

Theewara Vorakosit 2006: Efficient Runtime and Algorithms for Parallel Programming under Grid Environment. Doctor of Engineering (Computer Engineering), Major Field: Computer Engineering, Department of Computer Engineering. Thesis Advisor: Assistant Professor Putchong Uthayopas, Ph.D. 102 pages.  
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This dissertation addresses many challenges encountered in the building an efficient MPI run-time library on a Grid system. The first problem is how to enable the MPI run time library to fully utilize all Grid nodes under an environment where majority of the nodes are hidden behind the gateway nodes. The second problem is how to efficiently multicast MPI messages when the topology of the network is dynamic and highly heterogeneous.

For the first problem, this dissertation proposes a new way of modeling a Grid system as a set of virtual clusters. Using this model, a mathematical analysis has been provided to prove that an efficient and valid grid wide routing algorithm exists. In addition to addressing the routing problem, this dissertation also shows how to formulate Grid multicasting problem into a combinatorial optimization problem. Then two new multicast algorithms called GADT (Genetics Algorithm based Dynamic Tree) and LPBF (Longest Parallel Branch First) are proposed as the solutions. The first algorithm, GADT, uses evolutionary computing approach to generate a near optimal multicast schedule. But the algorithm requires a moderate run time which make it more suitable as a tool to find the maximum performance attainable than being used in an MPI runtime library. In contrast, LPBF is designed for a fast and efficient algorithm to be implemented in an MPI runtime library. LPBF employs an intelligent message scheduling technique to exploit an inherent communication and computation overlapping. Thus, the total transmission time of a multicast operation is reduced substantially.

The proposed algorithms have been tested using the simulation and the implementation on a grid system. An experimental Grid-enable MPI library named MPITH has been developed for that purpose. A campus grid in Kasetsart University, Thailand, is used along with the international Grid operated by PRAGMA project. It has been found that the proposed multicast algorithms perform efficiently in both simulation and on a real Grid test-bed system. Moreover, the proposed routing algorithm allows MPI applications utilize all the nodes that belong to a test Grid system with a very low performance penalty. In summary, the contribution of this dissertation is to propose the model and algorithms that can improve the performance of MPI run time library on the Grid systems. This will enable a large class of MPI applications to be ported and run on a large scale grid system efficiently.

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16 / 10 / 49