

**Cloud Computing and Distributed Systems Laboratory
and the Cloudbus Project**



Annual Report - 2014



Department of Computing and Information Systems

Melbourne School of Engineering

The University of Melbourne, Australia

1. Director's Message

I am pleased to report on the key activities and outcomes of **Cloud Computing and Distributed Systems (CLOUDS) Laboratory** at the University of Melbourne, Australia during the academic year 2014, which has been another extraordinary year in terms of research quality and international recognition of its members. The Lab has consolidated its position as one of the world-leaders in developing innovative solutions for Cloud Computing. The highlights of research activities and outcomes in 2014 are:



- The Lab successfully hosted four ARC research projects: Future Fellowship programme, Discovery Project, and 2 Industry Linkage Projects.
- Members of the CLOUDS Lab have authored 36 publications, which include 17 journal papers and 14 conference papers.
- The Lab's flagship Cloudbus Project has released various new modules for Aneka and CloudSim. CloudSim 3.0 Toolkit now contains modules for DVFS, web modelling and MapReduce application modelling. It has been used by several researchers in academia and industries around the world.
- Members have presented over 45 invited talks that include 15 keynotes delivered at international conferences held in China, India, Indonesia, and USA.
- The Lab successfully hosted research activities of over 20 scholars: 14 PhD students, 4 Research Fellows (2 at PostDoc level and 2 Software Engineers).
- "A Scientometric Analysis of Cloud Computing Literature" by German researchers (Leonard Heilig and Stefan Vo) from the University of Hamburg noted our University highly (#1) for cloud computing research impact.
- In 2014 alone, our papers have attracted over 7050 citations (ref: Google Scholar) and we hope this trend will continue!
- The Lab housed several (short and long term) international visitors (academic and PhD students) from India, China, Brazil, Estonia, Spain, and France.
- The Lab attracted funding for projects started in 2014: ARC Linkage with CA, others were from Australian Dept of Innovation (Australia India Strategic Research), Melbourne-Chindia Research Network in Cloud Computing, and Samsung.
- Our Lab's spin-off company, Manjrasoft has been recognised as one of the **Top 20 Cloud Computing companies** by the Silicon Review Magazine.
- Members of the Lab have led community efforts such as (a) the organisation of conferences (e.g., UCC 2014 in UK), (b) Editor-In-Chief of IEEE Transactions on Cloud Computing, and (c) Co-Editor-In-Chief of Journal of Software: Practice and Experience, which was established 40+ years ago.

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!

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Rajkumar Buyya', written in a cursive style.

Professor Rajkumar Buyya, PhD
Director, Cloud Computing and Distributed Systems (CLOUDS) Laboratory
Department of Computing and Information Systems
The University of Melbourne, Australia
Web: www.cloudbus.org

2. The Team

Director:

- Professor Rajkumar Buyya

Research Staff:

- Dr. Rodrigo N. Calheiros
- Dr. Amir Vahid
- Ms. Diana Barreto
- Mr. Tiago Justino

PhD Students

- Ms. Linlin Wu
- Mr. Adel Toosi
- Mr. Deepak Poola
- Ms. Atefeh Khosravi
- Mr. Nikolay Grozev
- Ms. Sareh Fotuhi
- Mr. Yaser Mansouri
- Mr. Roland Padilla
- Ms. Maria Rodriguez
- Mr. Chenhao Qu
- Mr. Le Tan Chanh Nguyen
- Ms. Yali Zhao
- Mr. Jungmin Jay Son
- Mr. Farzad Khodadadi
- Mr. Bowen Zhou
- Mr. Safiollah Heidari
- Mr. Xunyun Liu

Collaborators

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

Australian Research Council (ARC)

- R. Buyya, Dynamic resource provisioning for autonomic management of cloud computing environments, Future Fellowship, ARC, 2012-2016. Amount: \$786,168.
- M. Palaniswami and R. Buyya, Creating a Smart City Through Internet of Things, Linkage Project, ARC, 2012-2014. Amount: \$350,000.
- R. Buyya, A. Lachlan, and A. Wierman, Resource management algorithms and software systems for green cloud computing, Discovery Project, ARC, 2013-2015. Amount: \$315,000.
- R. Kotagiri, R. Buyya, C. Leckie, and S. Versteeg, Business goals and analytics driven management of cloud computing based information technology infrastructure, Linkage Project, ARC, 2013-2016. Amount: \$280,000.

