

Research directions profile in the Computing museum of the Institute of Mathematics and Computer Science, University of Latvia (IMCS)

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Abstract. The article describes information technology development in Latvia, in IMCS till middle of 90ties. History of IMCS represents usage of computers in typical computing center in the former Soviet Union and transformation from computing center to research institution. It also represents Latvian collaboration with Nordic countries which provided political, scientific and technological support. History, *e.g.*, documents, computer parts and photos are collected in Computer museum of IMCS.

Keywords: Research institute, Computing museum, History of Computer technology, Latvia.

1 Institute of Mathematics and Computer Science

The Institute of Mathematics and Computer Science, University of Latvia (IMCS) was established in 1959 as the computing research centre. It was the fourth computing research centre in the Soviet Union established with a goal to develop Latvian industry. Since the founding of the institute the best computing machines available in the USSR were installed and used there. Over the years the use of computing technology, relevant science field and technology itself has changed significantly. The number of people employed at the institute has varied through different times, ranging from 120-450; at present 230 employees work in IMCS.

Currently IMCS is the largest and the most relevant research institution in Latvia in the field of information technology, mathematics, computer science, computer linguistics. In recent years new scientific groups are established for development of interdisciplinary research and e-infrastructures (GEANT, GRID, cloud computing etc.).

2 Computing museum

Through the years along with the technology developments computing machines in IMCS were replaced with more advanced and progressive units. However engineers did not want to dispose of the old ones and decided to keep the most interesting of them as certain relics. By virtue of that Computing museum originated in 1984. The exhibits of the museum were complemented with photographs and documents which seemed to have historical value at that time. The founder of the Computing museum is IMCS and actually it also constitutes the history of IMCS. Since IMCS is the largest information technology research centre in Latvia at present, to some extent it also constitutes Latvian information technology history. Currently the Computing museum occupies 230 m² space, holds 13116 exhibits, of them 504 equipment units, 287 mainframe and workstation parts, 98 computers, 44 printers. During a year approximately 500 people visit the museum. The museum is headed by the former engineer of IMCS with work experience of more than 40 years who describes the exhibits with illustrations from his personal experience.

3 History of usage of computers in IMCS

Documents and equipment in the museum reflect on computing machines of passing age, their description and tasks which were solved with them. In the museum there is an exhibit for each computing machine used in IMCS. Either it is a photograph, separate computing unit or component but in several cases even the whole machine in its entirety. The history shows how the transition from Soviet model computers (BESM and MINSK) to Western computer (IBM, PDP etc.) cloning has taken place and how the regaining of Latvian independence has changed technology assessment values. For example efficiency started to play important role and due to that operation of service demanding ES EVM was prematurely suspended.

3.1 First computers in IMCS

Original computers were used at the initial stages of development of information technology field in USSR. The first one - BESM-2 was put in commercial production in 1958. IMCS received this machine with production number 5 – the fact which serves as substantial evidence for the role and competence of our computing centre. BESM-2 was a demanding machine and required great amount of engineers' work. However IMC's engineers were innovative and could introduce several important upgrades which allowed making the respective machine more efficient. In this regard IMCS had one of the best results in the whole Soviet Union.

At the end of 60-ties IMCS started using Minsk series computers. The machine had decimal (decimal-binary) notation with point fixed after the lower bit; numbers and instructions were coded with a variable-length sequence of characters. The instruction set had a variable number of addresses for operands. The instruction addresses were normalized and indexed.

The circuitry and instruction set of Minsk-23 completely differed from those of computers which existed before. It was the first domestic computer with alphanumeric logic as well as variable word and instruction length. A multitasking mode was also realized in Minsk-23. Minsk-32 closes the Minsk computer series.

Table 1. First computers used in IMCS.

Usage years	Computer
11.04.1961-21.08.1970	BESM-2 (first generation, vacuum tubes, 5000 op/s)
29.06.1964- 3.04. 1972	BESM-2M
11.04.1967- 6.04.1978	BESM-4 (second generation, transistors, 20 000 op/s)
	Computer modernization with FACIT ECM 64
1968-1975	Minsk-22, Minsk-23, Minsk-32 (7000 op/s)

In very special cases IMCS bought western computers, *e.g.*, IMCS had been granted currency to buy GE415. This allowed IMCS scientists to make comparisons of Computer technology development level in USSR and the West and to comprehend necessary tasks for software development. GE415 was a second generation computer with transistors, 40 000 - 90 000 op/s. GE400(s) were time-sharing information systems computers made by General Electric, introduced in 1964 and shipped until 1968. GE415 was used in IMCS from 03.09.1969. till 03.04.1983.

