

Grid Computing and Distributed Systems Laboratory and the Gridbus Project



Annual Report - 2007

By

Dr. Rajkumar Buyya

Associate Professor and Reader



Department of Computer Science and Software Engineering

The University of Melbourne, Australia

1. Director's Message



I am pleased to report on the key activities and outcomes of Grid Computing and Distributed Systems (GRIDS) Laboratory at the University of Melbourne, Australia during the academic year 2007, which has been a fantastic year for GRIDS Lab and its members. The GRIDS Lab continues to be one of the leading and innovative research groups in the area of Grid computing and distributed systems nationally and internationally. The highlights of research activities and outcomes in 2007 are:

- The Lab successfully launched two large research projects: (i) ARC (Australian Research Council) Discovery Project “QoS-based Scheduling of e-Research Application Workflows on Global Grids” and (ii) DEST (Department of Education, Science, and Training) International Science Linkage project on “Autonomic and Utility-oriented Global Grids for Powering Emerging E-Research Applications”.
- The Lab created a new and innovative enterprise Grid software technology, called Aneka, a platform supporting multiple parallel and distributed programming models; and filed for an Australian provisional patent heralding a pathway for its commercialisation.
- Members of GRIDS Lab have authored over 35 publications, which include 4 journal papers, 24 conference papers, and 4 edited conference proceedings.
- The Lab's flagship Gridbus Project has released “open source” Grid middleware technologies including the Grid Service Broker, Workflow Engine, and GridSim which are used by several researchers and users in academia and industries around the globe.
- Members have presented over 15 invited talks that include 2 keynote talks delivered at international conferences held in Europe (Italy) and Asia (Thailand).
- The Lab successfully hosted research activities of over 20 scholars: 8 research students (most of them were PhD students), 5 Research Fellows (at PostDoc level), 3 Software Engineers, and couple of Masters/honours students. Two Ph.D students have graduated.
- The Lab Director and many of its members have been recognised for their outstanding contribution to the creation and open sharing of Gridbus technologies nationally and internationally through Vice-Chancellor's “Knowledge Transfer (Commendation) Award”
- The Lab housed several (short and long term) international visitors (academic and PhD students) from China, India, Japan, Germany, Italy, and New Zealand.
- Received “Best Paper Award” for a research article co-authored with Hui Li from Leiden University, from the 3rd IEEE International Conference on e-Science and Grid Computing.
- Initiated two book projects “Content Delivery Networks” and “Market-Oriented Grid and Utility Computing” being published by Springer and Wiley respectively.
- Members of the Lab have led community efforts by (a) involving in the organisation of conferences (CCGrid 2007, Rio, Brazil and e-Science 2007, Bangalore, India), (b) serving on the Steering Committee of 6 international conferences and (c) Chairing the IEEE Computer Society's Technical Committee on Scalable Computing (TCSC) and propelling it into one of the most successful TCs within the IEEE Computer Society.

The Lab has secured two new grants for future activities from ARC: Discovery Project on InterGrid and Linkage Project with Microsoft as an industry partner. In addition, a member has own Australian PostDoctoral Fellowship for his continued research in GRIDS lab.

The Lab is always looking for talented, motivated, and dedicated “young” students and researchers to join its team. Please feel free to contact me with your ideas!

Associate Professor Rajkumar Buyya, PhD
Director, Grid Computing and Distributed Systems (GRIDS) Laboratory
Department of Computer Science and Software Engineering
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2. The Team

Director:

- Dr.Rajkumar Buyya, Associate Professor and Reader

Research Staff:

- Dr. Srikumar Venugopal
- Dr. Kyong Hoon Kim
- Dr. Chao Jin
- Dr. James Broberg
- Mr. Krishna Nadiminti
- Mr. Hussein Gibbins
- Mr. Xingchen Chu

PhD Students

- Ms. Jia Yu
- Mr. Anthony Sulistio
- Mr. Chee Shin Yeo
- Mr. Rajiv Ranjan
- Mr. Marcos Assunção
- Mr. Marco Netto
- Mr. Mukaddim Pathan
- Mr. Mustafizur Rahman
- Mr. Saurabh Garg

Masters by Research Students

- Khaled Talukder
- Suraj Pandey

Collaborators

- Colleagues holding research grants with the Director
 - International Visitors
 - Many collaborators involved in extending and using the Gridbus software
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3. Competitive Grants Funded Projects and Programs

Australian Research Council (ARC)

- R. Buyya, QoS-based Scheduling of e-Research Application Workflows on Global Grids, Discovery Project, Australian Research Council, Australia, 2007-2009. Amount: \$319,000.
- R. Buyya, A Novel Software System for .NET-based Enterprise Grid Computing, Linkage Project, Australian Research Council (ARC) and Microsoft Corporation, Australia, 2007-2010. Amount: \$395,000 (ARC: \$265,000 and Microsoft: \$130,000).
- R. Buyya and J. Abawajy, InterGrid: Peering Architecture and Policies for Internetworking Disparate Grids, Discovery Project, Australian Research Council (ARC), Australia, 2008-2010. Amount: \$216,000.
- J. Broberg and Z. Tari, Coordinated and Cooperative Load Sharing between Content Delivery Networks, Discovery Project, Australian Research Council (ARC), Australia, 2008-2010. Amount: \$315,000
- C. Kepert (1), D. Abramson (2) et. al., R. Buyya (9) et. al., P. Turner (43), et. al., and A. Zomaya (50), "Molecular and Materials Structure Network", ARC Research Network Program, Australian Research Council, Australia, 2004 to 2008/09. Amount: \$1,500,000.
- M. Palaniswami (1) et. al., R. Buyya (6) et. al., R. Evans (14) et. al., R. Kotagiri (21), et. al., and Y. Attikiouzel (50), "ARC Research Network on Intelligent Sensors, Sensor Networks and Information Processing", ARC Research Network Program, Australian Research Council ([ARC](#)), Australia, 2004/05 to 2008/09. Amount: \$2,250,000.

Commonwealth of Australia - CRC (Cooperative Research Centre) Grant

- R. Buyya was part of a team (as one of the contributed staff members from the Universities sector/The University of Melbourne) that successfully bid for eWater CRC led by Prof. Gary Jones. CRC received \$ 40.25million funding from Australian Government administered through the Department of Education, Science and Training, 2005-2012.
- R. Buyya (project manager) and team, *The Utility Grid Project: Autonomic and Utility-oriented Global Grids for Powering Emerging E-Research Applications*, International Science Linkages, Department of Education, Science & Training, Australia, 2006-2009. Amount: \$592,875.

Industry and Melbourne University

- S. O'Leary, R Dowell, B. Pyman, P. Harris, G. Kennedy, L. Wise, A. Goodwin, N. Eizenberg, C. Briggs, E. Reynolds, A. Smith, M. Galea, R. Buyya, E. Kazmierczak, and L. Irving, "Haptic and 3D Visual Immersive Environments", SRIF (Strategic Research Infrastructure Fund). The University of Melbourne, 2006-2008. Amount: \$500,000.
- J. Ellershaw, M. Duckham, A. Kealy, S. Winter, R. Tucker, J. Papandriopoulos, A. Overmars, R. Kotagiri, R. Buyya, Lars Kulik, E. Tanin, P. Mendis, H. Malano, D. Smith, "Sensor Network Student Laboratory and Research Facility", A. E. Rowden White Foundation Grant, 2007-2008. Amount: \$100,000
- S. Venugopal and J. Broberg, Adaptive Provisioning and Allocation for Shared Computing Resources using Virtual Machines, University of Melbourne Early Career Researcher Grants Scheme, 2008. Amount: \$30,000.

European Union Projects Grant:

- R. Buyya was part of a team and the University of Melbourne as an international partner in an European Union funded project led by Prof. Denis Caromel (INRIA, France), "Grids Programming with Components (GridComp), 2006-2009. Amount: € 1,928,278.00.

4. Publications

- The Lab publication record since its inception in 2002 highlighted in the Table below:

Publication Type \ Year	2002	2003	2004	2005	2006	2007
Books/Proceedings Edited	1	1	1	1	5	4
Journal Papers	6	1	4	5	6	4
Book Chapters	1	0	0	4	4	2
Conference Papers	4	7	9	16	15	24
Magazine/Other Articles	0	0	1	2	4	2
<i>Total</i>	12	9	15	28	34	36

Book Chapters

- Xingchen Chu and Rajkumar Buyya, [Service Oriented Sensor Web](#), Sensor Network and Configuration: Fundamentals, Standards, Platforms, and Applications, N. P. Mahalik (ed), pp.51-74, Springer-Verlag, [ISBN: 978-3-540-37364-3](#), Berlin, Germany, Jan. 2007.
- Chee Shin Yeo, Rajkumar Buyya, Marcos Dias de Assunção, Jia Yu, Anthony Sulistio, Srikumar Venugopal, and Martin Placek, [Utility Computing on Global Grids](#), Chapter 143, Hossein Bidgoli (ed.), [The Handbook of Computer Networks](#), ISBN: 978-0-471-78461-6, John Wiley & Sons, New York, USA, 2007.

Proceedings Edited

- Bruno Schulze, Rajkumar Buyya, Philippe Navaux, Walfredo Cirne, and Vinod Rebello, Proceedings of the 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007, Rio de Janeiro, Brazil), ISBN 0-7695-2833-3, IEEE Computer Society Press, Los Alamitos, California, USA.
- Thomas Fahringer, Rajkumar Buyya, Warren Smith, and Valerie Taylor, Proceedings of the 8th IEEE/ACM International Conference on Grid Computing(Grid 2007, Austin, USA), ISBN 1-4244-1560-8, IEEE Press, New York, USA.
- Yanbo Han, Gustavo Alonso, Rajkumar Buyya, and Chengzhong Xu, Proceedings of the 6th International Conference on Cooperative and Grid Computing (GCC 2007, Urumchi, China), ISBN 0-7695-2871-6, IEEE Computer Society Press, Los Alamitos, California, USA.
- Geoffrey Fox, Kenneth Chiu, and Rajkumar Buyya, Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, Bangalore, India), ISBN 0-7695-3064-8, IEEE CS Press, Los Alamitos, CA, USA.

Journal Papers

- Anthony Sulistio, Gokul Poduval, Rajkumar Buyya, and Chen-Khong Tham, [On Incorporating Differentiated Levels of Network Service into GridSim](#), Future Generation Computer Systems (FGCS), ISSN: 0167-739X, Volume 23, Issue 4, Pages: 606-615, Elsevier Science, Amsterdam, The Netherlands, May 2007.
- Bader Aljaber, Thomas Jacobs, Krishna Nadiminti, and Rajkumar Buyya, [Multimedia on Global Grids: A Case Study in Distributed Ray Tracing](#), Malaysian Journal of Computer Science, ISSN 0127-9084, Volume 20, Issue 1, University of Malaya Press, Kuala Lumpur, Malaysia, June 2007.

9. Chee Shin Yeo and Rajkumar Buyya, [Pricing for Utility-driven Resource Management and Allocation in Clusters](#), International Journal of High Performance Computing Applications, Volume 21, Issue 4, Pages: 405-418, ISSN: 1094-3420, SAGE Publications, Thousand Oaks, CA, USA, Nov. 2007.
10. Rafael Moreno-Vozmediano, Krishna Nadiminti, Srikumar Venugopal, Ana B Alonso-Conde, Hussein Gibbins, and Rajkumar Buyya, [Distributed Portfolio and Investment Risk Analysis on Global Grids](#), Special Issue on Network-Based Computing, Journal of Computer and System Sciences, Volume 73, Number 8, Pages: 1164-1175, ISSN 0022-0000, Elsevier Science, Amsterdam, The Netherlands, Dec. 2007.

Magazine Papers

11. Rajkumar Buyya and Kotagiri Ramamohanarao, [An Innovative Master's Program in Distributed Computing](#), IEEE Distributed Systems Online, Vol. 8, No. 1, IEEE CS Press, Los Alamitos, CA, USA, Jan. 2007.
12. Rajkumar Buyya and Srikumar Venugopal, [Cluster and Grid Computing: A Graduate Distributed-Computing Course](#), IEEE Distributed Systems Online, Vol. 8, No. 12, IEEE CS Press, Los Alamitos, CA, USA, Dec. 2007.

