# **IEEE International Workshop on Cluster Computing**

http://www.dgs.monash.edu.au/~rajkumar/tfcc/IWCC99/

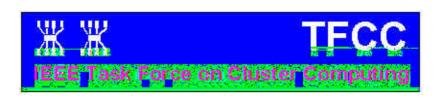


Centra Melbourne Hotel
Melbourne Convention Centre/World Trade Centre
Melbourne, Australia, December 2-3, 1999



**Technical Program** 







# **Premier Contributor**



# **Contributors**















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#### Registration Co-Chairs

Jahan Hassan, Monash University, Australia Shiranthi Ponniah, Monash University, Australia

# **SCHEDULE**

# **№** DAY ONE: Dec. 2, 1999

1		
8:30am-9:00am: Registration (open all day)		
9:00am-9:10am: Opening Remarks		
9:10am-10:00am: Keynote – "Fault-Tolerant Clust	ter Architecture for Business and Scientific	
Application'' – Kai Hwang		
10:00am-10:30am: Break – Refreshments		
10:30am-12:30pm:	10:30am-12:30pm:	
Session 1-A: Cluster Setup and Performance Measurement	Session 1-B: Cluster Communication Software and Protocols	
12:30pm-1:30pm: Lunch Break		
1:30pm-2:20pm: Keynote – "Clustering for Research and Production Scale, Parallel and Distributed Computing" –Anthony Skjellum		
2:20pm-2:45pm: Break – Refreshments		
2:45pm-4:25pm:	2:45pm-4:25pm:	
Session 2-A: Cluster File System and Parallel I/O	Session 2-B: Program Scheduling on Clusters	
4:25pm-4:45pm: Break – Refreshments		
4:45pm-5:45pm: Industry Talks		
Compaq Directions towards Scalable Cluster Computing - Bruce A. Foster HP MPI Cluster Features – Patrick Estep		
5:45pm-6:45pm: Poster Session		
7:00pm-9:00pm: Banquet		

# **№** DAY TWO: Dec. 3, 1999

8:30am-9:00am: Registration (open all day)		
9:00am-9:50am: Keynote – "From PC Clusters to a Global Computational Grid" - David Abramson		
9:50am-10:20am: Industry Talk - Sun Cluster Architecture - Ira Pramanick		
10:20am-10:40am: Break – Refreshments (Tea/Coffee)		
10:40am-12:00 noon:	10:40am-11:40am:	
Session 3-A: Cluster Mgmt. & Metacomputing	Session 3-B: Communication Optimisation	
12:00 noon –12:40pm:	11:40am-12:40pm:	
Session 4-A: Algorithms	Session 4-B: Cluster OS and Monitoring	
12:40pm-1:40pm: Lunch Break		
1:40pm-2:00pm: Invited Talk – Computational Astrophysics on Superclusters - Matthew Bailes		
2:00pm-3:30pm : Panel: "Cluster Computing R&D in Australia"		
3:30pm-3:45pm: Break – Refreshments		
3:45pm-4:45pm:	3:45pm-4:45pm:	
Session 5-A: Applications	Session 5-B: Cluster Programming	
4:45pm-5:30pm: Plenary – Beowulfs and Beyond: Past Accomplishments and Future Directions		
Thomas Sterling, California Institute of Technology		
5:30pm-5:40pm: Closing Remarks		

# **KEYNOTE ADDRESSES**

Chairs: Rajkumar Buyya/Mark Baker

Thursday 2<sup>nd</sup> December, 9:10am-10:00am: "Fault-Tolerant Cluster Architecture for Business and Scientific Application" by Kai Hwang, University of Southern California, USA

**Abstract:** This talk covers fault tolerant architecture, single-system-image (SSI) services, and innovative applications of clusters built with commodity components. I will introduce several new R&D ideas through the architectural design and benchmark experiences of the Trojans PC/Linux Cluster built at the University of Southern California. The Trojans cluster is unique in its architectural features supported by middleware consolidation and Linux/OS extensions. The major goal is to support critical SSI services and fault-tolerant operations of the cluster. A new hierarchical checkpointing scheme is presented for building large-scale clusters with a distributed RAID architecture.

