Book Review

By Dr. Ji Chen

Title: **Grid Computing For Electromagnetics**
by Luciano Tarricone, Alessandra Esposito
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The design of advanced electronic systems, such as wireless products, often requires several iterations of prototyping. Due to the complex nature of these products, accurate electromagnetic (EM) modeling/simulations have become necessary. However, most EM simulation tools are very CPU intensive. Often time, simulation time may go beyond one day. This makes some modeling/simulation tools not very applicable for practical designs.

With the recent advancement in parallel computing, it is now feasible to use "supercomputer" to alleviate such CPU intensive simulations. Among various parallel computing approaches, two distinct methods for computational electromagnetic society are the Open specifications for Multi Processing (OpenMP) based scheme and the message passing interface (MPI) based technique. Each paradigm has its own advantages and disadvantages. For practical electromagnetic simulations, it comes down to the affordability of computer platform vs high performance computing. In terms of Gflops per dollar, the MPI based approach typically has a clear advantage. For example, eight-node OpenMP UNIX workstations could cost around $100K, while an eight-node LINUX cluster, with similar performance and comparable amount of memory, can be assembled under $10K. Furthermore, if one can use available computer resources across the Internet, the cost for MPI computing will be even lower.

"Grid computing for electromagnetics" is one of the first books that give the background, implementation, and examples on how to develop your own parallel electromagnetic designs on grid environment. It is a book on parallel computing and beyond. It starts with the parallel high performance computing (HPC) and goes beyond it by introducing cooperative engineering and real time data management on grid environment. The core of this book is Chapters 4-6 where three EM applications, viz the parallel MPI finite-difference time-domain (FDTD) method, the cooperative CAE of rectangular aperture array antenna, and the planning, managing and monitoring of wireless radio base station network, are discussed under the GC framework. Before these applications are elaborated, the authors prepare the readers with some fundamental knowledge of GC by introducing what is a grid environment, explaining the enabling technologies and dedicated tools related to the GC, and describing a step-by-step procedure on how to build you own cluster in Chapters 1-3. Although Chapters 1-3 may not be interested to some researchers who have excellent computer administrative support, it is still recommended that readers go through these chapters since understanding the limitations of the grid environment will help us to design better scalable GC algorithms.

This book consists of seven chapters and four appendixes. The four appendixes describe some required knowledge related to GC. These include basics of UNIX/LINIX operating systems, some foundations of cryptography and security for grid environment, and some fundamental electromagnetics related to the examples in the books.

Chapter 1 covers the general concepts of grids for GC. Parallel and distributed programming are first reviewed. The web computing is then introduced and followed by the definition of computational grids, where both hardware and software facilities can be heterogeneous. This is a distinct difference between the GC and most current parallel computing platforms, where nodes are often unitary in terms of both software and hardware. Standard three-layer architecture is introduced guarantee smooth communications between different computer platforms.

To enable GC, enabling technologies and dedicated tools are described in Chapter 2. Objects orientation software designs concepts are first described. To enable GC on heterogeneous computer platforms, the grid middleware must be used. In particular, the book describes the Globus Toolkit (GT), one of such tools that enable the secured communications between different nodes on the grid environment. After a detailed description of the Globus Toolkit, the MPICH-G2, a MPI in grid environment based on GT is discussed. The MPICH-G2 allow users to couple multiple machines belong to the same grid for MPI applications.

In Chapter 3, the step by step procedure of setting up grid for GC is introduced. Following this procedure, readers, with some help from computer system administrator, should be able to set up his/her grid environment. The GT is used as the standard in this book and the set up details for the MPICH-G2 on grid environment is also provided.

Chapter 4 focuses on the implementation of the MPI FDTD in grid environments. After reviewing fundamentals of the FDTD method, the authors describe the MPI FDTD implementation. As expected, several barriers need to be inserted in the MPI FDTD implementation to synchronize the operations of processes. Considering the fact that each node on the grid can be heterogeneous, additional steps, such as installing of MPICH-G2 library at each node, copying and compiling source code at each node must be performed prior to MPI simulations. With these detailed set up procedure and software provided in the attached CD-ROM, readers are ready to explore the MPI FDTD code on a grid environment! It should be noted that the load balance is not immediately discussed in the chapter. Since the performance of each node and the network traffic between different nodes can be quite different on a grid environment, it is crucial to have balanced workload (in terms of CPU execution time) for each node. Some load balance discussions are provided in the next chapter and it is not hard for readers to develop their own schemes to decompose the original computational workload among various nodes to achieve the maximum speed up.

Chapter 5 describes the CAE of flange-mounted rectangular apertures using GC. Rather than repeating parallel implementations of numerical techniques, the emphasis hers is on the cooperative engineering, where multi-tasks are handled in the grid environment. This is beyond the traditional parallel computing where the goal is to reduce the CPU time of a single software package. Cooperative engineering allows each node has its own electromagnetic module related to a specified task of the entire design, GC will provide the common protocol that allows the smooth interaction among various nodes towards the whole system design.

Chapter 6 further discusses the real time data communication and management in the GC for wireless radio base station networks. The integrated system for network optimum planning (ISNOP) is used as an example and how to implement it in GC is provided. This application demonstrates that in addition to its functions in high performance computing and cooperative engineering, the GC can also be used towards real-time management for electromagnetic date produced by heterogeneous network of sources. In this application, the GT application programming interface is used for remote data access.

Overall, this is an interesting and practical book that gives the step by step instruction on how to build your first grid environment for electromagnetic applications. A CD-ROM, with necessary supporting software and some source codes, is attached at the end of the book. With some help from computer system administrator, one should be able to build up a simple five-node grid environment within one day and begin to explore the advantage of GC.

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