Tutorial

Title: Hot Topics in Cluster Computing and the Grid

Presenter(s):

Rajkumar Buyya
School of Computer Science and Software Engineering
Monash University,
C5.10, Caulfield Campus
Melbourne, VIC 3145, Australia
Phone: +61-3-9903 1969
Fax: +61-3-9903 2863
Email: rajkumar@csse.monash.edu.au
URL: http://www.csse.monash.edu.au/~rajkumar

Mark Baker
Division of Computer Science
University of Portsmouth
Mercantile House, Hampshire Terrace
Portsmouth
Hants, UK, PO1 2EG
Phone: +44 2392 845826
Fax: +44 2392 843106
Email: mark.baker@computer.org
URL: http://www.dcs.port.ac.uk/~mab/

Tutorial Abstract:

The growing popularity of the Internet along with the availability of powerful computers and high-speed networks as low-cost commodity components is changing the way we do computing. In addition, the emergence of two new computing paradigms, "cluster computing" and "global computing" (grid computing), is making developers rethink the way they design and implement their applications. The emerging technologies are enabling the coupling of a wide variety of geographically distributed resources such as desktop computers, clusters, storage systems, data sources, and scientific instruments, and allows them to be used as a single unified resource and thus forms what is popularly known as “computational grids”. In this tutorial we raise a number of open challenges that cluster computing and the grid researchers and developers need to address.

SECTION A: CLUSTER COMPUTING

The commercial success of clusters has pushed them into mainstream of general purpose computing. There is a need for a software tools and techniques that allows the management of cluster resources effectively and in a manner that is acceptable to majority of users. In this tutorial, we discuss current and emerging trends in cluster computing. In particular we cover cluster technologies in the areas of architectures, networking, single system image, management and application tools. We then move onto talk about four cluster systems that are deployed in commerce, industry and research environments. Finally, we summarise our findings, drawing a number of conclusions about current clusters and then briefly discuss emerging technology trends as well as mentioning how these will influence clusters of the future.

SECTION B: GRID COMPUTING

The tutorial focuses on the challenges in building commodity computational grids and computing portals that allows anyone to access to the resources from anywhere at anytime, of course from any platform including PDAs. We will discuss various approaches to building such systems by surveying the major international projects developing this upcoming technology. We will also address a number of the social and administrative issues that arise in order to build successful industrial-strength computational grids.

Outline:

1. Introduction and background
2. Cluster Architectures/Components
    - Linux/Solaris/Windows
    - Middleware
    - Programming Environments
    - Applications
3. Cluster Networking
    - Network technologies (NICs and switches)
        - Ethernet, Myrinet, ATM, SCI, etc.
        - Communication APIs: VIA, Active Messages, BIP, etc.
    - Cluster topologies
4. Single System Image alternatives
    - Hardware
    - Operating System
    - Subsystems
    - Tools and Applications
5. Cluster Tools
    - Management
    - Administrative
    - Application development
6. GRID Computing
    - Introduction
    - Challenging Issues
    - Grid Middleware and Services
    - Resource Management
    - Computational Economy
    - Computing Portals
    - Applications
7. Case Studies
    - Web serving (Hot Bot)
    - HPC (CPlant)
    - GRID (Internet Applications)
    - E-Commerce
    - ATLAS, PAPI, and NetSolve
    - Globus, Legion, IPG, Harness
    - Science Portals
8. Summary and Conclusions
    - Near and future trends in clusters

Schedule:

Part 1 (5%): Introduction and background
Part 2 (10%): Cluster Architectures
Part 3 (10%): Cluster Networking
Part 4 (10%): SSI
Part 5 (10%): Cluster Tools
Part 6 (20%): Computational Grids, Tools, and Applications
Part 7(30%): Case Studies
Part 8(5%): Conclusions

Note - % indicates the percent of overall time dedicated to each topic.

Duration:

Half day tutorial.