On a worldwide scale, many innovative applications have explored the supercomputing power of the PC/WS clusters. The talk illustrates several new applications for distributed multimedia processing, intelligent software agents, data-mining in E-commerce, and bio-informatics for health-care. We present recent research results on parallel image rendering, video-on-demand scheduling, financial and economic analysis, and parallel gene/DNA sequence matching. Impacts to information technology and scalable commodity computing trends will be discussed.

Thursday 2<sup>nd</sup> December, 1:30pm-2:20pm: "Clustering for Research and Production Scale, Parallel and Distributed Computing" by Anthony Skjellum, President, MPI Software Technology Inc., USA

Abstract: A lot of attention has been paid to so-called Beowulf/Avalon clusters, where PCs or Alphas are strung together with 100Mbit/s Ethernet and portable programs from supercomputers have been run on these, particularly when modest bandwidth and latency requirements are posed by the example applications. In addition, heroic efforts to scale clusters using early gigabit/s scalable fabrics has been done across the world, but these systems, like the Beowulf counterparts, have relied on software from the previous generation of multicomputers and supercomputing systems.

However, commercial-grade software tools (middleware and distributed environments) for clusters have matured considerably since the initial Beowulf type experiments, as have the availability of easy-to-use cluster interconnects. In this talk we review the technical achievements thus far in production-grade environments for both message passing and cluster scheduling, both for NT and Linux. This talk emphasises the option of having tools and hardware that is scalable, to varying degrees, and presents a taxonomy of hardware, software, and applications that divides the space of activities and also seeks to establish areas where additional opportunities for new software and other tools exist. Issues of security and scalability are considered as are cost of ownership vs. freeware, with proposed economic models for both company and university adopters of clusters. We discuss pros and cons of open source vs. commercial products as viable options moving forward.

Friday 3<sup>rd</sup> December, 9:00am-9:50am: "From PC Clusters to a Global Computational Grid" by David Abramson, Monash University, Australia

**Abstract:** PC Clusters have become an extremely inexpensive way to build quite high powered parallel machines, and it is clear that this trend will continue for some time. Such clusters can provide enormous computational power for individual projects or departments within an organisation. However, as the number of clusters increases within an enterprise, and then globally, there is the need for a software architecture which can integrate these into larger "grids of clusters".

This talk will focus on the issues of integratation, with particular reference to "Globus", an international effort designed to deliver a toolkit for programming on a global computational grid. I will cite our experience at using Nimrod (and its commercial counterpart, Clustor), a tool for performing parametric modelling, and explain the design and development of a new tool called Nimrod/G, which is "Grid Aware". Nimrod/G provides specific functions for resource location and scheduling where the machine base is highly variable. The talk will then discuss some of the related enhancements to Nimrod, such as Nimrod/O, a tool for performing complex computational optimisation using the grid.



#### Friday 3<sup>rd</sup> December, 1999

Chairs: Rajkumar Buyya/Mark Baker

#### Beowulfs and Beyond: Past Accomplishments and Future Directions

Thomas Sterling, California Institute of Technology and NASA Jet Propulsion Laboratory, USA

Beowulf-class PC cluster computing and other PC cluster systems have been in evolution for approximately 6 years driven by application requirements, technology opportunities, and experience with earlier workstation clusters and cycle harvesting on local area networks of desk tops. PC cluster computing is in transition from its inchoate phase of separate installed system implementation to shared community-wide hardware and software systems with industry support. When once the primary challenge was implementation of the hardware and programming end applications on small or moderate sized systems, today the dominant challenge is scalability beyond a thousand processors and the development of robust system management software for large multiuser, multitasking Beowulfs. The future directions for PC clusters will be, in part, driven by advances and changes in trends in hardware technologies including system-on-a-chip, processor-in-memory, and SMP-on-a-chip as well as new optical technologies for inter-node communications. But not all trends in technology will be conducive to future Beowulf-class systems and computing. The movement to turnkey consumer boxes such as set-top boxes, PDAs, and gameboys, are all inaccessible to being harnessed in general purpose clusters. This talk will summarize the range of accomplishments over the last half dozen years and will project the likely opportunities, directions, paths, and degree of advances for the next half dozen years. The talk will also reflect on the content and implications of the presentations comprising the IWCC technical agenda.