Other National Grants

- R. Ranjan, R. Buyya, R. Shyamasundar, A. Zaslavsky, S. Nepal, R. Calheiros, S. Chen, R. Ghosh, A. Haller, and O. Dabeer, "Innovative Solutions for Deployment of BigData and Disaster Management Applications on Clouds", Australia-India Strategic Research Fund (AISRF Round 7), Australian Department of Industry, 2013-2016. Amount: \$400,000.
- Indian partners received direct funding from Dept. of Science and Technology (DST), Govt. Of India. Amount: INR 10,200,000.

Industry and Melbourne University Grants

- R. Buyya, Z. Xiao, Y. Cui, Y. Wu, J. Cao, U. Bellur, R. K. Shyamasundar, R. K. Pisipati, B. Sinha, S. K. Nandy, J. Lakshmi, and T. V. Prabhakar, "Melbourne-Chindia Cloud Computing (MC3) Research Network", International Research and Research Training Fund (IRRTF), The University of Melbourne, 2013-2016. Amount: \$150,000.
 - R. Buyya and R. Calheiros, "A Platform for Green Cloud Computing", Global Research Outreach (GRO) Program, Samsung, South Korea, 2013-2014. Amount: \$100,000.
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4. Publications

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

Year Publication Type	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Books/Proceedings Edited	1	1	1	1	5	4	3	5	2	3	2	2	1
Journal Papers	6	1	4	5	6	4	10	13	8	9	15	17	17
Book Chapters	1	0	0	4	4	2	4	11	3	13	3	1	2
Conference Papers	4	7	9	16	15	24	22	27	15	14	12	6	14
Magazine/Other Articles	0	0	1	2	4	2	0	1	2	1	0	5	2
<i>Total</i>	12	9	15	28	34	36	39	57	30	40	32	31	36

Books/Edited

1. Rajkumar Buyya and Sabu M. Thampi (eds), Intelligent Distributed Computing, ISBN: 9783319112268, Springer International Publishing AG, Germany, 2014.

Book Chapters

2. Mohsen Amini Salehi, Jemal Abawajy, and Rajkumar Buyya, Taxonomy of Contention Management in Interconnected Distributed Systems, Computing Handbook, Third Edition: Computer Science and Software Engineering, T. Gonzalez, J. Diaz-Herrera, A. Tucker (eds), ISBN-13: 978-1439898529, CRC Press, Boca Raton, Florida, USA, May 2014.
3. Suraj Pandey, Letizia Sammut, Rodrigo N. Calheiros, Andrew Melatos, and Rajkumar Buyya, Scalable Deployment of a LIGO Physics Application on Public Clouds: Workflow Engine and Resource Provisioning Techniques, Cloud Computing for Data-Intensive Applications, 3-25pp, Li, Xiaolin, Qiu, Judy (Eds.), ISBN: 978-1-4939-1904-8, Springer, Berlin, Germany, 2014.

Journal Editorials

4. Cui Yong, Rajkumar Buyya, and Liu Jiangchuan, Cloud Computing, China Communications, Volume 11, No. 4, ISSN 1673-5447, China Institute of Communications (CIC) and the IEEE Communications Society (IEEE ComSoc), USA, April 2014.
5. Rajiv Ranjan, Rajkumar Buyya, Philipp Leitner, Armin Haller and Stefan Tai, A Note on Software Tools and Techniques for Monitoring and Prediction of Cloud Services, Software: Practice and Experience, Volume 44, Number 7, Pages: 771-775, ISSN: 0038-0644, Wiley Press, New York, USA, July 2014.