Conference Papers

13. Sherman Cheung, Xingchen Chu, Shengjin Xu, Rajkumar Buyya and Jiyuan Tu, [A Grid Based e-Research Platform for Clinical Management in the Human Respiratory and Vascular System](#), Proceedings of the 5th Australasian Symposium on Grid Computing and e-Research (AusGrid 2007, ACS Press, ISBN 1-920-68249-X), Jan 30 - Feb 2, 2007, Ballarat, Australia.
14. Chee Shin Yeo and Rajkumar Buyya, [Integrated Risk Analysis for a Commercial Computing Service](#), Proceedings of the 21st IEEE International Parallel and Distributed Processing Symposium (IPDPS 2007, IEEE CS Press, Los Alamitos, CA, USA), March 26-30, 2007, Long Beach, California, USA.
15. Al-Mukaddim Khan Pathan and Rajkumar Buyya, [Economy-based Content Replication for Peering Content Delivery Networks](#), TCSC Doctoral Symposium, Proceedings of the 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007, IEEE CS Press, Los Alamitos, CA, USA), May 14-17, 2007, Rio de Janeiro, Brazil.
16. Kyong Hoon Kim, Rajkumar Buyya and Jong Kim, [Power Aware Scheduling of Bag-of-Tasks Applications with Deadline Constraints on DVS-enabled Clusters](#), Proceedings of the 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007, IEEE CS Press, Los Alamitos, CA, USA), May 14-17, 2007, Rio de Janeiro, Brazil.
17. Marco Netto and Rajkumar Buyya, [Impact of Adaptive Resource Allocation Requests in Utility Cluster Computing Environments](#), Proceedings of the 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007, IEEE CS Press, Los Alamitos, CA, USA), May 14-17, 2007, Rio de Janeiro, Brazil.
18. Chao Jin, Rajkumar Buyya, Lex Stein, and Zheng Zhang, [A Dataflow Model for .NET-based Grid Computing Systems](#), Proceedings of the 3rd International Workshop on Grid Computing and Applications (GCA 2007, ISBN 978-981-270-773-4, World Scientific Press, Singapore), pp.25-37, June 6-7, 2007, Singapore.
19. Al-Mukaddim Khan Pathan, James Broberg, Kris Bubendorfer, Kyong Hoon Kim, and Rajkumar Buyya, [An Architecture for Virtual Organization \(VO\)-Based Effective Peering of Content Delivery Networks](#), Proceedings of the HPDC 2007 (16th IEEE International Symposium on High-Performance Distributed Computing) Workshop on the Use of P2P, Grid and Agents for the Development of Content Networks (ACM Press, NY, USA), June 26, 2007, Monterey Bay, California, USA.
20. Marcos Dias de Assunção, Werner Streitberger, Torsten Eymann, and Rajkumar Buyya, [Enabling the Simulation of Service-Oriented Computing and Provisioning Policies for](#)

- [Autonomic Utility Grids](#), Proceedings of the 4th International Workshop on Grid Economics and Business Models (GECON 2007, LNCS Volume 4685, Springer-Verlag, Berlin, Germany), Aug. 28, 2007, Rennes, France.
21. Christian Vecchiola, Krishna Nadiminti, and Rajkumar Buyya, [Image Filtering on .NET-based Desktop Grids](#), Proceedings of the 6th International Conference on Grid and Cooperative Computing (GCC 2007, IEEE CS Press, Los Alamitos, CA, USA), August 16-18, 2007, Urumchi, Xinjiang, China.
 22. Jia Yu, Michael Kirley, and Rajkumar Buyya, [Multi-objective Planning for Workflow Execution on Grids](#), Proceedings of the 8th IEEE/ACM International Conference on Grid Computing (Grid 2007, IEEE Press, IEEE Press, New York, USA), Sept. 19-21, 2007, Austin, Texas, USA.
 23. Kyong Hoon Kim and Rajkumar Buyya, [Fair Resource Sharing in Hierarchical Virtual Organizations for Global Grids](#), Proceedings of the 8th IEEE/ACM International Conference on Grid Computing (Grid 2007, IEEE Press, New York, USA), Sept. 19-21, 2007, Austin, Texas, USA.
 24. Marco A. S. Netto, Kris Bubendorfer, and Rajkumar Buyya, [SLA-based Advance Reservations with Flexible and Adaptive Time QoS Parameters](#), Proceedings of the 5th International Conference on Service-Oriented Computing (ICSOC 2007, LNCS Volume 4749, Springer-Verlag Press, Berlin, Germany), Sept. 17-20, 2007, Vienna, Austria.
 25. Khaled Talukder, Michael Kirley and Rajkumar Buyya, [Multiobjective Differential Evolution for Workflow Execution on Grids](#), Proceedings of the 5th International Workshop on Middleware for Grid Computing (MGC 2007, ACM Press, New York, USA), Nov. 27, 2007, Newport Beach, California, USA.
 26. James Broberg and Rajkumar Buyya, [A Multi-Commodity Flow Approach to Maximising Utility in Market-Based Distributed Systems](#), Proceedings of the 5th International Workshop on Middleware for Grid Computing (MGC 2007, ACM Press, New York, USA), Nov. 27, 2007, Newport Beach, California, USA.
 27. Agustin Caminero, Anthony Sulistio, Blanca Caminero, Carmen Carrion, and Rajkumar Buyya, [Extending GridSim with an Architecture for Failure Detection](#), Proceedings of the 13th International Conference on Parallel and Distributed Systems (ICPADS 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 5-7, 2007, Hsinchu, Taiwan.
 28. Anthony Sulistio, Kyong Hoon Kim, and Rajkumar Buyya, [On Incorporating an On-line Strip Packing Algorithm into Elastic Grid Reservation-based Systems](#), Proceedings of the 13th International Conference on Parallel and Distributed Systems (ICPADS 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 5-7, 2007, Hsinchu, Taiwan.
 29. Tom Kobialka, Rajkumar Buyya, Christopher Leckie, and Rao Kotagiri, [A SensorWeb Middleware with Stateful Services for Heterogeneous Sensor Networks](#), Proceedings of the 3rd International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP 2007, IEEE Press, Piscataway, New Jersey, USA), Dec. 3-6, 2007, Melbourne, Australia.
 30. Hui Li and Rajkumar Buyya, [Model-Driven Simulation of Grid Scheduling Strategies](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.
 31. Christoph Reich, Kris Bubendorfer, Matthias Banholzer, and Rajkumar Buyya, [A SLA-Oriented Management of Containers for Hosting Stateful Web Services](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.
 32. Mustafizur Rahman, Srikumar Venugopal, and Rajkumar Buyya, [A Dynamic Critical Path Algorithm for Scheduling Scientific Workflow Applications on Global Grids](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.
 33. Anthony Sulistio, Kyong Hoon Kim, and Rajkumar Buyya, [Using Revenue Management to Determine Pricing of Reservations](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.

34. Rajiv Ranjan, Lipo Chan, Aaron Harwood, Shanika Karunasekera, and Rajkumar Buyya, [Decentralised Resource Discovery Service for Large Scale Federated Grids](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.
35. Xingchen Chu, Krishna Nadiminti, Chao Jin, Srikumar Venugopal, and Rajkumar Buyya, [Aneka: Next-Generation Enterprise Grid Platform for e-Science and e-Business Applications](#), Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.
36. Christoph Reich, Matthias Banholzer, Rajkumar Buyya, and Kris Bubendorfer, [Engineering an Autonomic Container for WSRF-based Web Services](#), Proceedings of the 15th International Conference on Advanced Computing and Communication (ADCOM 2007, IEEE CS Press, Los Alamitos, CA, USA), Dec. 18-21, 2007, Guwahati, India.

5. Invited Presentations and Outreach

Keynote Talks at International Conferences

1. Market-Oriented Grid Computing and the Gridbus Middleware, International Research Workshop on Scheduling, June 25-29, 2007, Cetraro, Italy.
2. Panel - Current Status and Future Developments of Scheduling, Theory, Methods and of Applications to Grids, International Research Workshop on Scheduling, June 25-29, 2007, Cetraro, Italy.
3. Utility-Oriented Grid Computing, Thai Grid Computing Conference, August 23-24, 2007, Bangkok, Thailand.

Seminars

1. QoS-based Scheduling of e-Research Application Workflows on Global Grids, Deakin University, Geelong, Australia, May 4, 2007.
2. Utility Oriented Grid Computing and the Gridbus Middleware, Barcelona Supercomputing Center/Universitat Politècnica de Catalunya, Barcelona, Spain, June 22, 2007.
3. Introduction to Grid Computing: Trends, Challenges, Technologies, Applications, University of Calabria, Italy, June 25, 2007.
4. The Gridbus Middleware: Creating and Managing Utility Grids for Powering e-Science and e-Business Applications, University of Calabria, Italy, June 26, 2007.
5. Economy-based Grid Computing and the Gridbus Middleware, Texas A&M University, College Station, Texas, USA, Sept. 17, 2007.
6. Market-based Grid Computing and the Gridbus Middleware, Rutgers: The State University of New Jersey, Piscataway, New Jersey, USA, Sept. 24, 2007.
7. Market-Oriented Grid Computing and the Gridbus Middleware, The University of California, Irvine, California, USA, Sept. 28, 2007.
8. Internet Software Engineering: Complexity and Object Oriented Solutions, Karnataka College, Bidar, India, Dec. 27, 2007.
9. Grid Computing: Recent Advances, Centre for Development of Advanced Computing, Jawaharlal Nehru Technological University, Hyderabad, India, Dec. 28, 2007.

Conference Tutorials

1. Market-based Grid Computing and the Gridbus Toolkit, 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007), May 14-17, 2007, Rio de Janeiro, Brazil.
2. Market-based Grid Computing and the Gridbus Toolkit, The 8th IEEE/ACM International Conference on Grid Computing (Grid 2007), Sept. 19-21, 2007, Austin, Texas, USA.
3. Grid Computing and the Gridbus Middleware, 3rd IEEE International Conference on e-Science and Grid Computing, Dec. 10-13, 2007, Bangalore, India.
4. Utility-Oriented Grid Computing and the Gridbus Middleware, 15th International Conference on Advanced Computing & Communication (ADCOM 2007), Dec. 18-21, 2007, Guwahati, India.

6. Community Services (of Dr. Buyya)

IEEE Computer Society

1. Chair, IEEE Technical Committee on Scalable Computing

Journal Editorials

1. Associate Editor, *Future Generation Computer Systems (FGCS)* -- The International Journal of Grid Computing: Theory, Methods and Applications, ISSN: 0167-739X, Elsevier Press, Amsterdam, The Netherlands.
2. Editorial Board Member, *International Journal of Parallel, Emergent and Distributed Systems (IJPEDS)*, ISSN: 1744-5760, Taylor & Francis Group, UK.
3. Editorial Board Member, *International Journal of Web Services Research*, ISSN: 1545-7362, Idea Group Publications, USA, 2003 onwards.
4. Editorial Board Member, *International Journal of Grid and Utility Computing*, ISSN: 1741-847X, Inderscience Publishers, Geneva, Switzerland, 2004 onwards.
5. Editorial Board Member, *Multiagent and Grid Systems: An International Journal*, ISSN: 1574-1702, IOS Press, Amsterdam, The Netherlands, 2005 onwards.

Conference Steering Committee

1. Chair, IEEE/ACM International Symposium on Cluster Computing and the Grid: CCGrid 2007, Brazil
2. Chair, International Conference on e-Science and Grid Computing: e-Science 2007, India.
3. Member, IEEE/ACM Supercomputing Conference: SC 2007, USA
4. Member, IEEE International Conference on Cluster Computing: Cluster 2007, USA
5. Member, International Symposium on Computer Architecture and High Performance Computing: SBAC-PAD 2007, Brazil
6. Member, IEEE/ACM International Conference on Grid Computing: Grid 2007, USA

Conference Chair

1. Co-Chair, 3rd International Conference on e-Science and Grid Computing (e-Science 2007), Dec. 10-13, 2007, Bangalore, India.
2. Co-Chair, 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007), May 14-17, 2007, Rio de Janeiro, Brazil.

Misc. Services Chair

1. Publications Chair, 8th IEEE International Conference on Grid Computing (Grid 2007), September 19-21, 2007, Austin, USA.

Technical Program Committee Memberships

1. 14th IEEE International Conference on High Performance Computing (HiPC 2007), Dec. 2007, Goa, India.
2. 8th International Conference on Web Information Systems Engineering (WISE 2007), Dec. 3-7, 2007, Nancy, France.
3. 50th Annual IEEE Global Communications Conference (GLOBECOM 2007), Nov. 26-30, 2007, Washington, DC, USA.
4. IEEE/WIC/ACM International Conference on Web Intelligence (WI'07), November 2-5, 2007, Silicon Valley, USA.

5. 19th International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD 2007), October 24-27, 2007, October 24-27, 2007.
6. 8th IEEE International Conference on Grid Computing (Grid 2007), September 19-21, 2007, Austin, Texas, USA
7. 4th IEEE International Conference on Services Computing (SCC 2007), July 9-13, 2007, Salt Lake City, Utah, USA.
8. 7th International Conference on Algorithms and Architectures for Parallel Processing (ICA3PP-07), June. 11-14, 2007, Hangzhou, China.
9. 21st IEEE International Conference on Advanced Information Networking and Applications (AINA 2007), May 21-23, 2007, Niagara Falls, Canada.
10. 7th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2007), May 14-17, 2007, Rio de Janeiro, Brazil.
11. 5th Australasian Symposium on Grid Computing and e-Research (AusGrid 2007), Feb. 1, 2007, Ballarat, Australia.