# INDUSTRY TALKS

Thursday 2<sup>nd</sup> December, 1999

Chair: Anthony Skjellum, MPI Software Technology Inc., USA

#### Compaq Directions towards Scalable Cluster Computing

Bruce A. Foster, Compaq Computer Corporation, Boston Mass., USA

Scalable supercomputing using COTS (commodity-off-the-shelf) servers offers the concept of bridging the 20th Century to the 21st and providing quantum performance/price advantages with the fastest processors, compilers and interconnects available. Bruce will cover the details of Compaq's work in scalable supercomputing with reference to the U.S. DoE ASCI (Accelerated Strategic Computing Initiative) and other peak projects using Compaq's Alpha processor with the relevance of these to small, medium and large implementations in Australia and around the world.

#### **HP MPI Cluster Features**

Patrick Estep, Hewlett Packard, USA

We discuss the new HP cluster interconnect solution. This solution provides low latency, high bandwidth, and low cpu consumption messaging for MPI applications. Asynchronous messaging is supported, enabling overlapping of computation and communication. The cluster interconnect can also be used to perform intrahost transfers, providing datamover capability in hardware. We present application performance data.

We discuss future plans. Progress and plans for MPI-2 implementation will be covered. Work with partners including Platform Computing (LSF), Argonne National Laboratory (MPI-IO), and Etnus (TotalView debugger) will be discussed.

### Friday 3<sup>rd</sup> December, 1999

#### Sun Cluster Architecture

Ira Pramanick, Sun Microsystems, Inc., USA

Sun Microsystems is one of the leading vendors of clustering products, and will continue to make huge investments in clustering. This talk will present the main features of Sun Cluster, a clustering solution from Sun Microsystems, that is designed to provide high availability, scalibility and single-system image. Various components of Sun Cluster interact together to help achieve these goals, and this talk will describe three of those components: global networking, cluster file system and global devices. It will also touch upon the ease of cluster administration in Sun Cluster.

# **INVITED TALK**

Chairs: Kai Hwang, University of Southern California

## Computational Astrophysics on Superclusters

Professor Matthew Bailes, Swinburne Astrophysics and Supercomputing, Australia

The Swinburne Supercluster is a 66 Gflop cluster running Digital Unix (Tru64). Motivation for development of the cluster, the types of astronomical applications that are well-suited to clusters, and tools that help astronomers use the facility will be discussed.

# **PANEL**

## Cluster Computing R&D in Australia

The aim of the panel session is for Australian researchers to present a brief summary of their current work in the area of cluster computing, including highlighting aspects such as: important results, software made available and commercial products. In addition we would like panel members to address some of the following questions:

- What are the goals for future research on Cluster Computing in Australia?
- How do you see the field developing?
- What opportunities are there for Australia in this field?
- Should there be greater cooperation among researchers in Australia, and how can this be achieved?

There will be a brief question and answer session at the end.

# **Moderator**: Paul Roe, Queensland University of Technology

#### **Members:**

- □ David Abramson, Monash University
- Bill Appelbe, RMIT University
- ☐ Ken Hawick, University of Adelaide
- Albert Zomaya, University of Western Australia
- ☐ Matthew Bailes, Swinburne Astrophysics and Supercomputing Centre
- ☐ Chris Johnson, Australian National University
- □ Paul Roe, Queensland University of Technology
- □ Andrzej Goscinski, Deakin University
- ☐ John O'Callaghan, Australian Partnership for Advanced Computing

#### **Software Tools for Cluster Computing**

David Abramson

Clusters are a very cheap way of gaining computing power. However, the challenge is to produce software environments that provide an illusion of a single resource, rather than a collection of independent computers. I will briefly address this issue.

#### **Parallelising Compilers**

Bill Appelbe

Twenty years of research and development in parallelizing compilers still leaves us far short of the "holy grail" of a tool that could automatically convert serial programs into efficient parallel programs. The open question is what progress is likely in the next decade, and how compiler technology and tools will affect the adopting of cluster computing by a broad user community beyond expert programmers.