Journal Papers

6. Weiwei Lin, Chen Liang, James Z. Wang, and Rajkumar Buyya, Bandwidth-aware Divisible Task Scheduling for Cloud Computing, Software: Practice and Experience, Volume 44, No. 2, Pages: 163-174, ISSN: 0038-0644, Wiley Press, New York, USA, February 2014.

7. Mohsen Amini Salehi, Bahman Javadi, and Rajkumar Buyya, Resource Provisioning based on Preempting Virtual Machines in Distributed Systems, *Concurrency and Computation: Practice and Experience*, Volume 26, No. 2, Pages: 412-433, ISSN: 1532-0626, Wiley Press, New York, USA, February 2014.
8. Amir Vahid Dastjerdi and Rajkumar Buyya, Compatibility-aware Cloud Service Composition Under Fuzzy Preferences of Users, *IEEE Transactions on Cloud Computing*, Volume 2, Number 1, Pages: 1-13, ISSN: 2168-7161, IEEE Computer Society Press, USA, March 2014.
9. Mohsen Amini Salehi, Adel Nadjaran Toosi, and Rajkumar Buyya, Contention Management in Federated Virtualized Distributed Systems: Implementation and Evaluation, *Software: Practice and Experience*, Volume 44, No. 3, Pages: 353-368, ISSN: 0038-0644, Wiley Press, New York, USA, March 2014.
10. Nikolay Grozev and Rajkumar Buyya, Inter-Cloud Architectures and Application Brokering: Taxonomy and Survey, *Software: Practice and Experience*, Volume 44, No. 3, Pages: 369-390, ISSN: 0038-0644, Wiley Press, New York, USA, March 2014.
11. Saeid Abolfazli, Zohreh Sanaei, Ejaz Ahmed, Abdullah Gani, and Rajkumar Buyya, Cloud-Based Augmentation for Mobile Devices: Motivation, Taxonomies, and Open Challenges, *IEEE Communications Surveys and Tutorials*, Volume 16, Issue 1, Pages:337 - 368, ISSN: 1553-877X, IEEE Communications Society Press, USA, Jan-April 2014.
12. Zohreh Sanaei, Saeid Abolfazli, Abdullah Gani, and Rajkumar Buyya, Heterogeneity in Mobile Cloud Computing: Taxonomy and Open Challenges, *IEEE Communications Surveys and Tutorials*, Volume 16, Issue 1, Pages:369 - 392, ISSN: 1553-877X, IEEE Communications Society Press, USA, Jan-April 2014.
13. Md. Whaiduzzaman, Mehdi Sookhak, Abdullah Gani, Rajkumar Buyya, A Survey on Vehicular Cloud Computing, *Journal of Network and Computer Applications*, Volume 40, Number 1, Pages: 325-344, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, April 2014.
14. Thamarai Selvi Somasundaram, Kannan Govindarajan, Usha Kiruthika, and Rajkumar Buyya, Semantic-enabled CARE Resource Broker (SeCRB) for managing grid and cloud environment, *The Journal of Supercomputing*, Volume 68, Number 2, Pages: 509-556, ISSN: 0920-8542, Springer Science+Business Media, Berlin, Germany, May 2014.
15. Maria A. Rodriguez and Rajkumar Buyya, Deadline based Resource Provisioning and Scheduling Algorithm for Scientific Workflows on Clouds, *IEEE Transactions on Cloud Computing*, Volume 2, Number 2, Pages: 222-235, ISSN: 2168-7161, IEEE Computer Society Press, USA, April-June 2014.
16. Rodrigo N. Calheiros and Rajkumar Buyya, Meeting Deadlines of Scientific Workflows in Public Clouds with Tasks Replication, *IEEE Transactions on Parallel and Distributed Systems (TPDS)*, Volume 25, Issue 7, Pages: 1787 - 1796, ISBN: 1045-9219, IEEE CS Press, Los Alamitos, CA, USA, July 2014.
17. Adel Nadjaran Toosi, Rodrigo N. Calheiros, and Rajkumar Buyya, Interconnected Cloud Computing Environments: Challenges, Taxonomy, and Survey, *ACM Computing Surveys*, Volume 47, Number 1, Pages: 7:1--7:47, ISSN 0360-0300, ACM Press, New York, USA, July 2014.
18. Linlin Wu, Saurabh Kumar Garg, Steve Versteeg, and Rajkumar Buyya, SLA-Based Resource Provisioning for Hosted Software-as-a-Service Applications in Cloud Computing Environments, *IEEE Transactions on Services Computing (TSC)*, Volume 7, Number 3, Pages: 456-485, ISSN: 1939-1374, IEEE Computer Society Press, USA, July-September 2014.
19. Nithiapidary Muthuvelu, Ian Chai, Eswaran Chikkannan, and Rajkumar Buyya, QoS-based Task Group Deployment on Grid by Learning the Performance Data, *Journal of Grid Computing*, Volume 12, Numbers 3, Pages: 465-483, ISSN: 1570-7873, Springer Science+Business Media B.V., New York, USA, Sept. 2014.
20. Saurabh Kumar Garg, Adel Nadjaran Toosi, Srinivasa K. Gopalaiyengar, and Rajkumar Buyya, SLA-based Virtual Machine Management for Heterogeneous Workloads in a Cloud Datacenter, *Journal of Network and Computer Applications*, Volume 45, Number

