Russian Academy of Sciences
Program Systems Institute

Research Center for Multiprocessor Systems

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The Program Systems for Parallel Structures Laboratory, **PSPS Lab**.
The Botik Telecommunication Laboratory, **Botik Lab**.
The Uchcom Learning Communications Laboratory, **Uchcom Lab**.
The Programming Automation Laboratory, **PA Lab**.

Software and Hardware for Multiprocessor Systems

- Development of theory and methodology for automatic dynamic program parallelization
- Software design and development for multiprocessor systems within the framework of the SKIF Russia and Belarus Union Supercomputer Program:
  - cluster-level software development (CLSW) for the SKIF supercomputer family
  - application system development for the SKIF supercomputers
- Hardware development for multiprocessor systems
- Organization of students' schools/workshops with the purpose of training programmers for high-performance computers of the SKIF family

Learning Internet Resources Network Communities of Practice

- Building and research of network communities of practice
- Development of ways of introducing digital collections into teaching and learning processes
- Development and adaptation of social network resources to learning purposes
- Investigation of cognitive space of personality
- Research of personal psychology and computer technology interference
- Design and development of network learning resources

The SKIF Supercomputer Program

The SKIF Program was conducted in 2000—2004. A dozen of enterprises from Russia and Belarus took part in the Program. The leading developer on the Russia side was the Program Systems Institute, RAS; on the Belarus side — the United Institute of Informatics Problems, NAS.

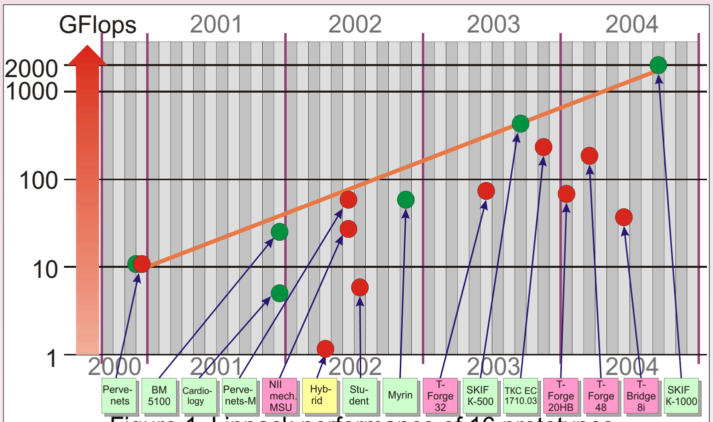


Figure 1. Linpack performance of 16 prototypes of the SKIF family

In 2000—2004 the Program participants developed the SKIF family (Series 1 and Series 2) of high-performance parallel-architecture computers. Design and software documentation was worked out. 16 prototypes with different performance capabilities (see Fig. 1) were produced. Acceptance tests were conducted. The most powerful models were the following:

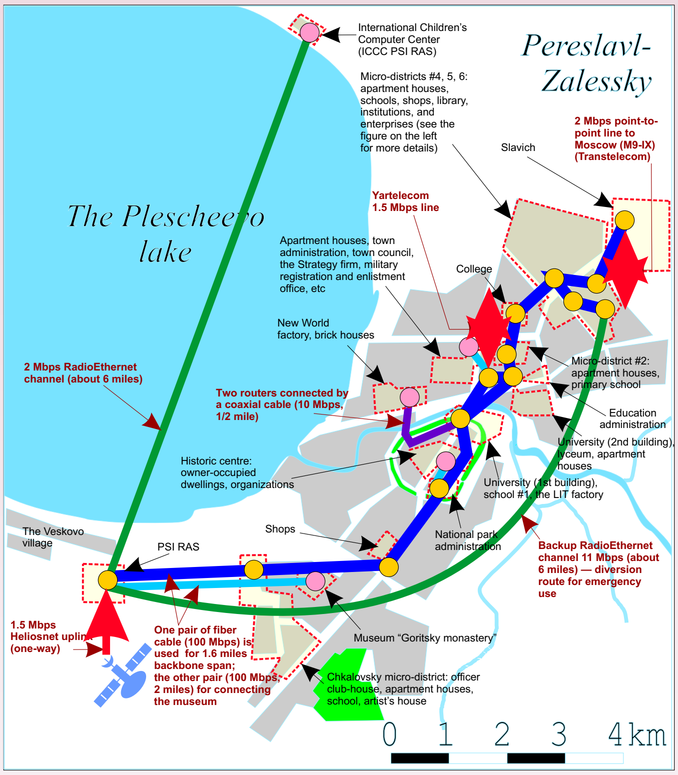
- **SKIF K-500** with peak performance 716.8 Gflops, Linpack performance 425.5 Gflops was ranked 407 in the November 2003 TOP500 List;
- **SKIF K-1000** with peak performance 2.534 Gflops, Linpack performance 2.032 Gflops was ranked 98 in the November 2004 TOP500 List.

