Design Features of High-Performance Multiprocessor Computing Systems

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EXECUTIVE SUMMARY

The chapter analyzes the ways of development of high-performance computing systems. It is shown that a real breakthrough in mastering parallel computing technologies can be achieved by developing an additional (actually basic) level in the hierarchy of hardware capacities of multiprocessor computing systems of MPP-architecture, the personal computing clusters. Thus, it is proposed to create the foundation of the hardware pyramid of parallel computing technology in the form of personal computing clusters. It is shown that on the basis of multiprocessor information systems processing and control, the control systems are implemented for many industries: space industry, aviation, air defense and anti-missile defense systems, and many others. However, the production of multiprocessor information processing and control systems is hampered by high cost at all its stages. As a result, the total cost of the system often makes it as an inaccessible tool. The use of modern multiprocessor cluster systems would reduce the costs of its production.

BACKGROUND

The paper analyzes the ways of development of high-performance multiprocessor computing systems. It is shown that a real breakthrough in mastering parallel computing technologies can be achieved by the development of an additional (actually, basic) level in the hardware hierarchy of multiprocessor computing systems of the *MPP* architecture - personal computing clusters. Thus, it is proposed to create the pyramid foundation of parallel computing technology hardware in the form of personal computing clusters. The scope of such systems is mastering parallel computing technologies, creation and debugging of parallel programs, including problem-oriented packages and libraries, as well as a simulation run of the software developed.

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Currently, significant interest in the construction of parallel multiprocessor computing systems (MCS) is determined by the use of standard public technologies and components (Bashkov et al., 2011; The Blackford MultiCore cluster specification, http://www.mvs.icc.ru/cluster_info.html; Ivaschenko et al., 2013; Latsys, 2003). This is due to a number of factors. Let's emphasize the main ones. First, according to market needs, the performance growth of the standard network technologies such as *GI(Gigabit Ethernet), FC (Fiber Channel)* and *IB (InfiniBand)* allows them to be seen as a communication medium for multiprocessor computing systems made by the *NUMA (Non-Uniform Memory Access)* (Non-Uniform Memory Architecture (NUMA)). Secondly, an essential factor was the growing popularity of the *Linux* freely distributed operating system. At the first stage of its use, it was positioned as the *UNIX* platform for the platforms based on Intel architecture, but relatively fast versions appeared for other popular microprocessors, including the leader in performance over the past few years, the *Alpha* microprocessors.

Depending on the problems features and the budget, the project system can have all kinds of configuration options. The most affordable standard motherboard is the *Core LGA1155 Z*77 motherboard, which includes two free *PCI Express* 3.0 8 line slots on the Core i7-4790K 4 GHz platform and *Gigabit Ethernet* network adapters and *FDR InfiniBand*, which allows increasing performance, reducing latency and reducing network power boards consumption. The cluster nodes are interconnected by *Gigabit Ethernet* switch and *InfiniBand*, which is designed for the corresponding number of ports. The number of nodes in the system and their configuration depends on the requirements for computing resources in the form of specific problems, and on the user's financial possibilities.

In addition, the sharp competition among manufacturers of computer technology leads to the fact that the situation when components market prices change rather dynamically, especially with regard to the release of new products models. A wide range of modern electronic products allows to certainly state that by using standard components it is possible to build high-performance computing systems of general purpose in a very short time with the maximum full consideration of the needs and capabilities of different users.

In regards to the mentioned above, let's emphasize several important features of the multiprocessor systems design. Today, making supercomputers include serial microprocessors, equipped with each own local memory, which are interconnected with some communication medium (Voevodin & Zhumaty,