- 10, Pages: 108-120, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, October 2014.
21. Mehran Garmehi, Morteza Analoui, Mukaddim Pathan, and Rajkumar Buyya, An Economic Replica Placement Mechanism for Streaming Content Distribution in Hybrid CDN-P2P Networks, *Computer Communications*, Volume 52, Pages: 60-70, ISSN: 0140-3664, Elsevier, Amsterdam, The Netherlands, October 2014.
 22. Nikolay Grozev and Rajkumar Buyya, Multi-Cloud Provisioning and Load Distribution for Three-Tier Applications, *ACM Transactions on Autonomous and Adaptive Systems (TAAS)*, Volume 9, Number 3, Article No.: 13, ISSN:1556-4665, ACM Press, New York, USA, October 2014.

Conference Papers

23. Jin Huang, Rui Zhang, Rajkumar Buyya, and Jian Chen, MELODY-Join: Efficient Earth Mover's Distance Similarity Join Using MapReduce, *Proceedings of the 30th IEEE International Conference on Data Engineering (ICDE 2014, IEEE CS Press, USA)*, Chicago, IL, USA, March 31-April 4, 2014.
24. Huber Flores, Satish Narayana Srirama, and Rajkumar Buyya, Computational Offloading or Data Binding? Bridging the Cloud Infrastructure to the Proximity of the Mobile User, *Proceedings of the 2nd IEEE International Conference on Mobile Cloud Computing, Services, and Engineering (MobileCloud 2014, IEEE CS Press, USA)*, Oxford, UK, April 8-11, 2014.
25. Chenhao Qu and Rajkumar Buyya, A Cloud Trust Evaluation System using Hierarchical Fuzzy Inference System for Service Selection, *Proceedings of the 28th IEEE International Conference on Advanced Information Networking and Applications (AINA 2014, IEEE CS Press, USA)*, Victoria, Canada, May 13-16, 2014.
26. Deepak Poola, Saurabh Kumar Garg, Rajkumar Buyya, Yun Yang, and Ramamohanarao Kotagiri, Robust Scheduling of Scientific Workflows with Deadline and Budget Constraints in Clouds, *Proceedings of the 28th IEEE International Conference on Advanced Information Networking and Applications (AINA 2014, IEEE CS Press, USA)*, Victoria, Canada, May 13-16, 2014.
27. Jian Song, Yong Cui, Minming Li, Jiezhong Qiu, and Rajkumar Buyya, Energy-Traffic Tradeoff Cooperative Offloading for Mobile Cloud Computing, *Proceedings of the 22nd IEEE/ACM International Symposium on Quality of Service (IWQoS 2008, IEEE Communications Society Press, New York, USA)*, Hong Kong, China, May 26-27, 2014.
28. Deepak Poola, Kotagiri Ramamohanarao and Rajkumar Buyya, Fault-Tolerant Workflow Scheduling Using Spot Instances on Clouds, *Proceedings of the 14th International Conference on Computational Science (ICCS 2014, Procedia Computer Science, Volume 29, Elsevier, The Netherlands)*, Cairns, Australia, June 10-12, 2014.