#### **Beowulf cluster systems**

Ken Hawick

Beowulf cluster systems are becoming widely prevalent at academic and industrial sites across the world. There are clear price-performance benefits over conventional supercomputer systems for many applications. Recent developments suggest that the Beowulf model is becoming viable not only for task farming applications but for large scale parallel programs with more intensive communications patterns. These issues are of great interest for the future of both cluster computing and parallel computing. Work is in progress to embody the research ideas in parallel computing from the last 20 years into libraries and templates of code to aid the use of Beowulf systems. Some links are given at: http://dhpc.adelaide.edu.au/projects/beowulf

#### **DISCWorld**

Ken Hawick

DISCWorld is a long term project to research the issues in building long lived, robust, distributed metacomputing systems. A great deal of software technology, particularly from the last few years enables "Problem Solving Environments" to be built. These aid non-specialists or rather application domain experts to use distributed clustered resources - both on their local network as well as services provided by specialist remote servers at other sites. DISCWorld is an attempt to assimilate state-of-the-art research ideas into a high level concept framework, manifesting itself as an ongoing series of prototypes and technology integration studies. Some further description and links are available at: http://dhpc.adelaide.edu.au/projects/DISCWorld

#### **Scheduling**

Albert Zomaya

In either sequential or parallel systems, the architecture is characterized by functional components, the communication topology and facilities, and control structures and mechanisms. However, there are several issues related to parallelization that do not arise in sequential programming. One of the most important issues is task-allocation, that is the breakdown of the total workload into smaller tasks assigned to different processors, and the proper sequencing of the tasks when some of them are interdependent and cannot be executed simultaneously. To achieve the highest level of performance it is important to ensure that each processor is properly utilized. This process is called load-balancing or scheduling and it is considered to be extremely "formidable" to solve. The scheduling problem belong to a class of problems known as NP-complete. See http://www.ee.uwa.edu.au/~paracomp/projects.html.

# Applications of the Swinburne Supercluster in Astrophysics

Matthew Bailes

The Swinburne supercluster is a 65-node configuration of alpha workstations which is involved in several major projects involving large-scale processing. The applicability of clusters to observational astronomy will be discussed along with tools to manage the processing and the proposed upgrade of the system to 256 nodes.

#### Parallel/cluster computing at ANU

Chris Johnson

Parallel and cluster computing at ANU have a long history and a diversity of projects and interests. There is a history of programming systems and operating systems research and development on the Fujitsu multiprocessor computers that range from AP1000 (128 x SPARC 1) to AP3000 (12 x 170 MHz UltraSparc) on fast proprietary networks, ranging from proprietary operating systems to Linux, and some (applications) history with a Thinking

Machines CM-5. There are currently at least 2 Beowulf clusters at ANU within the strict classification: 12 x 533 MHz Alphas on Fast Ethernet at ANU Supercomputer Facility (Ben Evans), and 9 x 400MHz Pentium IIs at Research School of Information Sciences and Engineering (Jonathan Baxter); and a project to purchase a 128 processor system is under way (combined RSISE and Dept of Computer Science), for a variety of applications and systems development projects.

In systems, the commodity cluster movement has been trading off faster communication against cost, and the proprietary machines' networks have also lost their previous balance of communications speed against processor speed. The two approaches have in common the need for operating systems developments to improve communications speeds through optimistic protocols, minimal buffering, user-process level calls, and coordinated scheduling of processes across the cluster. I expect that recent experience with the proprietary machines will feed across to developments in the Linux domain. It is also a concern to see that the software development environments for clusters are still at a very low level; simple, widely applicable, portable tools for the Linux cluster environment are a priority.

# The Mianjin Parallel Programming Language

Paul Roe

We have designed and implemented a parallel programming language, Mianjin, for programming non-dedicated clusters of workstations. Mianjin supports a virtual shared object space and uses type information to enforce safe communication in the presence of abstractions. I will outline some of the interesting features of Mianjin and our current cluster computing research at QUT www.plasrc.qut.edu.au/Gardens.