Community Information Sources

- Maintained a Grid Computing Information Centre at: <http://www.gridcomputing.com>, whose newsletter mailing list has over 2210 members. This website is often ranked as #1 source for grid computing by Google search engine.
- Maintained a Cluster Computing Information Centre at: <http://www.buyya.com/cluster>
- Contributing Editor for GridToday – <http://www.gridtoday.com>

7. International Visiting Researchers

- Prof. Dr. Christoph Reich, Hochschule Furtwangen University, Germany, Oct 2006-March 2007.
 - Christian Vecchiola, PhD Student, Università degli Studi di Genova, Italy, Oct 2006-Jan.2007.
 - Dr Kris Bubendorfer, Victoria University of Wellington, New Zealand, November 2006-June 2007.
 - Hui Li, University of Leiden, The Netherlands, March-June 2007.
 - Prof. T. S. Selvi, Anna University, Chennai, India, (July/Aug, 2007), Funded by GRIDS Lab/ISSNIP Group, May/June 2006.
 - Dr. Akiko Nakaniwa, Osaka Sangyo University, Osaka, Japan, Aug(19)-Sept.(15), 2007.
 - Dr. Pramod Kumar Konugurthi, Indian Space Research Organisation, Hyderabad, India, Aug 2007-Jan 2008. On DEST Fellowship.
 - Xiao Feng Wang, National University of Defense Technology (NUDT), Changsha, China, Nov 2007-Nov-2008. (China Scholarship Council's Fellowship)
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8. Selected Projects/Programs

Gridbus: Middleware for Utility-based Grid Computing

Web: <http://www.gridbus.org/>

An Inaugural Knowledge Transfer Award Winning Project at the University of Melbourne

The flagship project of the Grid Computing and Distributed Systems (GRIDS) Laboratory is the Gridbus Project which covers various research sub-projects that look into the management of distributed resources and scheduling of applications on global Grids. The Gridbus Project is unique in that it explores the practical application of well-known economic theories to solve resource management problems in Grids. In addition to fundamental R&D, the Gridbus Project has also partnered with various scientific, engineering, and business communities in applying Grid technologies to solve various challenging problems in e-Science and e-Business domains. The Gridbus Project has advanced the discipline of Grid computing in the following ways:

- Carried out fundamental research in distributed resource management and application scheduling on global Grids.
- Pioneered the principles of Grid economy as well as techniques and mechanisms that enable the delivery of Grid services as utility-like services.
- Proposed several adaptive scheduling algorithms for deploying applications on global Grids based on users' quality of service (QoS) requirements.
- Co-developed fundamental Grid technologies that enable the creation of scalable Grid environments as well as support the rapid development of Grid-enabled applications.
- Applied Grid technologies to several applications in collaboration with domain scientists, and deployed them both on national and international Grid infrastructure.

The research probes include:

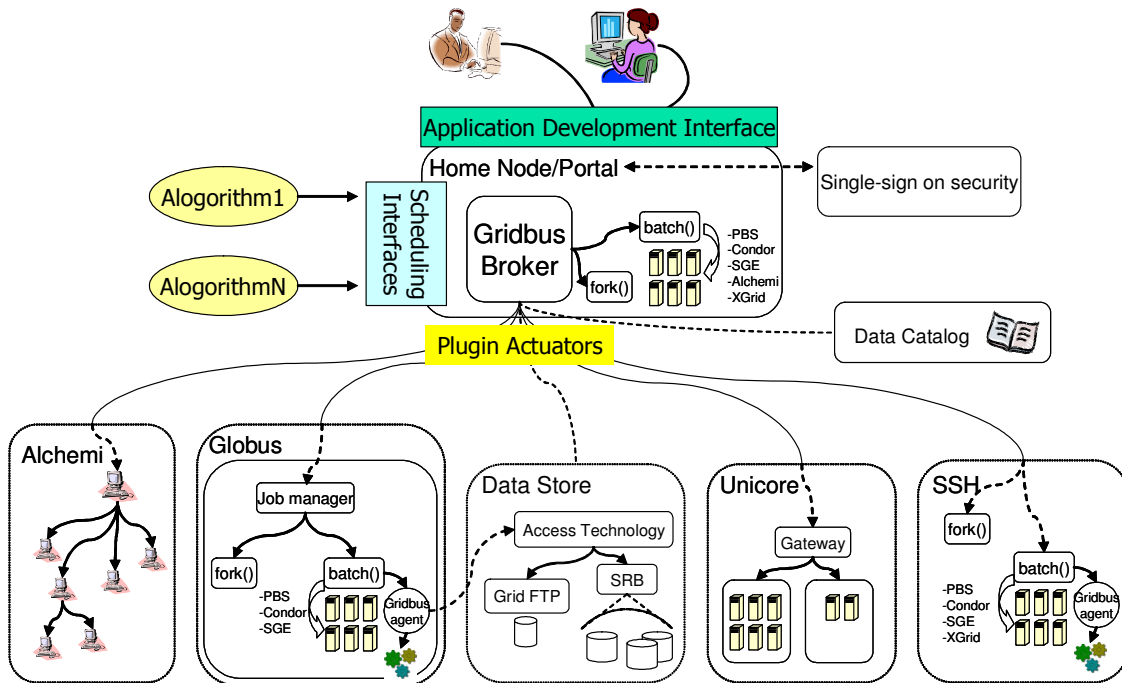
- Service-Oriented Grid Architecture
- Grid Economy and Resource Management.
- Grid Service Broker
- .NET based Enterprise Grid Framework (Aneka)
- Grid Workflows and Scheduling
- Service Level Agreements (SLA)-based Resource Allocation Systems (Libra).
- Grid Simulation Toolkit (GridSim).
- Resource Usage Accounting (GridBank).
- Grid Application Development Environment
- Open SensorWeb Architecture.
- InterGrid for peering and internetworking between islands of Grids
- Application Targets: Drug Discovery (*WEHI*), Neuroscience (HFI & *Osaka Uni*), Kidney Modelling, Natural Language Processing, High-Energy Physics, Catchment Hydrology (eWater CRC), and Financial Investment Risk & Portfolio Analysis (*Spain*).

The software developed as part of the Gridbus Project has been released as open source which enables practitioners around the world to benefit from the products of the Grid research carried out at the University of Melbourne. The Grid software technologies developed by the Gridbus Project such as Gridbus Broker, GridSim, and Alchemi have helped a broad range of people, from research students and established academics to industrial practitioners in institutions and enterprises around the world. Other activities such as training of students on real Grid projects, and tutorials and seminars in conferences around the world have produced benefits both in Australia and around the world. Therefore, by developing, sharing and teaching fundamental Grid technologies, the project has been able to make immense impact on scientific, engineering, and business communities around the world. Recently, the project received a large International Science Linkage (ISL) grant from the Commonwealth DEST to establish strategic research linkages with international projects based in Europe, USA, and Asia.

Gridbus Broker: A Scheduler for Automatic Deployment of Applications on Global Grids

Web: <http://www.gridbus.org/broker>

The Gridbus broker is an advanced service-oriented meta-scheduler for compute and data Grids, with support for a wide range of Grid middleware and services. It takes care of many functions that Grid applications require including discovering the right resources for a particular user application, scheduling jobs in order to meet deadlines and handling faults that may occur during execution. In particular, the broker provides capabilities such as resource selection, job scheduling, job management and data access to any application that requires distributed Grid resources for execution. The broker handles communication with the resources running different Grid middleware, job failures, varying resource availability, and different user objectives such as meeting a deadline for execution or limiting execution within a certain budget. Hence, it makes Grids more appealing and approachable to user communities who want to access the increased computing power but are not familiar with using distributed systems.



The Grid Resource Broker has been used in a variety of scenarios and application domains by different scientific and business organizations. These include executing data mining programs on grid resources (European Union Data Mining Grid led by DaimlerChrysler and University of Ljubljana); integrating different kidney models and visualizing them (Melbourne Medical School and Université d'Evry, France); business applications (Infosys and HCL) and exploring semantics-based composition and trust in Grids (Anna University as part of the Indian National Grid), to name a few. The broker is hosted as an open-source project on Sourceforge.net, a website where any interested developer can join a project they are interested in, download the source code and contribute to it. This ensures that the latest source code from the Project is directly available to the public and partners/users are able to contribute towards further enhancement of our technologies.

QoS-Oriented Grid Workflow Engine

Web: <http://www.gridbus.org/workflow>

The emerging e-Research paradigm enables researchers from different disciplines and organisations to engage in collaborative scientific investigation. They need to share geographically distributed resources owned by different organisations. e-Research applications need to negotiate with resource providers for guarantees on access time, duration and level of quality of service (QoS). To meet QoS requirements of e-Research application workflows, this project aims to develop Grid technologies that support (a) QoS-based scheduling of e-Research application workflows on distributed resources, (b) mechanisms for formulating, negotiating and establishing service level agreements (SLA) with resource providers and (c) SLA-based allocation and management of resources. Specifically, the project aims to:

- Define an architectural framework and principles for the development of QoS-based workflow management and SLA-based resource allocation systems,
- Develop QoS-based algorithms for scheduling e-Research workflow applications,
- Develop SLA-based negotiation protocols and resource allocation algorithms,
- Implement a prototype system by incorporating the algorithms and policies developed above, and
- Develop real world demonstrators in various scientific domains such as life sciences.

Key Reference: [1] Jia Yu and Rajkumar Buyya, Scheduling Scientific Workflow Applications with Deadline and Budget Constraints using Genetic Algorithms, *Scientific Programming Journal*, Volume 14, Issue 3-4, ISSN: 1058-9244, IOS Press, Amsterdam, The Netherlands, Nov. 2006.

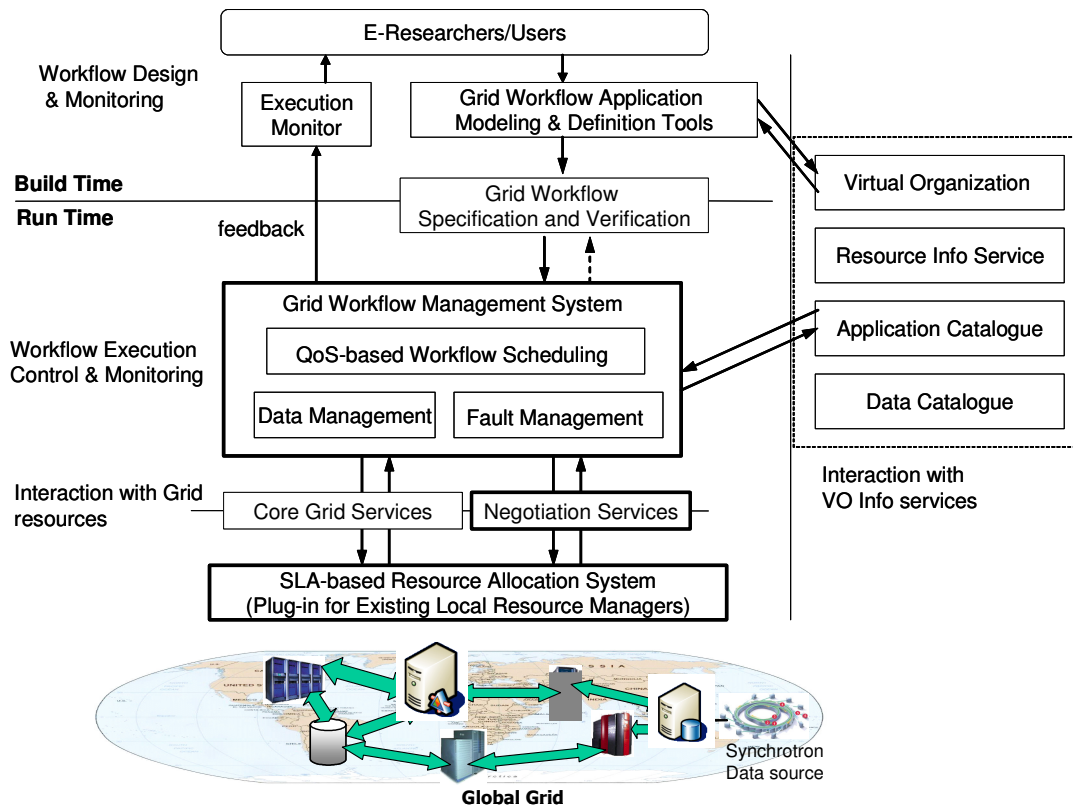


Fig. 1: Architecture of QoS-based workflow management and resource allocation system.

Service-Level-Agreements (SLA) based Management of Clusters and Data Centres

Web: <http://www.gridbus.org/libra/>

Clustering involves connecting two or more computers together to take advantage of combined computational power and resources. Hence, a cluster works as an integrated collection of resources that can provide a single system image to users. Clustering is a popular strategy for resource-intensive applications because it transparently spreads the processing of different jobs throughout the cluster. It is used for applications such as weather forecasting, oil explorations, drug discovery, investment risk analysis, and e-commerce data centres.