3.2 Mainframes in IMCS

Soviet economic planners decided to use the IBM design, although some prominent Soviet computer scientists had criticized the idea and suggested instead choosing one of the Soviet indigenous designs, such as BESM or Minsk. The first works on the cloning began in 1968; production started in 1972. The first subseries of the ES EVM, released in 1969-1978, included the models 1010, 1020, 1030, 1040 and 1050, which were analogous to System/360, and the more rare and advanced versions, incompatible with the IBM versions: 1022, 1032, 1033 and 1052. The electronics of the first models were based on TTL circuits; the later machines used ECL (emitter-coupled logic) design. ES 1050 had up to 1MB RAM and 64-bit floating point registers. The fastest machine of the series, ES 1052, developed in 1978. (Data about computer models and their relevance to clone models are taken from Wiki.)

The second subseries, which was released in 1977-1978, included the models 1015, 1025, 1035, 1045, 1055 and 1060, analogous to System/370.

Table 2. Mainframe types used in IMCS.

Usage years	Computer types
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16.05.1974- 31.12.1978	ES EVM-1020 (3. generation, integrated circuits, 11 800 op/s)
1976- 31.12.1987	ES EVM-1022 (80 000 op/s)
02.1980- 31.12.1987	ES EVM-1022-02 (80 000 op/s)
12.1982 - 1990	ES EVM-1060-02 (100 000 op/s)
2.03.1983 - 06.1989	ES EVM-1055M (450 000 op/s)
25.10.1989- 10.1992	ES EVM -1037" (4 000 000 op/s)

After Latvia regained independence operation of ES EVM was suspended in 1992 due to costly service – electricity and great maintenance staff.

3.3 Workstations in IMCS

The SM-4 was a Soviet PDP-11/40 computer clone. SM EVM was a general name for several types of Soviet minicomputers. Production started in 1975. Most types of SM EVM are clones of DEC PDP-11 and VAX. The common operating system was MOS, a clone of UNIX. IZOT was a Bulgarian produced model.

Table 3. Workstation types used in IMCS.

Usage years	Computer types
23.03.1981- 06.1989	SM-4 (180 000 op/s)
24.03.1985- 05.1989	IZOT-1016S
30.04.1987- 1990	IZOT-1055S
7.06.1989- 1990	IZOT-1080 (4 500 000 op/s)

3.4 Microcomputers and personal computers in IMCS

Acorn's BBC Micro computer dominated in the UK educational computer market during the 1980s and early 1990s, drawing many comparisons with Apple in the U.S. The Wang 2200 was cloned by the Soviet Union and was produced as "Iskra 226". DVK was a computer series of DEC PDC-11 and PDP-11. The Elektronika BK was a series of 16-bit PDP-11-compatible Soviet home computers. It was almost perfectly compatible with DEC LSI-11 line. These computers were used in schools in informatics classes: one KUVT and many BK or Yamaha, later AGAT (Apple-II). KUVT was based on a Z80 CPU (in fact Eastern clone of Intel 880), and used SCP, a CP/M compatible operating system. It was widely used in Russia and other East European countries for office and educational purposes. Iskra 1030 was a soviet 8086 compatible personal computer.

Table 4. Microcomputers and personal computer types used in IMCS.

Usage years	Computer types
1985-1993	„Acorn” UK education class
1986 -1993	Previous generation of personal

	computers: „ISKRA-226”
	„DVK”
	„KUVT-86”
	„BK-0010”
	„Robotron – 1715” (Eastern Germany)
	„Yamaha” (JAPAN)
1989- 1993	ISKRA-1030, IBM XT, AT, Mazovia, PS2

At the end of 80-ties and in the beginning of 90-ties rapid transition to western personal computers started.

4 Profile components – Signs of age

What were the original tasks solved and how did the technology help:

1. IMCS had a scientific spirit - in the first industrial soviet computers there were many technological deficiencies which demanded refinements and which in IMCS were carried out by innovative laboratory of engineers and electricians;
2. Installation of first computers substantially contributed to the research growth, particularly research in the development of methods of mathematical modeling of various physical processes, research in the development of software and research in theoretical computer science (Table 5 and Table 6);
3. Along with the research practical information systems for Latvian economics were developed (Table 7);
4. As from 70-ties there was a trend for cloning however IMCS retained its initiative to carry out original research. IMCS cloned only one system - CRJE (DUVZ), adoption of Conversational Remote Job Entry (Clone of CRJE) for OS ES EVM (Clone of OS/360).