# Operating Systems and Execution Environments Supporting Parallel Processing on Clusters Andrzej M. Goscinski

Many research groups from universities, research laboratories and industry have been involved in the last few years in studying the development of software which would enable efficient parallel processing on Clusters. Some results, in particular in the area of finding and expressing parallelism, are very good. However, parallelism management problems do not have satisfactory solutions and lessons learnt in one area are not used to form a uniform vision and approach to developing software to support parallel processing on Clusters. Available parallel programming packages, parallel programming languages and parallelising compilers are only supported by classical network operating systems, e.g., Unix-based. Parallelism management is very limited and does not go beyond basic process and communication management. Thus, there is a need to identify and discuss the basic issues of and solutions to the management of parallel processing on Clusters, and to propose a new solution. It is claimed that parallelism management be offered by an operating system that inherits some features of a distributed operating system and provides new services which address the needs of parallel processes, Cluster's resources, and application programmers. This approach will allow the achievement of high performance of parallel processing on Clusters; relieve the programmer from error prone and time consuming work of allocation of processes to workstations, interprocess communication and process synchronization; provide single system image by supporting transparency; make the whole Cluster based parallel system easy to use, and allow to use resources efficiently.

# Australian Partnership for Advanced Computing (APAC) Plans and Strategies John O'Callaghan

The Australian Partnership for Advanced Computing (APAC) has been established with a grant of \$19.5m from the Federal Government to underpin significant achievements in Australian research, education and technology diffusion by establishing and supporting an effective advanced computing capability ranked in the top 10 countries. One of the roles for APAC is to provide users particularly in the Higher Education sector with 'peak' computing systems far beyond the capacity that is currently available. Another important role for APAC is to strengthen the expertise and skills necessary for the effective use and development of these facilities. The broader role for APAC is to form a partnership to lead the development of an Australia-wide computing and communications systems infrastructure supported by Centres of Expertise in advanced computing. APAC is in the process of selecting a peak computing system for a National Facility to be based at the ANU, and developing strategies for strengthening complementary infrastructure at other locations around Australia. The talk will outline the current state of the APAC plans and strategies.

# TECHNICAL PAPERS

## Thursday 2<sup>nd</sup> December, 1999

#### **№** Session 1-A: Cluster Setup and Performance Measurement

Chair: Thomas Sterling, California Institute of Technology, USA

**Design and Analysis of the Alliance/University of New Mexico Roadrunner Linux SMP Super Cluster** David A. Bader, Arthur B. Maccabe, Jason R. Mastaler, John K. McIver III and Patricia A. Kovatch

Comparative Performance of a Commodity Alpha Cluster running Linux and Windows NT David Lancaster and Kenji Takeda

Comparing the Communication Performance and Scalability of a Linux and an NT Cluster of PCs, a Cray Origin 2000, am IBM SP and a Cray T3E-600

Glenn R. Luecke, Bruno Raffin and James J. Coyle

An Assessment of Gigabit Ethernet as Cluster Interconnect Jens Mache

Evaluation of the Performance of Multithreaded Cilk Runtime Systems on SMP Clusters

Liang Peng, Mingdong Feng and Chung-Kwong Yuen

#### **AND Session 1-B: Cluster Communication Software and Protocols**

Chair: Ken Hawick, Adelaide University, Australia

A Communication Staging Technique for Network Cache Interconnected Clusters

Amy W. Apon, Hsiang Ann Chen, Charlotte F. Fischer and Larry E. Wilbur

Communication Kernel for High Speed Networks in the Parallel Environment LANDA-HSN

Thierry Monteil, Jen-Marie Garcia, David Gauchard and Oliver Brun

Smart Cluster Network (SCNet): Design of High Performance Communication System for SAN

Naoshi Ogawa, Takahiro Kurosawa, Nobuhiro Tachino, Andreas Savva, Keisuke Fukui and Mitsuhiro Kishimoto

A High Performance Communications System for PODOS

Sudharshan Vazhkudai and Tobin Maginnis

Realistic Communications Model for Parallel Computing on Cluster

Anthony T. C. Tam and Cho-Li Wang

#### **№ Session 2-A: Cluster File System and Parallel I/O**

Chair: Tarek A El-Ghazawi, George Mason University, USA.