29. Md Hasanul Ferdous, Manzur Murshed, Rodrigo N. Calheiros, and Rajkumar Buyya, Virtual Machine Consolidation in Cloud Data Centers using ACO Metaheuristic, *Proceedings of the 20th International European Conference on Parallel Processing (EuroPar 2014, LNCS, Springer, Germany)*, Porto, Portugal, August 25-29, 2014.
30. Rajkumar Buyya, Rodrigo N. Calheiros, Jungmin Son, Amir Vahid Dastjerdi, and Young Yoon, Software-Defined Cloud Computing: Architectural Elements and Open Challenges, *Proceedings of the 3rd International Conference on Advances in Computing, Communications and Informatics (ICACCI 2014, ISBN: 978-1-4799-3078-4, IEEE Press, USA)*, New Delhi, India, September 24-27, 2014. - Keynote Paper.
31. Mohammed Alrokayan, Amir Vahid Dastjerdi, and Rajkumar Buyya, SLA-aware Provisioning and Scheduling of Cloud Resources for Big Data Analytics, *Proceedings of the 3rd International Conference on Cloud Computing for Emerging Markets (CCEM 2014, IEEE Press, USA)*, Bangalore, India, October 15-17, 2014.
32. Tiago Justino and Rajkumar Buyya, Outsourcing Resource-Intensive Tasks from Mobile Apps to Clouds: Android and Aneka Integration, *Proceedings of the 3rd International*

- Conference on Cloud Computing for Emerging Markets (CCEM 2014, IEEE Press, USA), Bangalore, India, October 15-17, 2014.
33. Raghavendra Kune, Pramod Kumar Konugurthi, Arun Agarwal, Raghavendra Rao Chillarige, and Rajkumar Buyya, Genetic Algorithm based Data-aware Group Scheduling for Big Data Clouds, Proceedings of the 2014 International Symposium on Big Data Computing (BDC 2014, IEEE CS Press, USA), London, UK, Dec. 8-11, 2014.
 34. Joarder Mohammad Mustafa Kamal, Manzur Murshed, and Rajkumar Buyya, Workload-Aware Incremental Repartitioning of Shared-Nothing Distributed Databases for Scalable Cloud Applications, Proceedings of the 7th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2014, IEEE CS Press, USA), London, UK, Dec. 8-11, 2014.
 35. Asad W. Malik, Kashif Bilal, Khurram Aziz, Dzmitry Kliazovich, Nasir Ghani, Samee U. Khan, and Rajkumar Buyya, CloudNetSim++: A Toolkit for Data Center Simulations in OMNET++, Proceedings of the 11th International Conference on High-capacity Optical Networks and Enabling/Emerging Technologies (HONET 2014), Charlotte, North Carolina, USA, December 15-17, 2014.
 36. Rodrigo N. Calheiros and Rajkumar Buyya, Energy-Efficient Scheduling of Urgent Bag-of-Tasks Applications in Clouds through DVFS, Proceedings of the 6th IEEE International Conference on Cloud Computing Technology and Science (CloudCom 2014, IEEE CS Press, USA), Singapore, Dec. 15-18, 2014.
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5. Invited Presentations and Outreach