Computational economy refers to the inclusion of user-specified QoS (Quality-of-Service) parameters with jobs so that resource management is based on a user-centric approach rather than on a system-centric approach. This essentially means that user QoS expectations such as deadline and budget play an important role in determining the priority of a job by the scheduler, than system policies like ordering jobs according to the basis of submission time. Current systems have no or limited support for resource management mechanisms to enable negotiation of differing QoS levels for different users and resource allocation to meet their competing demands. The main purpose of our project is to:

- Develop a framework for negotiating and establishing contract (SLA) between service providers and users
- Develop a resource management system and optimal scheduling algorithms that support SLA-based allocation of resources to meet user QoS requirements

Key References: [1] Jahanzeb Sherwani, Nosheen Ali, Nausheen Lotia, Zahra Hayat, and Rajkumar Buyya, Libra: A Computational Economy-based Job Scheduling System for Clusters, *Software: Practice and Experience*, Volume 34, Issue 6, Pages 573-590, May 2004.

[2] Chee Shin Yeo and Rajkumar Buyya, Service Level Agreement based Allocation of Cluster Resources: Handling Penalty to Enhance Utility, *Proceedings of the 7th IEEE International Conference on Cluster Computing (Cluster 2005)*, September 2005, Boston, MA.

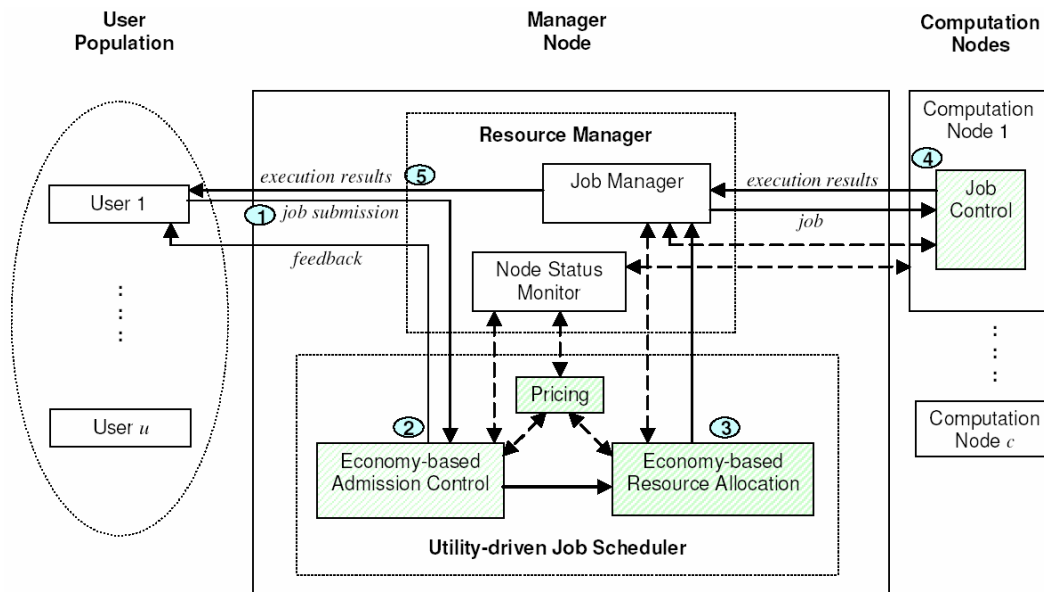


Fig. 1: SLA oriented allocation of Cluster and Data Centre resources.

Resource Co-Allocation in Multi-site Computing Environments

Web: <http://www.csse.unimelb.edu.au/~netto/research.html>

A number of distributed applications require simultaneous access to resources located in multiple administrative domains. In order to co-allocate resources in these environments, users need to reserve them in advance to meet their expected Quality of Service and enhance utility of their applications. Resource providers must frequently update their scheduling queues to reduce turnaround time of user requests and increase resource utilisation. However, as all sub-requests of a co-allocation request must start at the same time, any modification in a single site may affect the requests of other sites.

Due to the management complexity of resource co-allocation requests, their current usage is based on static advance reservations, which results in a low system utilisation. The aim of this project is to design and investigate management and scheduling policies for co-allocation requests with adaptive and flexible Quality of Service parameters.

An Application Driver: There are a number of applications, in both academic and commercial environments, that require resource co-allocation. Some examples are (i) applications that require computing power that is not available in a single site; (ii) applications that require different resource types that are not available in a single site; (iii) users who need to speed up the execution of their applications; and (iv) redundancy of resources to improve fault tolerance during an execution. In this project we use large scale parallel applications as a driver for the development of our resource management policies. As these applications require multiple supercomputers we have to deal with problems such as splitting the application according to resource availability, performing the rescheduling when there are updates in the scheduling queues and keeping synchronised the co-allocation requests in the different resource providers.

Key Reference: Marco A. S. Netto, Kris Bubendorfer and Rajkumar Buyya. *SLA-based advance reservations with flexible and adaptive time QoS parameters*. Proceedings of the International Conference on Service Oriented Computing (ICSOC), Vienna, Austria - September 17-20, 2007.

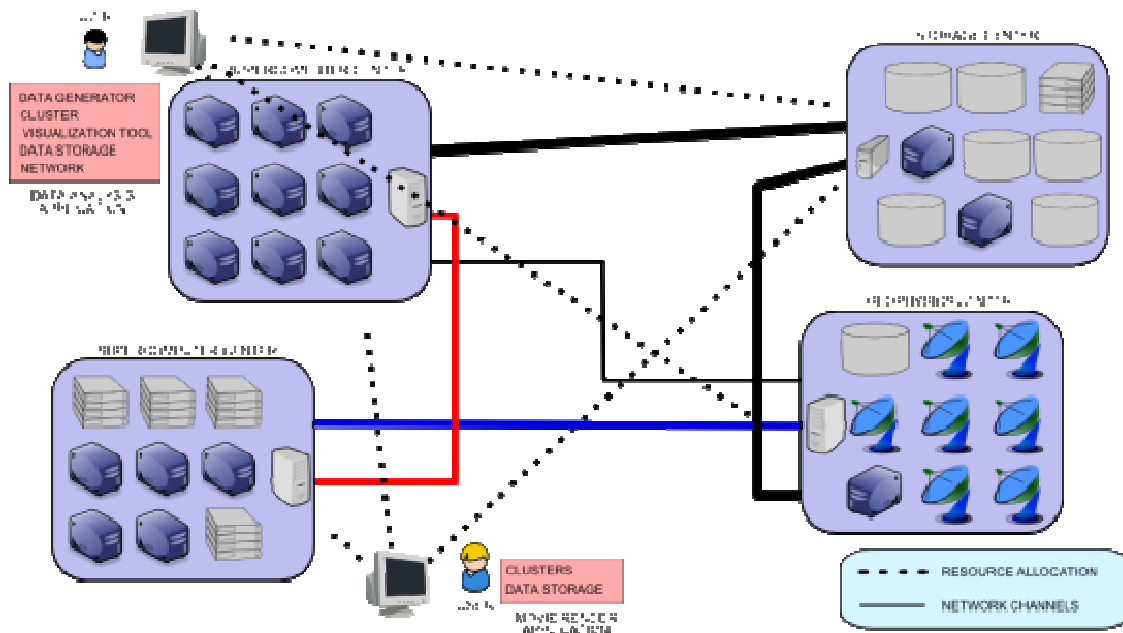


Fig. 1: Co-allocation of different types of resources from different organisations.

GridSim: A Toolkit for Modelling and Simulating Grid Computing Environments

Web: <http://www.gridbus.org/gridsim>

GridSim is a software platform that enables users to model and simulate the characteristics of Grid resources and networks with different configurations. GridSim is of great value to both students and experienced researchers who want to study Grids, or test new algorithms and strategies in a controlled environment. By using GridSim, they are able to perform repeatable experiments and studies that are not possible in a real dynamic Grid environment. Key features of GridSim are:

- Various allocation or scheduling policies can be made and integrated into GridSim easily, by extending them from one of the classes.
- Has the infrastructure or framework to support advance reservation, auction and Data Grid functionalities of a Grid system.
- Has the ability that reads workload traces taken from supercomputers for simulating a realistic Grid environment. This functionality is useful for testing a resource scheduling problem.
- Incorporates a background network traffic functionality based on a probabilistic distribution. This is useful for simulating over a public network where the network is congested.

Research students in the GRIDS Laboratory are themselves heavy users of GridSim and extend it whenever necessary for their own research needs. In the last 5 years, GridSim has been continuously extended in this manner to include many new capabilities and has also received contributions from external collaborators. In particular, National University of Singapore has contributed a QoS-based network module, and The University of Ljubljana has contributed a DataGrid module. Academic and industrial users of GridSim include: IBM, Unisys, HP, University of Southern California, France Telecom, Indian Institute of Technology, and Sweden's Umeå University. The table below lists some of the more prominent users of GridSim.

Table 1: Various users of GridSim and their targeted application domain for simulation.

Application Domain	Organisation
Scientific Workflows	The University of Southern California, USA
Business Grids	IBM Research Lab
Grid Resource and Virtual Organisation	Umeå University, Sweden
Network modelling	National University of Singapore
Grid Security Studies	France Telecom
Scheduling Studies	University of Malay
Grid economics	Technical University of Catalunya, Spain
Grid Market Studies	Indian Institute of Technology
Semantic Grid Studies	Monash University
Utility-based Resource Management	The University of Manchester, UK
DataGrid Simulation	The University of Ljubljana, Slovenia.
Data Centre Modelling	Unisys, USA
Multi-Criteria Grid Scheduling	Poznan Supercomputing Center, Poland
Hierarchical Scheduling	Universidad Complutense de Madrid, Spain
Grid Network Buffer	The University of Castilla La Mancha, Spain

InterGrid: Peering Architecture and Policies for Internetworking Disparate Grids

Web: <http://www.gridbus.org/intergrid>

Grid computing enables the creation of Cyberinfrastructure for e-Research applications. Several nations around the world including Australia have developed their own national Grids based on the notion of virtual organisations. These dispersed Grid initiatives have resulted in islands of Grids without any support for peering arrangements between them. This limitation will impede realisation of full potential of the Grid computing paradigm. This InterGrid project aims to revolutionise Grid computing by investigating and developing (a) architectural principles for interlinking Grids, (b) mechanisms for resource provisioning and allocation within and across Grids and (c) peering policies and algorithms for inter-Grid resource management.

An Application Driver: Scientists from U.S.A, France, New Zealand and Australia have developed mathematical models of kidney functions and have been sharing these models via Grids. It is easy to extrapolate this to sharing of different models related to other organs that are developed within Grids dedicated to them. In order to build a complete model of the human physiology (e.g. IUPS Physiome Project) one needs the capability that supports composition of models from different Grids. These models may be discovered through distributed information services enabled by peering of such Grids, which are controlled by the respective communities. Realising this scenario requires participants to allocate resources from different islands of Grids in a seamless manner, and permit peering among Grids, which are under different administrative policies and political boundaries – as indicated in Figure 1.

Key Reference: Marcos Dias de Assunção, Rajkumar Buyya and Srikumar Venugopal, [InterGrid: A Case for Internetworking Islands of Grids](#), Concurrency and Computation: Practice and Experience, Online ISSN: 1532-0634; Print ISSN: 1532-0626, Wiley Press, New York, USA, 2007.