Research Center for Multiprocessor Systems

Hardware and Software Solutions for Regional Networks

- Development of cost effective hardware and software solutions for regional (urban and rural) computer networks (BOTIK Technologies)
- Design, maintenance, and development of regional networks in Pereslavl (the Botik Telecommunication System) for further testing and enhancement of the Botik technologies
- Transfers of the approved technology to Russian regions and the CIS countries

The BOTIK Telecommunication System, Pereslavl-Zalessky


International Children's Computer Center (ICCC PSI RAS)
Pereslavl-Zalessky
Micro-districts #4, 5, 6: apartment houses, schools, shops, library, institutions, and enterprises (see the figure on the left for more details)
Slavich
2 Mbps point-to-point line to Moscow (M9-IX) (Transtelecom)
The Plescheevo lake
Yartelecom 1.5 Mbps line
Apartment houses, town administration, town council, the Strategy firm, military registration and enlistment office, etc
College
New World factory, brick houses
Micro-district #2: apartment houses, primary school
2 Mbps RadioEthernet channel (about 6 miles)
Two routers connected by a coaxial cable (10 Mbps, 1/2 mile)
Education administration
University (2nd building), lyceum, apartment houses
Historic centre: owner-occupied dwellings, organizations
University (1st building), school #1, the LIT factory
The Veskovo village
Shops
PSI RAS
National park administration
Backup RadioEthernet channel 11 Mbps (about 6 miles) — diversion route for emergency use
1.5 Mbps Heliosnet uplink (one-way)
One pair of fiber cable (100 Mbps) is used for 1.6 miles backbone span; the other pair (100 Mbps, 2 miles) for connecting the museum
Museum "Goritsky monastery"
Chkalovsky micro-district: officer club-house, apartment houses, school, artist's house
0 1 2 3 4 km

The Botik Telecommunication System provides Pereslavl enterprises, organizations, and private persons with high-speed (100 Mbps at the backbone, 10—100 Mbps at subscribers') Internet access at a reasonable price. Since 2000 Botik has been exponentially growing: all main quantitative indices (number of subscribers, amount of data transferred, etc) almost double each year.

These days — in late 2005 — Botik has more than 300 subscribers including 100 organizations and 800 private persons — in a town of 45,000 inhabitants; the number of computers connected to Botik exceeds 3000.

Botik's technical solutions for building cost-effective computer networks have been implemented in several regions of Russia and the CIS (www.samal.kz — Almaty, Kazakhstan; www.urbannet.ru — Moscow, Russia; www.aviel.ru — Ramenskoye, Moscow, Russia; and others).

The Refal Plus Programming System

1. Use presentation of object Refal expressions as arrays. This presentation of Refal expressions has some advantages over other methods. Specifically, it permits — while executing Refal programs — to effectively compute the length of a Refal expression and construct sub-expressions taking into account the length and position of subexpressions in Refal expressions. An effective realization of these two operations promoted the development and use of a new approach to effective realization of syntactic identification in Refal.

2. A direct compilation of Refal programs into an imperative language. The system implemented a method of direct compilation of Refal programs into an abstract imperative language which can be subsequently represented as any target platform using a back-end module.

3. Openness, flexibility, and reasonable modularity. The system represents a set of separate modules having well-defined interfaces among them. The source code of the modules is available. The system compiler is written in Refal Plus. Run-time support libraries for different platforms are realized in high-level languages such as C++, Java, C#, T++. Among other things, this approach must guarantee a high level of system portability.

4. Support of possible extensions. System's modular structure permits to easily modify its functionality without modifying the most part of the code and the system as a whole.

Metacomputations and Functional Programming Languages

- Supercompilation and automatic program conversion.
- Application of metacomputations to theoretical and practical programming.
- The Refal and Flac functional programming languages.
- Realization of the Refal Plus programming system for different platforms, including multiprocessor systems.
- The CAC, DoCON computer algebra systems.
- Realization of a standard library project of the BAL-0.01 fundamental algebra for the Haskell programming language.

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