By the Lab Director:

Keynote Talks at International Conferences

1. Market-Oriented Cloud Computing and Big Data Applications, International Symposium on Big Data and Cloud Computing Challenges (ISBCC-2014), March 27-28, 2014, VIT University, Chennai, India.
2. Market-Oriented Cloud Computing and Big Data Applications, 5th International Conference on Information and Communication Systems (ICICS 2014), April 1-3, 2014, Irbid, Jordan.
3. Market-Oriented Cloud Computing and Big Data Applications, International Doctoral Symposium on Applied Computation and Security Systems (ACSS 2014), April 18-20, 2014, Kolkata, India.
4. Market-Oriented Cloud Computing and Big Data Applications, High-Performance Grid and Cloud Computing Workshop, In conjunction with 28th International Parallel and Distributed Processing Symposium (IPDPS 2014), May 19-23, 2014, Phoenix, Arizona, USA.
5. Panel - Architect Cloud and HPC for Big Data Era, 14th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid 2014), May 26-29, 2014, Chicago, Illinois, USA.
6. Market-Oriented Cloud Computing and Big Data Applications, 6th International Symposium on Parallel Architectures, Algorithms and Programming (PAAP 2014), July 13-15, 2014, Beijing, China.
7. Market-Oriented Cloud Computing and Big Data Applications, 3rd International Conference on Advances in Computing, Communications and Informatics (ICACCI-2014), September 24-27, 2014, Noida, Delhi, India.
8. Market-Oriented Cloud Computing and Big Data Applications, 5th International Conference on the Next Generation Information Technology (Confluence 2014), September 25-26, 2014, Amity University, Noida, Delhi, India.
9. Clouds and Big Data: Big Science to Big Population Applications, 2014 International Conference on Computer, Control, Informatics and Its Applications (IC3INA 2014), October 21-22, 2014, Bandung, Indonesia.
10. Market-Oriented Cloud Computing and Big Data Applications, 4th IEEE International Conference on Big Data and Cloud Computing (BDCloud 2014), Dec. 3-5, 2014, Sydney, Australia.
11. Market-Oriented Cloud Computing and Big Data Applications, International Conference on Information and Communication Technologies (ICICT 2014) December 3-5 2014, Kochi, India.
12. Market-Oriented Cloud Computing and Big Data Applications, 11th IEEE India Conference on Emerging Trends and Innovation in Technology (INDICON 2014), Dec. 11-13, 2014, Pune, India.
13. Market-Oriented Cloud Computing and Big Data Applications, International Conference on Graph Algorithms, High Performance Implementations and Applications, Dec. 17-19, Coimbatore, India.
14. Market-Oriented Cloud Computing and Big Data Applications, 6th International Conference on Advanced Computing (ICoAC 2014), Dec. 17-19, 2014, Chennai, India.
15. Energy-efficient Cloud Computing, International Symposium on Data Intensive Computing (DIC 2014), December 27, 2014, New Delhi, India.
16. Market-Oriented Cloud Computing and Big Data Applications, International Conference on Big Data and Analytics for Business, December 28-29, 2014, New Delhi, India.

National Conferences

1. Cloud Computing: Opportunities and Challenges, One day Workshop On Cloud Computing and the Aneka Platform, University of Calcutta, Kolkata, India, March 16, 2014.
2. Market-Oriented Cloud Computing and Big Data Applications, International Research Workshop on Cloud Computing, Jawaharlal Nehru University (JNU), New Delhi, India, September 26-27, 2014.
3. Market-Oriented Cloud Computing and Big Data Applications, Faculty Development Program on Cloud Computing and Social Networks, MCKV Institute of Engineering, Kolkata, India, Oct. 14, 2014.
4. Market-Oriented Cloud Computing and Big Data Applications, International Research Workshop on Recent Computing Technologies, Dec. 21-22, 2014, Jaipur, India.