Soda: A File System for a Multicomputer

Bruce Janson and Bob Kummerfeld

File Replication for Enhancing the Availablity of Parallel I/O Systems on Clusters

Hau-Yang Cheng and Chung-Ta King

#### I/O in the Gardens Non-Dedicated Cluster Computing Environment

P. Roe and S-Y Chan

#### MPI-IO on a Parallel File System for Clusters of Workstations I/O

Taki Hakan and Gil Utard

### Single I/O Space for Scalable Cluster Computing

Roy S. C. Ho, Kai Hwang and Hai Jin

## **№** Session 2-B: Program Scheduling on Clusters

Chair: Andrzej Goscinski, Deakin University, Australia.

#### Formal Specification of Virtual Process Topologies

Kamran Kazemi and Chris McDonald

#### Task Partitioning Utilizing Available Time on Multiprocessor Systems for a Given Schedule

Oscar R. Lopez-Bonilla

#### An Efficient Resource Allocation Scheme for Gang Scheduling

B. B. Zhou, P. Mackerras, C. W. Johnson, D. Walsh and R. P. Brent

#### **Building and Scheduling Parallel Adaptive Applications in Heterogeneous Environments**

D. Kebbal, E. G. Talbi and J. M. Geib

#### **Cost-Efficient Load Distribution Using Multicasting**

J. Tan

#### Friday 3<sup>rd</sup> December, 1999

#### **№** Session 3-A: Cluster Management and Metacomputing

Chair: Rajkumar Buyya, Monash University, Australia.

## Investigation to Make Best Use of LSF with High Efficiency

Fumie Costen, John Brooke and Mike Pettipher

#### **Self Migrating Threads for Multi-Agent Applications**

Naoya Suzuki, Munehiro Fukuda and Lubomir F. Bic

#### **High Performance Distributed Objects for Cluster Computing**

Lionel Brunie, Laurent Lefevre and Oliver Reymann

#### Resource Manager for Globus-based Wide-area Cluster Computing

Y. Tanaka, M. Hirano, M. Sato, H. Nakada and S. Sekiguchi

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#### **♦ Session 3-B: Communication Optimisation**

Chair: Mark Baker, University of Portmouth, UK

#### Optimizing User-Level Communication Patterns on the Fujitsu AP3000

Jeremy Dawson and Peter Strazdins

# Algorithms for Stable Sorting to Minimize Communications in networks of Workstations and their Implementation in BSP

Christophe Cerin and Jen-Luc Gaudiot

# **Key Message Algorithm: A Communication Optimization Algorithm in Cluster-based Parallel Computing**

Ming Zhu, Wentong Cai and Bu-Sung Lee

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## **A** ■ Session 4-A: Algorithms