Mathematical scientists and high qualification engineers worked in the institute. Owing to practical tasks – mainly solving specific commissioned assignments with methods of mathematical modeling – initiative emerged to develop such software which could be used not only for solving of specific assignments but also for solving of large groups of assignments. Thus first IT research directions appeared. Original software was developed – compilers and software development tools (Table 6), e.g., computer usage counting system, software development and complex systems modeling languages and tools (later GRADE, MOLA), now - semantic WEB (term coined by W3C director Tim Berners-Lee).

From specific assignments three institute’s activity directions resulted – development of information systems, mathematical models in natural sciences and research in computer science. History of IMCS illustrates how very limited computing resources contribute to evolution of theoretical researches.

Table 5. Developed research directions in IMCS.

Research direction	Description
Software debugging and testing	From development of automation tools for practical needs to theoretical research and experimental systems
Inductive synthesis of algorithms from examples	Theoretical research and experimentation
Specification languages	For telephone exchange, real time system and business models
Software development tools	Research and development of tools
Modeling and simulation of discrete processes	Theory, practical simulation of telephone exchange call load balancing
Computational linguistics	Latvian language research with computers
Graph theory	From theory to printed circuit board design
Mathematical methods and modeling of physical processes	Theory and computer modeling

Table 6. Notable original software developed in IMCS from 1970 to 1980.

Programming language or software tool	Description	Computer (operating system)
Fortran	Compiler implementation; compiler had restrictions	BESM-4
SMOD	Macro command system for information system development	Minsk-32
TRANS	Automation of translation, debugging and execution of programs	Minsk-32
PL/I	Original PL/I Compiler. Interpreter of PL/I commands for software debugging on visual PL/I machine. PL/I Handbook, printed twice in Statistika (Moscow), Polish translation of book (Warsaw)	OS ES EVM (Clone of OS/360)
RIGAL	Language and tools for Compiler implementation	OS ES EVM (Clone of OS/360), SM-4, IZOT
SDL (System description Language)	Real System specification language: tools used for system prototyping and debugging.	SM-4, IZOT
MAUS (Computer	System counts usage of all computer	OS ES EVM (Clone of

usage system)	account resources (processor, peripherals, I/O operations) and calculates expenses.	OS/360), MAUS included in base of operating system and maintained in all soviet produced computers
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Table 7. Information systems developed in IMCS from 1970 to 1980.

Description	Computer (operating system)
Wholesale store for agriculture, including accounting system	Minsk- 22, Minsk-32
City traffic simulation system	BESM-4
Operative planning system for production in enterprise	GE-415
Information system for Electronic production at Factory Komutators	Ge-415
Construction and building management system	Ge-415
Higher education student registration system	OS ES EVM
Agriculture resources optimization for land usage	OS ES EVM
Pension calculation and payment system	OS ES EVM
Informatics in schools	PC

5 Collaboration with Nordic countries

Hereinafter we shall illustrate extensive cooperation with the Nordic countries which commenced in the nineties.

For ages Baltic sea has separated and united Latvia and Scandinavian states. There are only 500 km between Riga and Stockholm and only 200 km between Ventspils and Visby. During soviet years cooperation with Nordic countries was rare, *e.g.*, BESM-4 modernization with FACIT ECM 64 (ECM 64 is the magnetic tape storage unit or the Carousel Memory, developed by Facit Electronics AB, Stockholm).

After restoration of Latvian independence cooperation with Nordic countries started and it brought political, scientific and technological support. We will mention three cooperation directions.

1. Collaboration with Oy International Business Machines AB, Tietokuja 2, Helsinki.

First initiatives on IBM commencing its operation in Latvia began in spring 1991 however contract between IMCS and IBM branch in Helsinki was signed in May 1992. Within the framework of the contract IBM and IMCS provided each other with

mutual consultations. The operation of IBM in Latvia was important equally to the development of IMCS and the development of information technology field in Latvia in general, encouraging its lively up growth by technology exhibitions, industry's annual conferences etc.

2. Collaboration with Swedish Institute.

The Swedish Institute (SI) is a public agency that promotes interest and confidence in Sweden and around the world. After Baltic States- Estonia, Latvia, Lithuania - regained independence at the beginning of 1990, Scandinavian countries helped a lot to establish relations between them and Western academic community. SI provided possibility for Latvian information technology scientists to visit and have a short time work in KTH in Stockholm Chalmers University of technology in Göteborg, Upsala, Lincoping and other research centers. Two co-authors of this paper also enjoyed hospitality of Prof. Janis Bubenko jr. during their sabbatical leave at Royal Institute of Technology in 1991. Through increased contacts and new networks, knowledge and innovative ideas could be shared and applied in the future to many research areas. Prof. Janis Bubenko jr. (Royal Institute of Technology) and Prof. Arne Solvberg (Trondheim Technical University) jointly established biannual international conference "Baltic Databases and Information Technology". 2010 is the year of the 9th DB&IS. Both professors still are working on Advisory Committee of DB&IS.