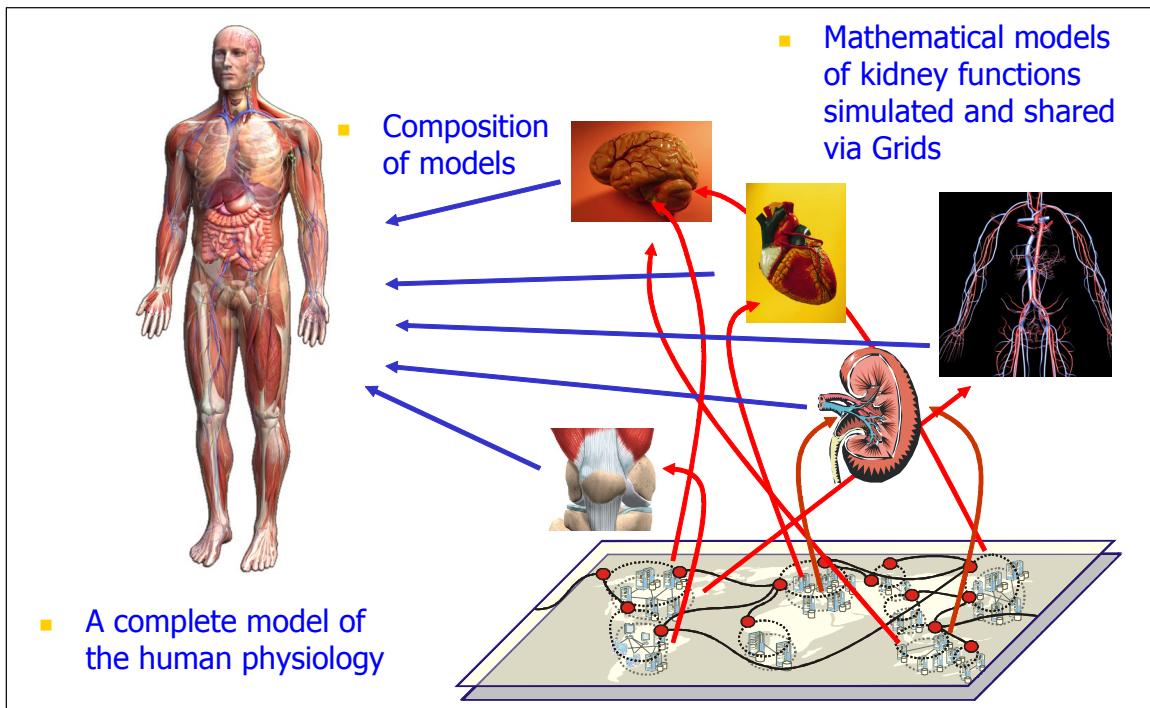


Fig. 1: InterGrid-based Integrated Human Physiome Environment.

iCDN: Internetworking of Content Delivery Networks

Web: <http://www.gridbus.org/cdn>

Content Delivery Networks (CDNs) replicate content over several mirrored Web servers, strategically placed at various locations to deal with flash crowds and to enhance response time. The requirements for providing high quality service through global coverage might be an obstacle for new providers, as well as affecting commercial viability of the existing ones. Although many CDN providers exist, they do not cooperate in delivering content to end users in a scalable manner. This project aims to provide a means for distinct CDNs to coordinate and cooperate with other CDNs, by investigating and developing (a) an architecture for an open and decentralized system to support effective internetworking between CDNs achieved through peering arrangement; (b) protocols for service delivery in a cooperative environment of CDNs; (c) economic models for an effective content replication policy; and (d) policies for autonomic management of service level through resource negotiation in an on-demand basis.

An Application Driver: An internetworking of CDNs is formed by a set of autonomous CDNs, which cooperate through a mechanism that provides facilities and infrastructure for cooperation in order to virtualize multiple providers. Architecture of a system to assist the creation of internetworking between CDNs is shown in Figure 1. Such a constellation permits flexible resource sharing and dynamic collaboration between autonomous CDNs in the form of Virtual Organizations (VOs). The 'resource sharing' approach in the internetworked CDNs model endeavours to balance a CDN's service requirements against the high costs of deploying customer-dedicated and therefore over-provisioned resources. Proper management and cooperation will enable a CDN to avoid violating SLAs even when the service demands could not have been predicted ahead of time.

Key Reference:

- [1] Buyya, R., Pathan, A. M. K., Broberg, J., and Tari, Z. A Case for Peering of Content Delivery Networks. *IEEE Distributed Systems Online*, 7(10), USA, Oct. 2006.

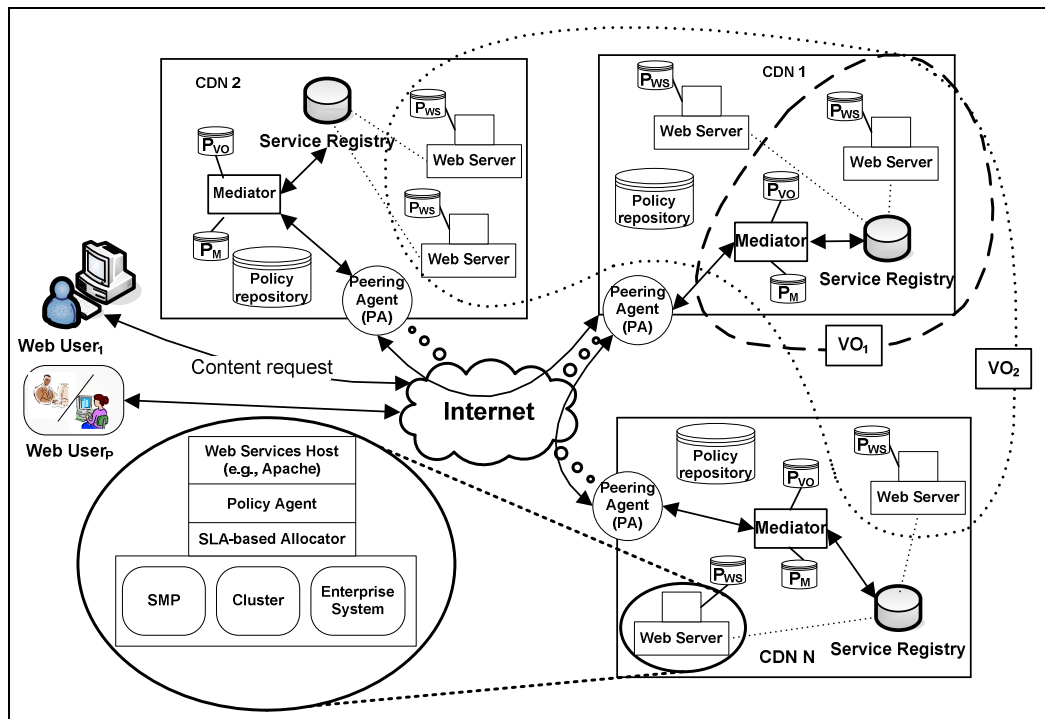


Fig. 1: Architecture of a system to assist the creation of internetworked CDNs

9. Software Releases

1. Grid Service Broker (v.3.1) Software

The Gridbus Project at the University of Melbourne (Australia) released a new version of the Grid Service Broker. The broker provides capabilities such as resource selection, job scheduling, job management and data access to any application that requires distributed grid resources for execution. The broker handles communication with the resources running different grid middleware, job failures, varying resource availability and different user objectives, such as meeting a deadline for execution or limiting execution within a certain budget.

With the current release, version 3.1, a new organizational structure is provided for the broker, wherein the core is separated from additional capabilities provided as plug-ins that can be selected according to usage requirements. A new Ant build file has been provided to enable selection of plug-ins and the automatic configuration of the broker thereof. Also available is a new external plug-in that uses the capabilities of the Gridbus broker to schedule grid workflows.

New features include:

- Plug-in structure for middleware and programming models.
- Ant build file for automatic downloading and configuration of broker installation.
- Workflow engine plug-in.
- Thread programming model plug-in (similar to Alchemi Grid Threads).

Gridbus in e-Science Enablements

The Gridbus Broker has been used in Grid enabling several e-Science and e-Business applications. The most recent usages include:

- European Union-funded Data Mining Grid Project, which developed set of grid-based data-mining tools and used Gridbus Broker in managing execution of data mining computations on global grids: www.datamininggrid.org/.
- KidneyGrid partners, including Melbourne Medical School and Université d'Evry (France), created a grid portal that integrated distributed kidney models.
- As part of the Australian National Grid (APACGrid), a portal for docking of molecules from CDB with protein target with the aim of discovery potential drug candidates: <http://grid.apac.edu.au/OurUsers/MolecularDocking>.

Base Technologies

The Gridbus Broker v3.1 supports/uses the following middleware: Globus 2.4.x, Globus 4.0.2, Alchemi 1.0.6, Condor 6.8.4, OpenPBS 2.3, SGE, NWS 2.8, SRB(Storage Resource Broker) 3.x
The Gridbus Broker v3.1 supports/uses the following programming model:

- Task/Job model.
- Gridbus Workflow.
- Grid Threading Programming Model.

The Gridbus Broker v3.1 can utilize a resource via SSH for submitting and executing grid jobs on: OpenPBS 2.3, Condor 6.8.4, SGE, Fork (on Unix-like OSes). The broker source code, binaries, documentation and manual can be downloaded from www.gridbus.org/broker/.

2. GridSim Toolkit 4.1

The Gridbus Project at The University of Melbourne, Australia has released the next-version of Grid simulation software, the GridSim Toolkit 4.1. The new version of GridSim adds a new functionality that supports resource failures and failure detection of Grid resources.

All components developed as part of the GridSim Toolkit are released as "open source" under the GPL license to encourage innovation and pass full freedom to our users. In addition, we have decided to use SourceForge (<http://sourceforge.net/projects/gridsim>) for hosting our future releases and developments. This allows us to share and and to collaborate further on new functionalities. Therefore, contributions to the GridSim Toolkit are greatly appreciated.

The early version of our GridSim toolkit has been used/downloaded by several academic and commercial organizations around the world including: University of Southern California (USA), California Institute of Technology (USA), Argonne National Labs (USA), University of Manchester (UK), CERN, Universidad de Santiago de Compostela (Spain), Indian Institute of Technology, Tsinghua University (China), Sun Microsystems, IBM Research, Unisys, HP, Northrop Grumman Information Technology, British Telecom and EMC Corp.

The GridSim software has been used for modeling and simulating many interesting systems and ideas. For example, IBM Research uses our DataGrid package to simulate a grid meta-scheduler that tightly integrates the compute and data transfer times of each job. Another example is Universidad de Santiago de Compostela's extension of GridSim to optimize execution of parallel applications on a Grid. Our own uses include simulating economic Grid scheduler in a competitive economy model, economic based cluster scheduler and cooperative Grid federation.

The contributors to the GridSim software (from early to new version) are:

- Rajkumar Buyya, GRIDS Lab @ The University of Melbourne.
- Manzur Murshed, GSCIT @ Monash University, Australia.
- Anthony Sulistio, GRIDS Lab @ The University of Melbourne.
- Gokul Poduval and Chen-Khong Tham, National University of Singapore.
- Marcos Dias de Assuncao, GRIDS Lab @ The University of Melbourne.
- Uros Cibej and Borut Robic, The University of Ljubljana, Slovenia.
- Agustin Caminero, Universidad de Castilla La Mancha (UCLM), Spain.

To download the GridSim software, please visit the Gridbus Project web site at <http://www.gridbus.org/gridsim/>

10. Continuing Members Profile and Activities

Member Self Profile: Srikumar Venugopal

In 2007, I entered into my new role as a Postdoctoral Research Fellow in the GRIDS Lab appointed to work on the ARC Discovery project “QoS-based Scheduling of e-Research Workflows on Grids”. This project examines the execution of scientific workflows in a manner that satisfies users’ Quality of Service (QoS) metrics by identifying their requirements, discovering resources that can guarantee QoS by forming binding Service Level Agreements (SLAs), and then scheduling the workflow tasks in order to meet the requirements.



Service consumers, such as brokers, and service providers have differing goals when it comes to creating SLAs. Therefore, one of the major thrusts in 2007 was to create a protocol for SLA negotiation between providers and consumers. We have successfully achieved this through the creation of a negotiation system between the Gridbus broker (as a consumer) and Aneka, a .NET-based Enterprise grid software developed in the GRIDS Lab (as a provider). The negotiation protocol is based on Rubinstein’s Alternate Offers Protocol in which the reply to a proposal can be a counter-proposal. The consumer and provider can exchange counter-proposals until they reach an agreement, or until one of them decides to cancel the negotiation. Further details can be obtained from the relevant GRIDS Lab Tech. Report¹.

Other than this, I have worked with other members of the GRIDS Lab in order to pursue some interesting research directions. One such effort was to adapt the well-known Dynamic Critical Path (DCP) algorithm to schedule workflows onto Grid resources. A paper on this was published in the proceedings of eScience 2007. Another effort was to adapt ProActive, a component-based Grid framework, to work with the Gridbus broker. In addition, we have jointly applied for an Australian provisional patent on the support for multiple programming models in Aneka.

I was happy to receive a Knowledge Transfer Award (Commendation) from the Vice-Chancellor of the University of Melbourne for the Gridbus Project. I have also received a Distinguished Volunteer Award from the IEEE Computer Society for my participation in the activities of IEEE Technical Society on Scalable Computing (TCSC).

In 2008, I will continue my work on SLA negotiation with focus on different strategies and support for different application models. I will also look into SLA-based resource allocation in utility grids and to develop brokering strategies in such environments.

¹ S. Venugopal, X. Chu, and R. Buyya, “ A Negotiation Mechanism for Advance Reservations using Alternate Offers Protocol”, Tech Report, GRIDS-TR-2008-1, Grid Computing and Distributed Systems (GRIDS) Laboratory, University of Melbourne, Australia

Member Self Profile: SungJin Choi

My name is SungJin Choi. I completed my Ph.D. at the Distributed systems Lab., Department of Computer Science & Engineering, Korea University under the supervision of Professors ChongSun Hwang and SangKeun Lee, focusing on resource management and scheduling in Desktop Grid, in August 2007. After that, I joined the GRID Lab in September, 2007 as a post-doctoral researcher. This post-doctoral program is supported by Korea Research Foundation (KRF) and the University of Melbourne.