Chair: Peter Strazdins, Australian National University, Australia

# Massively Parallel Simulated Annealing Embedded with Downhill - A SPMD Algorithm for Cluster Computing

Zhihui Du, Sanli Li, Shuyou Li, Mengyue Wu and Jing Zhu

# Unobtrusive Workstation Farming Without Inconveniencing Owners: Learning Backgammon with a Genetic Algorithm

Paul J. Darwen

## **№** Session 4-B: Cluster OS and Monitoring

Chair: Chung-Ta King, National Tsing Hua University, Taiwan

## Nomad: A Scalable Operating System for Clusters of Uni and Multiprocessors

Eduardo Pinheiro and Ricardo Bianchini

#### **Contractual Operating System - Design and Problems**

Wai-kong Cheuk, Chi-kwong Li and Wai-Yip Chan

#### Cluster Probe: An Open, Flexible and Scalable Cluster Monitoring Tool

Zhengyu Liang, Yundong Sun and Cho-Li Wang

#### **↑** Session 5-A: Applications

Chair: Hai Jin, University of Southern California, USA

#### Lattice Field Theory on Cluster Computers: Vector- vs. cache-centric Programming

C. Best, N. Eiker, T. Lippert, M. Peardon and K. Schilling

#### A Finite Element Solver for Convection Diffusion Problems Using a Cluster of PCs

Renata Simoes Silva

# **№** Session 5-B: Cluster Programming

Chair: Chris McDonald, University of Western Australia, Australia

#### Sharing the Garden GATE: Towards an Efficient Uniform Programming Model for CLUMPS

Darren Butler and Paul Roe

#### **Debugging Parallel Programs Using Incomplete Information**

Simon Huband and Chris McDonald

# The Influence of Concurrent Process Duplication on the Performance of Parallel Applications Executing on COWs

Michael Hobbs and Andrzej Goscinski

# **LOCAL INFORMATION**

# **Melbourne, the city:**

"Melbourne is a diverse and cosmopolitan city. The town is home to some of Australia's biggest shopping complexes and sophisticated boutiques, glorious food halls and elegant restaurants, with a wide range of ethnic foods being readily available. It is regarded as one of the cultural, culinary, sporting and shopping capitals of Australia with a great selection of events and festivals to entertain locals and visitors. A short drive out of the city is the Mornington Peninsula, Melbourne's summer playground and the Dandenongs, which locals claim has "the very best nature has to offer" -- Australian Tourism Net

# **Workshop Venue: Workshop Venue:**

#### Centra Melbourne Hotel

Corner Flinders & Spencer Streets PO Box 417, Melbourne Convention Centre/World Trade Centre Melbourne, Victoria 3005, Australia

Phone: (61-3) 9629 5111 Fax: (61-3) 9629 5624

Email: mail@melbourne.centra.com.au

## ✓ Wisa:

Please contact your local Australian High Commission to obtain up-to-date information on visa requirements.

# **△** Currency and Credit Cards:

The currency is the Australian Dollar. Currency exchange facilities are available for all incoming and outgoing flights at all international airports in Australia. This can also be done in most banks.

The most commonly accepted credit cards are American Express, Bankcard, Carte Blanche, Diners Club, MasterCard, Visa and their affiliates.

# **✓ ■ Weather:**

The conference will be held in the summer. Temperatures in the summer varies from the mid twenty degrees (Celsius) to the mid thirty degrees.

## **→ ■** Hotel Information:

IWCC'99 participants will get special rates at the following hotels:

#### Centra Melbourne Hotel Pacific International Terrace In

Please mention that you are an IWCC'99 participant while making bookings to get the special discounted rate. Please make all your bookings directly with the hotels. The hotel booking forms can be downloaded from the IWCC'99 web site.

# IEEE International Workshop on Cluster Computing (IWCC'99)

Dec. 2-3, 1999, Melbourne Convention Centre, Melbourne, Australia.

http://www.dgs.monash.edu.au/~rajkumar/tfcc/IWCC99/index.html

# **REGISTRATION FORM**

# **Registration Fee**

Advance Registration (By Nov. 5) in AU\$		Late/On-site Registration in AU\$	
IEEE Members	240	IEEE Members	280
Non-members	315	Non-members	355
Full-time Students	198	Full-time Students	240

(The registrat	ion fee includes a copy of proceedings, lunches, and refreshments on Dec. 2-3 and banquet.)			
	ber, membership no. please:			
Other Cost I	<u>tems</u>			
Each	n Additional Proceeding: AU\$ 110			
Each	Additional Banquet Ticket: AU\$ 36 (in case you want to bring non-participant/friend).			
<b>Participant</b>	Details			
•	Name:			
Affiliation &				
Ema	il:			
Payment In	formation			
	( <b>Preferred Method</b> ) Payment by credit card in Australian dollars (AU\$).			
I wish to pay	AU\$ by Visa / MasterCard / Bankcard:			
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Expiry date (	mm/yyyy):/			
NI C.1				
Name of the	card-holder:			
Signatura	Date:			
Signature	Date.			
Ontion Two	Payment may be made by cheque or bank draft payable to "TFCC/IWCC'99, Monash			
	and must be in Australian Dollars and drawn on an Australian bank.			
I enclose che	que/bank draft no.: for AU\$ payable			
to "TFCC/IV	VCC'99, Monash University", Melbourne, Australia.			
Mail to:	Rajkumar Buyya			
	School of Computer Science and Software Engineering			
	Monash University, Clayton Campus			
	Melbourne, VIC. 3168, Australia			
	Phone: +61-3-9905 1502 (office); +61-3-9544 2159 (home)			
	Fax: +61-3-9905 5146 (credit card payments can be faxed)			
	Email: rajkumar@dgs.monash.edu.au			