Parallel Computations in Solving Modern Problems of Science and Technology

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Significant progress has been achieved during the last fifteen years due to a wide introduction of multiprocessor computer systems. The massively parallel systems are a powerful tool, which makes it possible to advance the solution of particularly complicated problems of pure science and applied researches.

It should be underlined that to use multiprocessor systems effectively it is necessary to take into account and master the specific features of parallel processing in both the construction of computer algorithms and their program implementation.

Nowadays an essential experience of solving complex problems by means of such systems has been accumulated; however there exist objective difficulties in realizing traditional computational approaches to constructing parallel algorithms.

Russian computer systems MBC-100, MBC-1000 meet the requirements of mastering the maintenance and realizing the collective access of users via the telecommunication networks [1].

The creation of teraflops computer systems means the solution of a complex scientific-technological problem. Due to the united software-hardware basis it became possible to realize significant advances in mastering and introduction of parallel computer technologies and to solve many unsolvable problems.

On this basis a big cooperation of co-executives has been arranged lately. It has a significant scientific-technological potential. At present several scientific directions have been established where the application of parallel computations turned out to be most efficient. Specifically, they include:

- The problems of computer biology, the deciphering of molecule structure, the gene code analysis among them [2, 3].
- Computer problems of mechanics and, mostly, applied aerodynamics. These solutions have complex spatial structure and to obtain them one needs to construct computational grids adapted to the sought-for solution [4, 5].
- Computational problems of modern physics and, first of all, the investigation of plasma under extreme conditions [7].
- Computational problems of modern quantum chemistry [9].

Essential theoretical and applied results have been obtained and new approaches have been formed for each of these directions. Lately, discrete models have been commonly used in computer mechanics to describe the dynamics and the elastoplastic behavior of materials taking into account their microstructure. Violation of continuity of a material under strong deformation and destruction makes it considerably difficult to describe these processes within classical approaches. The use of the discrete description (for the number of particles $\sim 10^8 - 10^9$) enables reliable simulation of material behavior for large deformations and continuity breakage [6].

The use of high-performance systems also made it possible to apply new, more complete mathematical models of describing plasma behavior including the problems of controllable

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thermonuclear fusion, the problems of studying the interaction of various kinds of radiation with a substance on the basis of constructing quantum-statistical models, Rosseland paths, of state equations, etc. These researches have essential technological applications.

Having used the detailed description of passing of neutrons and gamma-quantum units in complex environments we managed to carry out detailed calculations of shields in nuclear installations with the decrease of the initial radiation intensity by 10^{10} – 10^{14}, the accuracy percent being guaranteed [8].

The scope of computations for the abovementioned and many other directions of research requires to use 500-1000 processors in the systems of MBC-1000 kind and a wide range of parallel computer algorithms and program packets. Nowadays there exists significant experience of mastering of massively parallel systems and the obtained volume of program product in a great variety of computer applications. With the accumulation and generalization of technological and mathematical operation the system and applied software is being improved and the scientific-technological reserve for further development of massively parallel systems is being created.

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