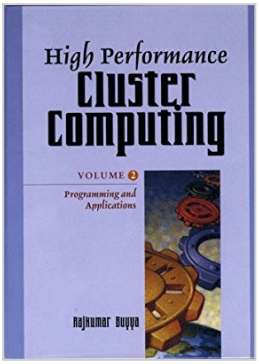

High Performance Cluster Computing: Programming and Applications, Volume 2

By Rajkumar Buyya

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Volume 2 discusses programming environments and development tools, Java as a language of choice for development in highly parallel systems, and state-of-the-art high performance algorithms and applications. DLC: High performance computing.

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Editorial Review

From the Inside Flap
Preface

The initial idea leading to clusters computing was developed in the 1960s by IBM as a way of linking large mainframes to provide a cost-effective form of commercial parallelism. During those days, IBM's HASP (Houston Automatic Spooling Priority) system and its successor, JES (Job Entry System), provided a way of distributing work to a user-constructed mainframe cluster. IBM still supports clustering of mainframes through their Parallel Sysplex system, which allows the hardware, operating system, middleware, and system management software to provide dramatic performance and cost improvements while permitting large mainframe users to continue to run their existing applications.

However, cluster computing did not gain momentum until three trends converged in the 1980s: high performance microprocessors, high-speed networks, and standard tools for high performance distributed computing. A possible fourth trend is the increased need of computing power for computational science and commercial applications coupled with the high cost and low accessibility of traditional supercomputers. These building blocks are also known as killer-microprocessors, killer-networks, killer-tools, and killer-applications, respectively. The recent advances in these technologies and their availability as cheap and commodity components are making clusters or networks of computers (PCs, workstations, and SMPs) an appealing vehicle for cost-effective parallel computing. Clusters, built using commodity-off-the-shelf (COTS) hardware components as well as free, or commonly used, software, are playing a major role in redefining the concept of supercomputing.

The trend in parallel computing is to move away from specialized traditional supercomputing platforms, such as the Cray/SGI T3E, to cheaper and general purpose systems consisting of loosely coupled components built up from single or multiprocessor PCs or workstations. This approach has a number of advantages, including being able to build a platform for a given budget which is suitable for a large class of applications and workloads.

This book is motivated by the fact that parallel computing on a network of computers using commodity components has received increased attention recently, and noticeable progress towards usable systems has been made. A number of researchers in academia and industry have been active in this field of research. Although research in this area is still in its early stage, promising results have been demonstrated by experimental systems built in academic and industrial laboratories. There is a need for better understanding of what cluster computing can offer, how cluster computers can be constructed, and what the impacts of clustering on high performance computing will be.

Though a significant number of research articles have been published in various conference proceedings and journals, the results are scattered in many places, are hard to obtain, and are difficult to understand, especially for beginners. This book, the first of its kind, gathers in one place the current and comprehensive technical coverage of the field and presents it in a tutorial form. The book's coverage reflects the state of the art in high-level architecture, design, and development, and points out possible directions for further research and development. Organization

This book is a collection of chapters written by leading scientists active in the area of parallel computing

using networked computers. The primary purpose of the book is to provide an authoritative overview of this field's state of the art. The emphasis is on the following aspects of cluster computing:

Requirements, Issues, and Services System Area Networks, Communication Protocols, and High Performance I/O Techniques Resource Management, Scheduling, Load Balancing, and System Availability Possible Models for Cluster-Based Parallel Systems Programming Models and Environments Algorithms and Applications of Clusters

The work on High Performance Cluster Computing appears in two volumes:

Volume 1: Systems and Architectures Volume 2: Programming and Applications

This book, Volume 2, consists of 29 chapters, which are grouped into the following three parts:

Part I: Programming Environments and Development Tools Part II: Java for High Performance Computing Part III: Algorithms and Applications

Part I focuses on various programming paradigms, models, and environments, including MPI, PVM, tuple space programming, component based programming, debuggers, and OS services for wide area applications. Part II covers Java for high performance computing, focusing on Java variants supporting MPI, JVM, SPMD paradigm, and web-based computing. Part III discusses various parallel algorithms and applications designed for your cluster programming environments. The application areas discussed include the use of clusters in image processing, electromagnetics, ocean modeling, CFD simulation, and biological applications modeling. Readership

The book is primarily written for graduate students and researchers interested in the area of parallel and distributed computing. However, it is also suitable for practitioners in industry and government laboratories.

The interdisciplinary nature of the book is likely to appeal to a wide audience. They will find this book to be a valuable source of information on recent advances and future directions of parallel computation using networked computers. This is the first book addressing various technological aspects of cluster computing in-depth, and we expect that the book will be an informative and useful reference in this new and fast growing research area.

The organization of this book makes it particularly useful for graduate courses. It can be used as a text for a research-oriented or seminar-based advanced graduate course. Graduate students will find the material covered by this book to be stimulating and inspiring. Using this book, they can identify interesting and important research topics for their Master's and Ph.D. work. It can also serve as a supplementary book for regular courses taught in Computer Science, Computer Engineering, Electrical Engineering, and Computational Science and Informatics Departments, including:

Advanced Computer Architecture and Its Applications Parallel Programming Scalable Computing Environments Parallel Programming Environments Programming Network of Workstations Cluster Programming and Applications Applications Development on Clusters Distributed and Concurrent Systems and Programming Parallel Algorithms and Applications Cluster Computing Resources on the Web

The various software systems discussed in this book are freely available for download through the Internet. Please visit this book's website,

phptr/ptrbooks/ptr-0130137855.html

for pointers/links to further information on downloading Educational Resources, Cluster Computing Environments, and Cluster Management Systems.

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March, 1999

From the Back Cover

A comprehensive guide to today's most advanced R&D in highly parallel programming and applications.

Volume 1 of this two-volume set collected today's best work on the systems aspects of high performance cluster computing. Now, in High Performance Cluster Computing: Programming and Application Issues, Volume 2, Rajkumar Buyya brings together the world's leading work on programming and applications for today's state-of-the-art "commodity supercomputers."

The book is organized into three areas: programming environments and development tools; Java(tm) as a language of choice for development in highly parallel systems; and state-of-the-art high performance algorithms and applications. All three areas have seen major advances in recent years-and in all three areas, this book offers unprecented breadth and depth. Coverage includes:

* New parallel programming techniques and tools, including MP and PVM, active objects, scoped behavior, and LiPS.
* State-of-the-art debuggng techniques: Code liberation, global renaming, name reclamation, and debugging interfaces.
* The WebOS: Designing operating system services for wide-area applications.
* Leveraging Java(tm) to the fullest: Distributed objects, the HPspmd model, and more.
* Clustered Web servers and other high performance Web applications.
* Real-time resource management, climate ocean modeling, parallel reflexive reasoning, content-based image retrieval, biomedical applications, and more.

About the Author

Together with Volume 1, High Performance Cluster Computing: Programming and Application Issues, Volume 2 captures the growing power of the cluster computing revolution. Whether you are a developer, researcher, administrator, manager, or user, these pages will show you the future of computing.

RAJKUMAR BUYYA is a researcher at the School of Computer Science and Software Engineering, Monash University, Melbourne, Australia. He was Guest Editor for the Special Issue on High Performance Computing on Clusters, Parallel and Distributed Computing Practices Journal, and author of Mastering C++ and Microprocessor x86 Programming. He is a speaker in the IEEE Computer Society Chapter Tutorials Program and Chairman of the IEEE Computer Society Task Force on Cluster Computing.

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