Level:

25% Introductory, 30% Intermediate, and 50% Advanced.

Required experience:

The purpose of this tutorial is to overview the current trends and options in cluster and grid-based technologies and systems. The purpose of the case studies are to highlight how the choices made influence the services that can be expected from each cluster type and grid systems.

Expected audience:

Students, academics, application developers, system designers

Presenter's profile:

Rajkumar Buyya
Monash University, Australia

Rajkumar Buyya is a Research Scholar at the School of Computer Science and Software Engineering, Monash University, Melbourne, Australia. He was awarded Dharma Ratnakara Memorial Trust Gold Medal for his academic excellence during 1992 by Kuvempu/Mysore University. He is co-author of books: *Mastering C++* and *Microprocessor x86 Programming*; and recently, he has edited a two volume book on *High Performance Cluster Computing*: Architectures and Systems (Vol. 1); Programming and Application (Vol.2) published by Prentice Hall, USA. He served as Guest Editor for the special issues of international journals: Parallel and Distributed Computing Practices, Informatica: An International Journal of Computing and Informatics, and Journal of Supercomputing.

Rajkumar is a speaker in the IEEE Computer Society Chapter Tutorials Program. Along with Mark Baker, he co-chairs the IEEE Computer Society Task Force on Cluster Computing. He has contrbuted to the development of HPCC system software environment for PARAM supercomputer developed by the Centre for Development of Advanced Computing, India.

Rajkumar conducted tutorials on advanced technologies such as Parallel, Distributed and Multithreaded Computing, Client/Server Computing, Internet and Java, Cluster Computing, and Java and High Performance Computing at international conferences. He has organised/chaired workshops, symposiums, and conferences at the international level in the areas of Cluster Computing and Grid Computing. He also serves as a reporter for Asian Technology Information Program, Japan/USA. His research papers have appeared in international conferences and journals.

His research interests include Programming Paradigms and Operating Environments for Parallel and Distributed Computing.

Dr Mark Baker
University of Portsmouth, UK
Mark Baker started working in the field of High Performance Computing at Edinburgh University (UK) in 1988. In Edinburgh he was involved in the development of parallel linear solvers on a large Transputer-systems using Occam. From 1990 until 1995 Mark was a project leader of a group at the University of Southampton (UK). This group was involved in developing and supporting environments and tools for a range of parallel and distributed systems. It was whilst at Southampton that Mark started to actively investigate and research software for managing and monitoring distributed environments. In 1995 Mark took up a post as Senior Research Scientist at NPAC, Syracuse University (USA). Whilst at NPAC Mark researched and wrote the widely sited critical review of the Cluster Management Systems. At Syracuse Mark worked on a range projects involving the major HPC groups and Labs. in the US. It was during this period that he worked closely with Prof. Geoffrey Fox on a variety of cluster and metacomputing related projects.

Since 1996, Mark has been a Senior Lecturer in the Division of Computer Science at the University of Portsmouth. At Portsmouth Mark lectures on network architectures, client/server programming and open distributed systems. Mark's current research is focused on the development of tools and services for PC-based distributed systems. Mark also tracks international metacomputing efforts and is involved with Java Grande and the definition of a Java interface to MPI.

Mark has recently contributed a number of articles on cluster computing, including a chapter for the *Encyclopaedia of Microcomputers*, a paper for *Software Practice and Experience* and was the editor and a contributor to a white paper on cluster computing. Mark is co-chair of the recently established IEEE Computer Society Task Force on Cluster Computing (TFCC) and is currently a visiting Senior Research Scientist at Oak Ridge National Lab., USA.

Mark is on the international editorial board of the Wiley Journal, Concurrency: Practice and Experience and regularly reviews papers for many journals in his field, including IEEE Computer and Concurrency. Mark gave the Cluster Computing tutorial at HPDC in Los Angeles in 1999. A full list of Mark's activities can be found on his Web site.