Prof. Janis Bubenko jr. has been awarded Dr. honoris causa from Riga Technical University (2004) and University of Latvia (2010).

3. Collaboration with NORDUnet.

After restoration of Latvian independence IMCS began to work on building IP network. In 1992 IMCS hired Lattelekom and ESTI telekom analog communication channel to Tallinn. As from 1993 NORDUnet provided its help to develop IP network for research and educational purposes. NORDUnet help was useful both technologically and financially. Controversies over which network solution is the most appropriate - X.25 or IP - lasted till 1995. Lattelekom with its technology supported X.25 while NORDUnet actively defended introduction of internet platform. In 1995 LATNET (network maintained by Laboratory of IMCS) had 64k link via Tallinn to Helsinki (FUNET) and 128k link to Stockholm KTH (NORDUnet). There was implemented load sharing between two links, so that aggregate capacity was 192k (and it was filled by 100% during daytime). 5 biggest universities, about 10 research institutions, 3 libraries and many more nonprofit organizations were connected to LATNET. Inside LATNET new service providers were emerging, like LANET (another Latvian Academic Network), Bank Communications Center, etc. LATNET received almost no local support for supporting academic users - they were sponsored a little from commercial users and greatly by the Nordic Council of Ministers and PHARE (The Programme of Community aid to the countries of Central and Eastern Europe), who were paying for international lines and donating equipment. (Unfortunately no one wants to pay to people making it all running, for small daily expenses, local lines and dial-up pools - this was sponsored from the commercial users.)

The wireless Internet access network in Latvia was started in 1993 when the IMCS (LATNET) installed the first city-wide wireless LAN link to connect a remote university campus to the central building, located 5 km apart from each other. At that time spread spectrum wireless LAN technology was little known. Inspiration to start

these tests come from a Cylink demonstration of spread spectrum wireless data link during the INET'93 workshop in San Francisco, and from Stockholm KTH network operations center staff which brought the first wireless LAN cards to Riga in autumn of 1993.

The work [1] summarizes Nordic countries point of view on cooperation with LATNET (at present Sigmanet), laboratory of IMCS.

“The first contacts with Baltic computer scientists were created when the NORDUNET program was still going on. Members of the NORDUnet community were active in this new collaboration. In Finland, FUNET was contacted by Estonian scientists interested in building data networks. In Sweden, SICS (Swedish Institute for Computer Science) was approached first by the Latvians. And in Norway, Rolf Nordhagen from the University of Oslo, cooperated with the Lithuanians. R.Nordhagen recalls, that in fact the first outside network connection from Baltic country was established from Vilnius, Lithuania, to the Norwegian Uninett via satellite already in 1991.

Mats Brunell, the project manager of the NORDUnet program, was working at SICS when the Latvian Institute of Electronics and Computer Science contacted the Swedish to establish research collaboration. The Baltic researchers expressed their interest in getting a connection to NORDUnet and via NORDUnet also to the Internet. Brunell began to organize a project for Nordic–Baltic networking collaboration. After a visit to Riga, Latvia, in May 1991, Brunell initiated the BALTnet project with the objective of establishing communication services with the Baltic states, primarily for the research and education community. The funding for the project was sought and received from the Nordic Council of Ministers, which granted 7.5 million Danish crowns for BALTnet.

The BALTnet project was established in 1993, and Mats Brunell was named project leader. He continued in this task until 1995. Then the BALTnet project was moved from SICS to the University of Oslo and Rolf Nordhagen took over the management.

The goal of BALTnet was to support the development of Baltic education and research networks. The work was accomplished by organizing seminars for Baltic networkers, buying equipment for research institutes and financially supporting international connectivity. In addition, the Nordic networking specialists helped Baltic scientists to establish contacts with other European networkers and with networkers in the United States.

Peter Villemoes considers that the NORDUnet community played a very important role in the Baltic countries when the three countries were building their first research networks. According to Villemoes, the early collaboration and connection to NORDUnet and to the Internet had a beneficial effect on Baltic networking – collaboration with the Nordic countries ensured that “of the former Soviet states, the Baltic countries became the most advanced in networking.””

The success of networking in Latvia and in all Baltic states was based on international co-operation and help, including the support of the Nordic Council of ministers. For example, LATNET (at present Sigmanet) was the Latvia partner in the BALTnet project established by the Nordic Council of ministers in 1993.

References

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About the Authors

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