My research topics include resource management & scheduling in Desktop Grid, peer to peer computing, mobile agent and distributed systems. As a researcher working with professor Buyya, I focus on (1) trust scheduling for result certification, (2) incentive scheduling using reputation of volunteers in a Desktop Grid computing environment. Trust scheduling for result certification aims to detect and tolerate the erroneous result in order to guarantee trusted execution. It is categorized into non-reputation-based and reputation-based trust scheduling. Non-reputation-based trust scheduling tolerates malicious resources or a variety of hardware and software malfunctions without using volunteer's reputation in a scheduling procedure.

In a reputation-based trust scheduling, result certification is coupled with the reputation of volunteers. In this case, the more a volunteer produces a correct result, the higher its reputation (especially, credibility) becomes. Incentive mechanisms aim to encourage resources' owners to donate their resources eagerly, reliably and trustworthily. It gives rewards (such as, money, resources, ranking, etc.) to volunteers for their donation. Incentive scheduling also has the same goals, but it is more related with resource selection and management. It tries to give incentives to eager, reliable and trustworthy volunteers in a scheduling procedure. It also attempts to inflict punishment (for example, penalty, exclusion from scheduling, low reputation and ranking, etc.) on selfish, faulty, and untrustworthy volunteers. Currently, I finished the taxonomy and survey of Desktop Grids and submitted it to ACM Computing surveys.

- Ph.D thesis: Group-based Adaptive Scheduling Mechanism in Desktop Grid, August, 2007
- SungJin Choi, HongSoo Kim, EunJoung Byun, MaengSoon Baik, SungSuk Kim, ChanYeol Park, and ChongSun Hwang,, "Characterizing and Classifying Desktop Grid," IEEE/ACM International Symposium on Cluster Computing and the Grid (CCGRID 2007), Seventh International Workshop on Global and Peer to Peer Computing (GP2P), pp. 743-748, May 2007.
- SungJin Choi, Rajkumar Buyya, HongSoo Kim, EunJoung Byun, MaengSoon Baik, JoonMin Gil, Chanyeol Park, "A Taxonomy of Desktop Grids and its Mapping to State-of-the-Art Systems," submitted to ACM Computing Surveys.

Member Self Profile: Rajiv Ranjan

I joined the University of Melbourne as Doctor of Philosophy student in the year 2002 under Dr. Rajkumar Buyya and Dr. Aaron Harwood. The topic of my Ph.D. thesis was "Coordinated Resource Provisioning in Federated Grids". My PhD research work included design and implementation of both experimental and theoretical aspects of decentralized network-based systems in particular Grid computing and Peer-to-Peer (P2P) systems. The primary focus of my work was to develop fundamental algorithms and protocols to facilitate a large scale, decentralized and federated Grid resource sharing environment.



One of the important achievement of year 2007 was that I was able to graduate as a Ph.D. scholar on December 19, 2007. Further, one of the external reviewers also stated the thesis work as outstanding and being in the top 5% of all PhDs that he had either read in detail, or examined, and recommended that the thesis should be considered for the Chancellor's Prize for Excellence in the PhD thesis. Currently, I am working as a Post-doctoral research Fellow in the GRIDS Laboratory under Dr. Rajkumar Buyya. Other major accomplishment for the year 2007 was publishing 2 papers in the highly reputed journals including *IEEE Communication Surveys and Tutorials*² and *Future Generation Computers System*³.

I proposed a novel solution to decentralised resource indexing⁴ in a federated resource sharing environment. A spatial publish/subscribe index was utilized for organising distributed grid resource data. Distributed Hash Table (DHT) routing substrate formed the basis for delegation of d -dimensional service messages. DHTs are proven to be self-organising, fault-tolerant and scalable. Further, publish/subscribe way of resource discovery adheres well to the need of Grid computing participants who are separated in time and space. The work was validated resource through extensive simulation based study.

I implemented the Alchemi-Federation system that logically inter-connects the Internet wide distributed Alchemi Desktop Grids. The broker service in the Alchemi-Federation was implemented in C-sharp (.Net environment), while the resource discovery and tuple space services were written in Java. FreePastry P2P routing substrate was utilised as the DHT service. FreePastry is an open source implementation of well-known Pastry DHT. To enable inter-process communication between .Net and Java environment, two web services were implemented.

² Rajiv Ranjan, Aaron Harwood, Rajkumar Buyya, Peer-to-Peer Based Resource Discovery in Global Grids: A Tutorial, *IEEE Communications Surveys and Tutorials*, IEEE Communications Society Press, USA (accepted on July 16, 2007) .

³ Rajiv Ranjan, Aaron Harwood and Rajkumar Buyya, A Case for Cooperative and Incentive-Based Federation of Distributed Clusters, *Future Generation Computing Systems*, ISSN: 0167-739X, Elsevier Press, Amsterdam, The Netherlands, 2007 (in press, accepted on May 22, 2007).

⁴ Rajiv Ranjan, Lipo Chan, Aaron Harwood, Shanika Karunasekera, and Rajkumar Buyya, Decentralised Resource Discovery Service for Large Scale Federated Grids, *Proceedings of the 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007)*, IEEE CS Press, Los Alamitos, CA, USA), Dec. 10-13, 2007, Bangalore, India.

Member Self Profile: James Broberg

In 2007 I worked on autonomic and utility-driven scheduling techniques for Grids under the DEST project, “The Utility Grid Project: Autonomic and Utility-Oriented Global Grids for Powering Emerging e-Research Applications”. This led to several important outcomes. The problem of maximising utility in market-driven distributed computing systems was studied in depth. In such systems, users have jobs that need to be processed, for which they are willing to proportionally compensate a provider to perform depending on the utility they receive. Rather than dealing with service providers directly, users facilitate access through brokers who can virtualise and make available the resources of multiple service providers, achieving greater economies of scale, improving throughput and reducing cost.



We approached this problem by modelling the system as an adaptation of the classical multi-commodity flow problem to the market-based, utility driven problem. A highly distributed solution was proposed, where each node can operate independently whilst reaching a near-optimal global state where each participant is satisfied. [1]

In conjunction with my colleagues, I also examined the recent innovations in Market-oriented Grids and Utility Computing (from 2000-2007), looking at the state-of-the-art in price setting and negotiation, grid economy management and utility-driven scheduling and resource allocation, and identify the advantages and limitations of these systems. We then looked to the future of these systems, examining the emerging ‘Catallaxy’ market paradigm. [2]

In parallel with these efforts, I have continued my work on Peering of Content Delivery Networks (CDNs) (<http://www.gridbus.org/cdn>) [3]. In late 2007 it was announced that my ARC Discovery proposal for 2008-2010 was successful. As a result, from 2008 I am an Australian Postdoctoral Fellow researching “Coordinated and Cooperative Load Sharing between Content Delivery Networks” as part of the successful Discovery Grant (DP0881742, 2008-2010) with collaborators at the University of Melbourne (GRIDS Laboratory) and RMIT University (Distributed Systems & Networking Discipline).

I am also actively researching “Adaptive Provisioning and Allocation for shared computing resources using Virtual Machines” along with Dr. Srikumar Venugopal, as part of our successful University of Melbourne Early Career Researcher (ECR) grant for 2008.

[1] J. Broberg, R. Buyya, A Multi-commodity Flow Approach to Maximising Utility in Linked Market-Based Grids, In Proceedings of the 5th International Workshop on Middleware for Grid Computing (MGC 2007), November 2007.

[2] J. Broberg, S. Venugopal, R. Buyya, Market-oriented Grids and Utility Computing: The state-of-the-art and future directions, Journal of Grid Computing, Springer, Germany (accepted on Sept. 9, 2007).

[3] A. Khan Pathan, J. Broberg, K. Hoon Kim, R. Buyya, An architecture for virtual organization (VO)-based effective peering of content delivery networks, In Proceedings of the Second Workshop on Use of P2P, GRID and Agents For the Development of Content Networks, Pages 29-38, ACM Press, New York, NY, June 2007.

[4] J. Broberg, P. Zeepongsekul and Z. Tari, Approximating Bounded General Service Distributions, In Proceedings of the Twelfth IEEE Symposium on Computers and Communications (ISCC 2007), Pages 817-823, July 2007.

Al-Mukaddim Khan Pathan, Rajkumar Buyya and James Broberg, Internetworking of CDNs, Content Delivery Networks, In Press, Springer-Verlag, Germany, 2008

Member Self Profile: Xingchen Chu

I have been in GRIDs lab since late 2005 and currently I am a research fellow in the lab who is responsible for designing and implementing software systems as well as writing research papers. 2007 was a very excellent year for me in this lab. I would like to briefly describe my work in 2007 on both software development and research publications



In terms of software development efforts, there were several projects which I had involved. First of all, I played a leading role of the design and implementation of the new-generation of Desktop Grid software system called Aneka.

The project started late 2006 and was greatly enhanced during 2007. As one of the founders of Aneka technology, I am one of the holders of an Australia provisional patent based on Aneka. Another interesting project I had done during 2007 was that I had developed an integration solution enabling scheduling component-based applications on Grids using the Gridbus broker and ProActive framework. I gave a presentation on this work in EU-funded GridComp meeting in Beijing. I was also leading the efforts of the new release of the Gridbus Broker 3.1 in the middle of 2007.

Based on my efforts on those projects, I had very good chances to publish research papers. I co-authored a "A Service-Oriented Grid Environment for Integration of Distributed Kidney Models and Resources" Journal paper in "Concurrency and Computation: Practice and Experience (CCPE)" which is in press and accepted on June 11, 2007. I, as a co-author, published "Aneka: Next-Generation Enterprise Grid Platform for e-Science and e-Business Applications" paper in e-Science 2007: IEEE International Conference on e-Science and Grid Computing. I also co-authored "Grid Resource Broker for Scheduling Component-Based Application on Distributed Resources" as a chapter in a book on "Cyberinfrastructure", which will be published in 2008. Besides these research papers, I was also involved in writing a Book on Object Oriented Programming using Java which is to be published soon by an international publisher.

As my assistance to community in helping the use of our Grid software for creation e-Science application had been recognised by the University, I, as co-winner, received the Vice Chancellor's Knowledge Transfer Excellence (Commendation) Award.

Member Self Profile: Chao Jin



During 2007, the second year I stayed within GRIDS Lab research group, I worked on several important research topics within the domain of Enterprise Grids and finished 4 publications. Furthermore, I also made contributions to the development of an Enterprise Grid system.

One of my main efforts during 2007 was focusing on the development of a .NET-based SOA (Service Oriented Architecture) software infrastructure to simplify the creation of .NET based Grid environments. As one important feature, this .NET based Grid environment can be configured to support various programming models through service container techniques. This feature can simplify the research work on various programming models for Grid environments. Furthermore, I implemented several important applications to show the effectiveness of the system. I also helped to show demos for GridExpo and e-Science 2007 conference.

As one of the important applications for our .NET-based Grid system, I developed Jeeva, which is a web portal for protein secondary structure prediction and aims to simplify the process of discovering and releasing new protein prediction algorithms. The web portal system is built over the .NET-based Grid platform, and supports user management and maintains the historical prediction results for each register user. Through a joint work with the bioinformatics research group led by Prof. M. Palaniswami in the department of electrical engineering, we had successfully implemented a machine learning based protein secondary structure prediction algorithm invented by Dr. Jayavardhana Gubbi in our web portal system and showed a large scale demo over 40 Windows machines in the e-Science 2007 conference.

I also worked on the scheduling polices for coarse-grained dataflow applications in Grid environments. My scheduling algorithm can handle the tough problems of heterogeneity and fault tolerance while meeting the performance requirements for dataflow applications in enterprise Grids.

Based on my research work, I co-authored two papers, which were published in the 3rd IEEE International Conference and Grid Computing at Bangalore, India during Dec. 10-13, 2007 and the 3rd International Workshop on Grid Computing and Applications at Biopolis, Singapore in June 2007. Furthermore, I have one book chapter under submission.

Member Self Profile: Chee Shin Yeo

I am a Ph.D. candidate in the GRIDS Laboratory. My general topics of interests include distributed computing (cluster, Grid and peer-to-peer computing), services computing and utility computing. My Ph.D. research focuses on utility-based resource management for cluster computing.

In 2007, I propose using risk analysis techniques to evaluate the effectiveness of resource management policies to support utility computing for a commercial computing service⁵. First, I identify essential objectives or goals that a commercial computing service needs to achieve in order to support the utility computing model. Then, I present two simple and intuitive methods: (i) separate risk analysis and (ii) integrated risk analysis to determine the best resource management policy for a single objective and combinations of objectives respectively.



I also perform a detailed analysis of a pricing mechanism for utility-based resource management in clusters by examining its performance based on parallel workload characteristics from a real supercomputer center trace⁶.

Finally, I collaborate with other members within the GRIDS Laboratory to jointly contribute a book chapter about utility computing on global Grids⁷. The book chapter introduces the reader to the potential of Grids as utility computing environments, components of a utility Grid, utility-based resource allocation at various levels of a utility Grid, and solutions provided by commercial vendors to support utility computing.

