and electrical amplification; integral-optical modular ESD; hierarchical holographic ESD; associative ESD".
Project "ESD based on multi-layer silicon structures".
Project "ESD based on bubble memory".
Project "Devices of ultra- thick magnetic recording of digital information".
Project "Information protection in ESD".

8.2 Result of Performed Work

Some investigations and developments have been performed on the base of the Laboratory of new ESD in Bulgarian Academy of Sciences. The works performed within this ISP did not play sizeable role as they were behind the leading world investigations in this area.

Currently, the achieved parameters of ESD capacity and reliability greatly exceeded all forecasts and expectations announced more than twenty years ago. Thus, for example, it was formulated a task to achieve capacity 1 Gbytes on one magnetic disc; now 100 Gbytes capacity is usual for HDD in PCs. It was a task to achieve 1–5 Mbyte on semiconductor external memory, now flash-memory devices with more than four Gbytes are available.

9 Software Engineering for New Generation Computer Systems (ISP-8)

Responsible Country: USSR
Participating countries: Bulgaria, Germany, Mongolia, Czechoslovakia
Supervisor: Doctor Valentin Semik (USSR)

9.1 Working Goal

Creation of scientifically substantiated programming technology for new generation professional personal computers, covering the whole "life cycle" of software product and setting up the basis for industrial software and software documentation manufacturing; development of new methods for increasing reliability of application computer programs. ISP-8 included three projects outlined below.

Project "Experimental system of automated design, production, and support of software for new generations professional personal computers".
Project "Development of the methods for software reliability improvement".
Project "Technology of computer system architecture and software design".

9.2 Result of Performed Work

There were created instrumental-technological complexes of object-oriented programming for graphical systems development, for concurrent and pipeline calculations design and implementation.

It is reasonable to note that within this project it was paid special attention to the difference between *technology of programming* (tools, supporting program design, and coding in computer systems) and *technology of tasks solution* (designated for the end users of application systems). Such approach is obvious now and it is widely used in computer software development.

10 New Algorithms and Architectures for Information Processing (ISP-9)

Responsible Countries: USSR, Bulgaria
Participating Countries: Germany, Czechoslovakia
Supervisors: Academicians Vladimir Pugachev and Alexander Samarsky (USSR) and academicians S. Markov, professors Kiril Boyanov and J. Mikloshko (Bulgaria)

10.1 Working Goal

The activity had four specific goals described as follows.

- Investigation and development of the common conceptual basis for evolution of mathematical modeling and computer experiment methods for solving tasks destined to creation of perspective computer hardware, its element base and software;
- Development and investigations of methods for automated compilation on computers equations for statistical characteristics in the tasks of stochastic systems processes analysis and synthesis, implementation in practice corresponding application packages;
- Development of algorithms and architectures for new types of computer systems including algorithms for concurrent calculations, implementation in practice corresponding application packages;
- Creation of multi-processor systems of traditional and non-traditional architecture basing on concurrent data processing.

10.2 Result of Performed Work

Based upon a great number of performed fundamental researches there were developed application packages (including such as for the big tasks of linear algebra, stochastic systems, processes in electron-hole plasma, heat load on computer components, etc) oriented toward users and non-professional programmers; they developed special language tools destined to create software for data driven computers.

Currently, the process of development and accumulation of different methods and algorithms for different type programs solving is actively continuing. Most of the ideas formulated in these projects found their realization in large modern mathematical software systems.

11 Informatics for Education (ISP-10)

Responsible Country: Bulgaria
Participating Countries: Hungary, Germany, Mongolia, USSR
Supervisor: Academician Blagovest Sendov (Bulgaria)

11.1 Working Goal

Creation of algorithmic, software and hardware means for informatics in education based on new generation computer systems (at first – on professional and educational personal computers) and carrying out large-scale experiments on means and methods of information technologies application in education. The main direction for this activity included the following.

- Investigation of necessary modifications in learning programs and methodologies to bring them in correspondence with potentials of new information technologies;
- Development of learning programs and manuals on informatics for all levels of education;
- Development of software means for interaction with computer (language for primary education, information-logical languages, structural programming languages, languages for robots controlling and so on);
- Creation of the models for teaching processes and tasks solving;
- Integration of different means and methods for construction learning process models using methods of cognitive psychology and artificial intelligence;
- Investigation and development of methods and tools for certification, replication and support of software for the area of educational informatics;
- Development of software tools for learning courses and pedagogical programs preparation;
- Creation of dialog teaching and consulting systems using methods of logical deduction, knowledge bases and modeling basing on the conception of computational experiment;
- Development of architecture of simulator complexes for teaching popular professions bind with computer (microprocessor) devices manufacturing and application;
- Organization of experimental centers of educational informatics for testing and tuning scientific and organizing forms of the research results familiarization.

11.2 Result of Performed Work

A considerable number of methodologies and software means ensured new information technologies usage in different levels teaching processes were developed. The active implementation of information technologies into the learning process took place in many countries. Special research Institute for Information Technologies in Education was established by the UNESCO (in Moscow, Russia).

Investigations in the area of wide implementation of information technologies to education process are continuing also at present in the most part of formulated in the project directions. In general the correctness of the formulated ides have been confirmed during passes twenty years.

12 Conclusion

From the above, we can see that in the process of its activity, the CNGCS headed by academician Boris Naumov succeed in detecting the main stream among many details

and placed the emphasis on creation of *new generation computer systems*, not only on *computer devices*. Additionally, individual projects have been interconnected by joining them up in integrated scientific projects, which also have been closely interconnected. Finally, almost everything formulated in the conception projects looks today as obvious – exactly in such way modern information and computational systems are created. However, it is necessary to take into account that these projects have been prepared more than twenty years ago, where at that time many things were not so obvious as they are today; PCs, the internet, and mobile communications were not widespread technologies at that time.

Reference

[1] Conception of New Generation Computers. International Center of Scientific and Technical Information, Moscow (1985) (in Russian)