⁵ Chee Shin Yeo and Rajkumar Buyya, Integrated Risk Analysis for a Commercial Computing Service, Proceedings of the 21st IEEE International Parallel and Distributed Processing Symposium (IPDPS 2007, IEEE CS Press, Los Alamitos, CA, USA), March 26-30, 2007, Long Beach, California, USA.

⁶ Chee Shin Yeo and Rajkumar Buyya, Pricing for Utility-driven Resource Management and Allocation in Clusters, International Journal of High Performance Computing Applications, Volume 21, Issue 4, Pages: 405-418, ISSN: 1094-3420, SAGE Publications, Thousand Oaks, CA, USA, Nov. 2007.

⁷ Chee Shin Yeo, Rajkumar Buyya, Marcos Dias de Assunção, Jia Yu, Anthony Sulistio, Srikumar Venugopal, and Martin Placek, Utility Computing on Global Grids, Chapter 143, Hossein Bidgoli (ed.), The Handbook of Computer Networks, ISBN: 978-0-471-78461-6, John Wiley & Sons, New York, USA, 2007.

Member Self Profile: Anthony Sulistio

I am a Ph.D. candidate in the GRIDS Laboratory. My general topics of interests include distributed computing (cluster, Grid and peer-to-peer computing), advance reservation, simulation and software engineering. The aims of my research are:

1. to investigate how AR can be incorporated and deployed into Grid systems; and
2. to examine how to regulate AR demands and the supply of resources.

Towards accomplishing my research aim (1), I have presented a system model for allowing users to query resource availability with fuzzy parameters, such as duration time and number of nodes required¹. With this elastic model, the resource provider can present the users with a preferred offer (suitable AR slot) & a list of alternatives. Hence, the users can *self-select* or choose the best option in reserving their jobs according to their Quality of Service (QoS) constraints.



Towards achieving my research aim (2), I have proposed the use of revenue management (RM) to determine pricing of reservations in order to increase resource revenue². Without any policies, the resource accepts reservations based on a first come first serve basis and subject to availability. Thus, AR jobs are treated similar to high priority ones in resource queuing systems. To address this problem, the resource provider can apply RM techniques to *shift demands*, and to ensure that resources are allocated to applications that are highly valued by the users.

In the above cases, the evaluations were conducted on GridSim, an open-source Grid simulation toolkit. In September 2007, a new version of GridSim was released to incorporate failure detections³, a joint work with University of Castilla La Mancha (Spain). The efforts on working on GridSim, as part of the Gridbus Project, have been recognized through the Vice-Chancellor's Commendation Award for Excellence in Knowledge Transfer. Therefore, I was honoured to receive this award.

In December 2007, I attended the 13th International Conference on Parallel and Distributed Systems (ICPADS'07) in Hsinchu, Taiwan, and the 3rd International Conference on e-Science and Grid Computing (e-Science'07) in Bangalore, India to present the above work. I was happy to receive the IEEE TCSC eScience 2007 Student Travel Grant. After attending the e-Science'07 conference, I visited Infosys in Bangalore for a week as a research visitor to meet Dr. Anirban Chakrabarti and Dr. Sumit Bose, where I presented my research work and GridSim to their research group.

¹ On Incorporating an On-line Strip Packing Algorithm into Elastic Grid Reservation-based Systems. Accepted in ICPADS'07.

² Using Revenue Management to Determine Pricing of Reservations. Accepted in e-Science'07.

³ Extending GridSim with an Architecture for Failure Detection. Accepted in ICPADS'07.

Member Self Profile: Marcos Dias de Assunção

I was born in a small town called Videira located in the state of Santa Catarina in the south of Brazil. I have spent most of my life in another small town called Fraiburgo. I have obtained a Masters degree in computer science at the Federal University of Santa Catarina (UFSC) in Florianópolis, Brazil.

I joined GRIDS Lab in March 2005 when I started my PhD. Since then, I have been working on policies for inter-Grid resource allocation enabled by peering arrangements amongst Grids. We term "Grid Internetworking" the mechanisms for resource provisioning, selection and allocation across Grids.

In 2007, I focused on resource provisioning by third party entities termed InterGrid Gateways. These gateways have limited provisioning rights over islands of resources and collaborate amongst them by exchanging resource shares when capacity is available. Currently, I am working on how resource providers can provision resources to third party entities such as gateways yet remain ultimate control over the resources. Furthermore, we plan to investigate how to provision resources across islands of resources based on this information given by resource providers.



Member Self Profile: Marco A. S. Netto

I am Marco A. S. Netto, I have a Bachelor (2002) and Master degree (2004) in Computer Science, both from the Pontifical Catholic University of Rio Grande do Sul (PUCRS), Brazil. Currently I am a third year PhD student at the University of Melbourne, Australia. My main interests are scheduling of parallel and distributed applications and resource management of computational systems.

Phone: 0432185160



In 2000, when I was still an undergraduate, I started to get interest on research management and scheduling. In that year, I joined a new research centre on high performance computing (CPAD), which is a partnership between PUCRS and Hewlett-Packard Brazil. During the period of 2000-2004, I worked with resource management and scheduling for high performance computing environments under supervision of Dr. Cesar A. F De Rose. In that period I developed tools, wrote research papers, and patents. In addition, during my master's research (2002-2004) I worked with simulations for structural Bioinformatics on desktop machines under supervision of Dr. Osmar Norberto de Souza. In 2005, I moved to Sao Paulo to work in the InteGrade's group. This group develops middleware for executing parallel applications on desktop machines. During that period, I was involved with scheduling of Bulk Synchronous Parallel (BSP) applications under supervision of Dr. Alfredo Goldman.

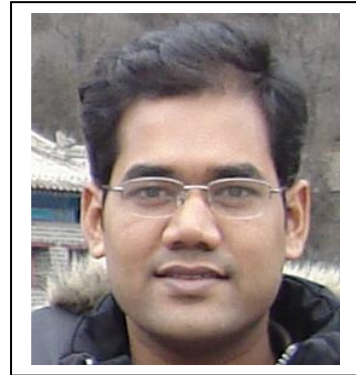
In 2006, I joined GRIDS Lab, at the University of Melbourne, Australia, to pursue my PhD under supervision of Dr. Rajkumar Buyya. My research has been focused on resource management and scheduling of parallel applications, which extends my past background. However, different from my previous research, at this time I am considering environments where quality-of-service is present, and users are paying to achieve it. My thesis is on (re)scheduling of applications that require resource co-allocation.

I started the year of 2007 working with advance reservations. I explored the use of flexible advance reservations (ARs) and I introduced the concept of adaptive advance reservations, in which the ARs could change the flexibility over time. After that, I worked with scheduling and rescheduling of parallel applications on multi-site environments. I introduced a model for resource co-allocation that relies on two operations: (i) shifting of starting time; and (ii) processor remapping. The main conclusion of this second work is that when using conservative backfilling-based scheduling queues, the local jobs cannot fill all the gaps produced by the wrong estimations of application runtimes, therefore rescheduling of multi-site jobs is required. Furthermore, the processor remapping operation allows multi-site jobs to be migrated to a single cluster while they are waiting for resources, and hence the wide area network overhead can be eliminated.

I am currently using the lessons I learnt in 2007 to investigate the problem of rescheduling co-allocation jobs on deadline-and-priority-based queues. For the list of publications and details about my past and current work, please visit my webpage:<http://www.csse.unimelb.edu.au/~netto>

Member Self Profile: Mukaddim Pathan

I am a Doctor of Philosophy (PhD) student in the **Grid Computing and Distributed Systems Laboratory**, Department of Computer Science and Software Engineering, The University of Melbourne, Australia. I have completed my Masters by Research to PhD conversion in April 2007.



Currently, I'm working in the project, entitled "Coordinated Management and Peering of Content Delivery Networks". This project aims to provide a means for distinct CDNs to coordinate and cooperate with other CDNs, by investigating and developing (a) an architecture for an open and decentralized system to support effective internetworking between CDNs achieved through peering arrangement; (b) protocols for service delivery in a cooperative environment of CDNs; (c) economic models for an effective content replication policy; and (d) policies for autonomic management of service level through resource negotiation in an on-demand basis.

In 2007, I've co-edited the book entitled "Content Delivery Networks", Lecture Notes in Electrical Engineering, Vol. 9, Springer-Verlag, Germany with A/Prof. Rajkumar Buyya, Director of GRIDS lab. During this period, I have published research papers in renowned international conferences. Some of my works have also been published as technical reports from GRIDS lab. I am currently working as a reviewer of a few renowned international conferences as well as international journals and magazines such as Computer Communications and IEEE Software. Currently, I am involved in the organization of the UPGRADE-CN workshop along with the High Performance Distributed Computing (HPDC) conference 2008.

In the coming years, I would focus on the prototype implementation for peering CDNs. I would also develop necessary algorithms and protocols for internetworking, and evaluate their performance on the developed prototype. In this context, I am going to release a technical report which specifies the software engineering requirements specifications based on our proposed architecture. It provides a short description of the software being specified and its purpose, including relevant benefits, objectives, and goals. Therefore, it specifies the next release of an evolving product containing its own scope statement as a subset of the long-term strategic product vision.

Member Self Profile: Mustafizur Rahman

I am a second year PhD student under the supervision of Dr. Rajkumar Buyya in Grid Computing and Distributed Systems (GRIDS) Laboratory of The University of Melbourne. My research interest includes scheduling and optimization of scientific workflow applications as well as autonomic management of Grid workflow systems. The main focus of my PhD research is to develop mechanisms for scheduling and autonomic management of scientific workflow applications on global Grids³.



During 2007, I have investigated different strategies for Grid workflow scheduling. In the first half of 2007, I proposed a Dynamic Critical Path (DCP) based workflow scheduling algorithm¹ that determines efficient mapping of workflow tasks by calculating the critical path in the workflow task graph dynamically. Based on simulation study, it has been proved that the proposed DCP based approach can generate better schedule for most of the type of workflows irrespective of their size particularly when resource availability changes frequently.

In the second half of 2007, I worked on developing a decentralized and cooperative workflow scheduling technique². The developed approach utilizes a Peer-to-Peer (P2P) coordination space in order to coordinate the application schedules among the Grid wide distributed workflow brokers. The performance and feasibility of this workflow scheduling approach has been tested through an extensive trace driven simulation study.

Since I joined GRIDS lab in 2006 as a Masters student, in December 2007, I applied for the conversion from Masters to PhD candidature and presented my work in the conversion seminar. On successful completion of the conversion process, I started pursuing my research as a PhD student at the end of 2007.

In December 2007, I attended 3rd IEEE International Conference on e-Science and Grid Computing, organized by the Centre for Development of Advanced Computing (C-DAC) of India. In the conference, I presented my paper¹ and demonstrated Gridbus Workflow Engine. I received the "Best Research Demo Award" which was sponsored by IEEE Computer Society Technical Committee on Parallel Processing (TCPP).

Besides doing my research, in 2007, I was also involved in other activities regarding professional development. I was a student volunteer of "itSMFA 10th National Conference and Expo on IT Service Management" organized in Melbourne, August 2007. After attending "e-Science 2007" conference, I also visited Infosys at Bangalore, India for one week as a research visitor. I am a student member of ACM, IEEE and IEEE Computer Society.

¹ Mustafizur Rahman, Srikumar Venugopaul, and Rajkumar Buyya, "Dynamic Critical Path based Algorithm for Scheduling Scientific Workflow Applications on Global Grids", in Proceedings of 3rd IEEE International Conference on e-Science and Grid Computing (e-Science 2007), India, December 2007.

² Rajiv Ranjan, Mustafizur Rahman, and Rajkumar Buyya, "A Decentralized and Cooperative Workflow Scheduling Algorithm", accepted in 8th IEEE International Symposium on Cluster Computing and the Grid (CCGRID 2008), France, May 2008.

³ Mustafizur Rahman, and Rajkumar Buyya, "An Autonomic Workflow Management System for Global Grids", accepted in 2nd IEEE TCSC Doctoral Symposium, in conjunction with 8th IEEE International Symposium on Cluster Computing and the Grid, France, May 2008.

Member Self Profile: AKM Khaled Ahsan Talukder

I have started my masters by research study in February, 2007. My principal supervisor is Dr. Michael Kirley and Dr. Rajkumar Buyya is my co-supervisor. I was awarded Australian Leadership Award 2007 by AusAID. I have completed my bachelor's degree from Rajshahi University of Engineering and Technology, Bangladesh.



My research interest includes Genetic and Evolutionary Computation for Multiobjective Optimization. I am also interested in Multiobjective Optimization in Dynamic and Noisy Environments, especially where shift of Pareto-front is unpredictable and noisy. Designing new genetic operators for directional convergence is also one of my interests. The main research motivation is to apply these techniques in practical applications, such as in Workflow Scheduling, electronic circuit sizing and other engineering design optimizations.

Currently I am working on high speed convergence of evolutionary multiobjective optimization; to achieve this goal, I have incorporated Dynamic System Identification and Fourier Domain Analysis to approximate the future Pareto-front so that a normal evolutionary run will be able to reach to the optimal solutions within fewer objective evaluations. My next goal is to adopt the same idea for combinatorial optimization problems and its applications to Multiobjective Grid Workflow Scheduling. I have also developed a Differential Evolution based workflow scheduling.

Although, incorporating the idea of Dynamic System Identification / Fourier Domain Analysis for combinatorial problem is almost impossible, so I am trying to speed up the combinatorial search process by developing new genetic operators for scheduling problems with the help of Extended Forma Analysis (EFA). EFA is widely used in designing new genetic operators from domain knowledge, so that after each genetic operation (Crossover/Mutation), the domain specific constraint (such as, "precedence" in case of DAG) is always preserved, eventually this approach will help to save the time complexity of a normal Multiobjective Genetic Algorithm by avoiding the infeasible solutions.

Member Self Profile: Saurabh Kumar Garg

I am a PhD student under the supervision of Dr. Rajkumar Buyya in Grid Computing and Distributed Systems (GRIDS) Laboratory of The University of Melbourne. I started my candidature from August 2007. I completed my 5-year Integrated Master of Technology in Mathematics and Computing from Indian Institute of Technology (IIT) Delhi, India, in 2006. After completing my post graduate degree, I joined IBM Indian Research Laboratory Delhi, where I worked in the area of High Performance Computing. There, I designed and optimized the FFT and Random Access benchmark for Blue Gene/L which is fastest supercomputer from IBM. Here in Melbourne University, I have been awarded with various scholarships like Nicta-Topup Scholarship, MIFRS, and MIRS for my PhD candidature.



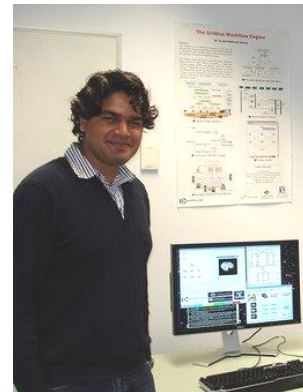
After joining GRIDS Laboratory, I studied various research works in the field of Grid computing. Thus, I studied utility computing, market principles in grid computing, SLA based resource allocation, workflow, data grids etc. This study not only gave me a strong foundation in the area but also gave me insight for some of the open problems. I developed my expertise in simulation modelling particularly in Grid Simulation Toolkits such as GridSim and Gridbus Broker. I also developed a simple design of meta-broker while working on Gridbus Broker.

My current research interest is in developing various market based design for metabroker which will map resources to resource consumers. I examined the problem of contention at a resource by introducing a third party meta-broker by allocating resources to users in a coordinated manner. To solve this problem, I proposed an LP based Genetic algorithm for efficient resource allocation with minimum combined user spending in Commodity markets. I simulated this algorithm using GridSim and compared the performance of this algorithm with other previously proposed scheduling algorithms¹.

¹*Saurabh Kumar Garg, Pramod Kumar Konugurthi, and Rajkumar Buyya, A Linear Programming Driven Genetic Algorithm for Meta-Scheduling on Utility Grids.*

Member Self Profile: Suraj Pandey

I finished my Master's degree from Inha University, South Korea in February 2007. After enrolling as a Ph.D. student and doing course work in KAIST, South Korea, for 6 months, I realized that my interests lie in Distributed Computing rather than core databases. So, I joined GRIDS Lab as a Masters by Research student (leading to a Ph.D. degree) in June 2007 under IPRS and MIRS scholarships. Prof. Rajkumar Buyya is my supervisor.



In 2007, I started my research degree by exploring core concepts in Grid Computing such as: resource management and scheduling, co-allocation and advanced reservations, data grids, workflows, simulation tools such as Gridsim. Without wasting much time, I got interested in **Scheduling of Workflows in Data-Intensive Environments**. I have been since working on this area and achieved results as follows:

- 1) I have been successful in writing a research proposal which clearly states my research problem and challenges. The paper: Title: "Scheduling of Scientific Workflows on Data Grids" has been accepted for publication at the 2nd IEEE TCSC Doctoral Symposium in conjunction with the 8th IEEE International Symposium on Cluster Computing and the Grid (CCGrid 2008), Lyon - France / May 18-22, 2008.
- 2) I have submitted a proposal to demonstrate our software titled "**Gridbus Workflow Engine for fMRI Analysis on Global Grids**" that forms the core part of my research for the "First IEEE International Scalable Computing Challenge (SCALE 2008)".
- 3) I have implemented modules to cleanup storage space used by Gridbus Workflow Engine so that the storage is efficiently used.
- 4) I have demonstrated at the "Grids & e-Research Expo" organized by the Grids lab on Nov 30, 2007. The software built by one of our seniors was enhanced and presented at the expo.

I am currently working on the following topics:

- 1) I am currently working on an algorithm based on Neural Networks that provides an approximate solution to my research problem.
- 2) I am coding algorithms for the Gridbus Workflow Engine that will be demoed at the SCALE 2008.

I hope to demonstrate very well at the SCALE 2008 competition. I hope to publish my current work in upcoming conferences without much due. The year 2008 will be my playground for hard work and remarkable achievements.

Visiting Member Self Profile: Xiaofeng Wang

I'm Xiaofeng Wang, from Jiangsu Province, China. I have been visiting student to Grid Computing and Distributed Systems Laboratory (GRIDS Lab) since Nov 2007. I received my Master degree in Computer Science at NUDT (National University of Defence Technology), China in 2006. Now I'm a second year PhD student at NUDT. And I got a scholarship from the CSC (China Scholarship Council) to have a study under supervisor Rajkumar Buyya for one year.



Before I came to Melbourne University, I did some project work on high performance network and some research work on Role Based Access Control (RBAC). I took part in a group to design the software for TOE (TCP/IP Offline Engineer), and I implemented the adapter driver aiming to support RDMA (Remote DMA) function. For RBAC, I studied some problem about ATN (Automated Trust Negotiation). I have submitted a paper to Journal of Software China. I extend the RT (Role Based Trust Negotiation) language to support the definition of complicated access control policy and negotiation policy. It can also support the new trust negotiation method, called Distributed Trust Proving.

Now I'm doing some work about trust resource management in distributed systems. To deal with behaviour trust problem, first I'm going to figure out the security service parameters related to trust computing such as authentication service, integrity service and confidentiality service. Second, I want to do some work on reliability oriented scheduling. To guarantee a high success probability for a job, the reputation of the service provider must be considered. And various heuristic rules and genetic algorithms can be used to make a scheduling. Since the failure can't be avoided sometimes, the resilient scheduling must be supplied. I want to do some work about the replication scheduling and verification technologies.

I'm also an easy going guy. I like music, movie and travelling etc. So, I'm really happy to be here to have many new friends.

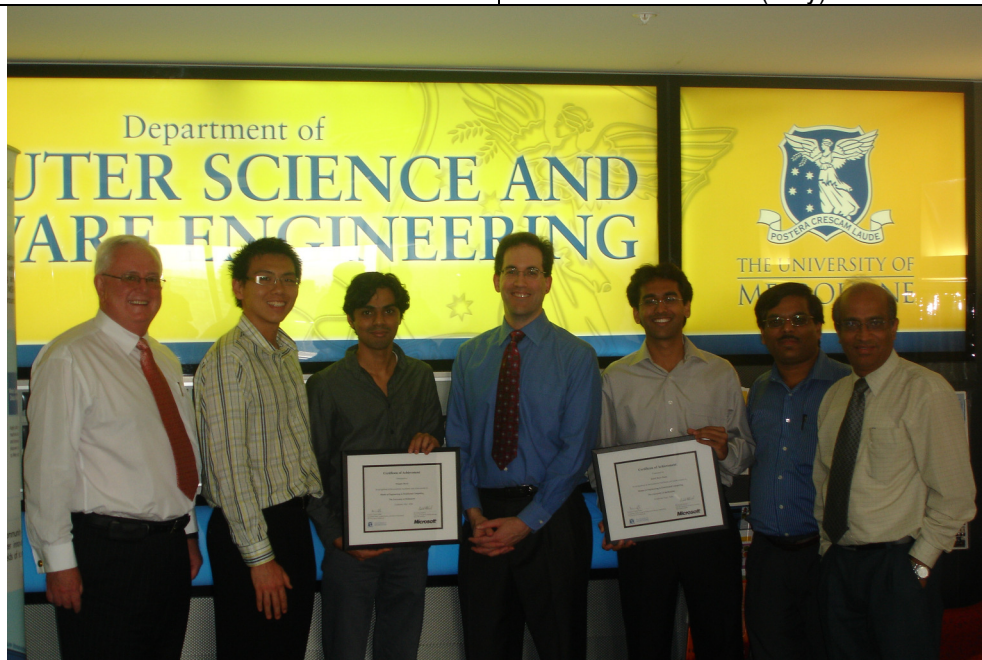
11. Moments with Visitors and International Hosts



ARC e-Research Workshop, Canberra, a view from Old Parliament to New (Jan)



CCGrid 2007 Conference Opening, Rio, Brazil (May)



MEDC Students with Microsoft Award: Microsoft delegates (Kevin Schofield, John Warren, Bernard Oh) and colleagues (Feb)



Australian and European Grid Collaboration Workshop - 2007 (Jan 29)



DEST Project Visit: Barcelona, Spain (June)



With Europe's fastest supercomputer @ BSC



University of Calabria Supercomputing Center



International Workshop on Scheduling, Cetraro, Italy with EU researchers (June).



Thai National Grid Center, Bangkok (Aug)



ThaiGrid Supercomputers and its Director



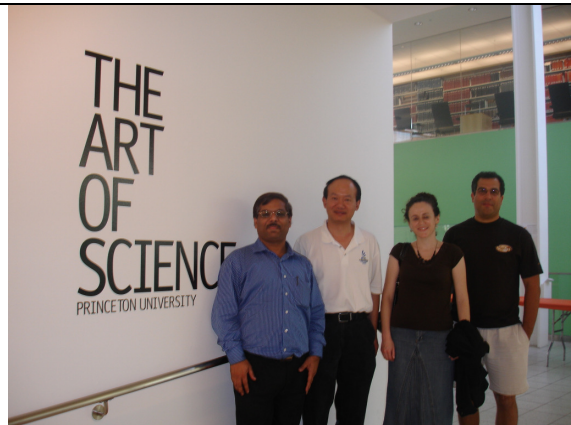
Valerie Taylor, Texas A&M University (Sept)



DEST Project Visit: Rutgers – New Jersey State University



With Manish Parashar and Team @ Rutgers



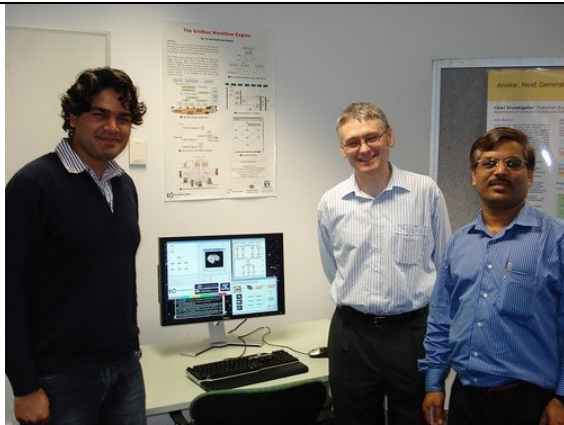
Princeton University: Kai Li, Marc Fiuczynski



with PlanetLab rootnode @ Princeton



Receiving a Knowledge Transfer Award from the Vice Chancellor (Nov 2007)



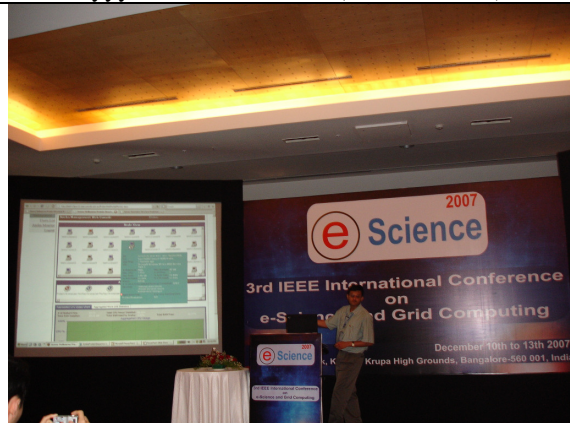
Grids & e-Research Expo organized by the GRIDS Lab on Nov 30, 2007



e-Science 2007 conference inauguration with lighting of the lamp: S. Ramakrishnan, Madhavan Nair, A. K. Chakravarti, Geoffrey Fox, Rajkumar Byyya, N. Balakrishnan (Dec. 10, 2007)



Rahman demonstrating Gridbus Workflow Engine



Srikumar demonstrating Aneka