Seminars - in Cloud Computing area:

1. Birla Institute of Technology and Science, Pilani (BITS Pilani), Dubai, UAE, April 6, 2014.
 2. VelTech University, Chennai, India, March 29, 2014.
 3. University of Hyderabad, Hyderabad, India, April 8, 2014.
 4. Maulana Azad National Institute of Technology (MANIT), Bhopal, Madhya Pradesh, India, April 11, 2014.
 5. Rajiv Gandhi Technical University, Bhopal, Madhya Pradesh, India, April 11, 2014.
 6. Acropolis Technical Campus, Indore, Madhya Pradesh, India, April 15, 2014.
 7. Clemson University, Clemson, South Carolina, USA, May 24, 2014.
 8. Sahyadri Kannada Sangha, Seattle, USA, June 1, 2014.
 9. Microsoft Corporation, Redmond, Seattle, USA, June 2, 2014.
 10. Universitat Politcnica de Catalunya (UPC), Barcelona, Spain, July 10, 2014.
 11. Chinese Academy Of Sciences (CAS), Beijing, China, July 15, 2014.
 12. Beijing Jiaotong University (BJTU), Beijing, China, July 16, 2014.
 13. Tsinghua University, Beijing, China, July 17, 2014.
 14. Indian Institute of Science (IISc), Bangalore, India, July 22, 2014.
 15. SJB Institute of Technology (SJBIT), Bangalore, India, July 23, 2014.
 16. Dr. Ambedkar Institute of Technology (AIT), Bangalore, India, July 24, 2014.
 17. University of Melbourne, Australia, July 29, 2014.
 18. University of New South Wales (UNSW), Sydney, Australia, Aug. 7, 2014.
 19. Macquarie University, Sydney, Australia, Aug. 11, 2014.
 20. Indian Institute of Technology Kanpur (IITK), Kanpur, India, Sept. 30, 2014.
 21. Indian Institute of Information Technology (IIIT), Allahabad, India, Oct. 7, 2014.
 22. Banaras Hindu University (BHU), Varanasi, India, Oct. 8, 2014.
 23. Kalyani Government Engineering College, Kalyani, India, Oct. 13, 2014.
 24. Binus University, Jakarta, Indonesia, Oct. 20, 2014.
 25. Rajagiri School of Engineering and Technology, Kochi, India, Dec. 5, 2014.
 26. Rajarambapu Institute of Technology, Sangli, India, Dec. 10, 2014.
 27. Defence Institute of Advanced Technology, Pune, India, Dec. 12, 2014.
 28. Malaviya National Institute of Technology, Jaipur, Dec. 19, 2014.
 29. Indian Institute of Technology (IIT), Kharagpur, India, Dec. 30, 2014.
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6. Selected Community Services

By the Lab Director:

IEEE Computer Society

1. Chair of Advisory Board, IEEE Technical Committee on Scalable Computing

IEEE Transactions on Cloud Computing

1. Editor in Chief (EiC), 2013-to date.

Software: Practice and Experience (Wiley)

1. Editor in Chief (EiC), 2014-to date.

Journal Editorials

1. Editorial Board Member, *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, *Multiagent and Grid Systems: An International Journal*, ISSN: 1574-1702, IOS Press, Amsterdam, The Netherlands, 2005 onwards.

Conference Steering Committee

1. Co-Chair, International Conference on e-Science(e-Science) series, 2005- to date.
2. Member, IEEE International Conference on Cluster Computing (ClusterXY), 1999-to date.
3. Member, International Symposium on Computer Architecture and High Performance Computing, 2005-to date.
4. Chair, IEEE/ACM International Conference on Utility and Cloud Computing (UCCxy), 2010-to date.

Technical Program Committee Memberships

1. 20th IEEE International Conference on Parallel and Distributed Systems (ICPADS 2014), December 16 19, 2014, Hsinchu, Taiwan.
2. 5th International Conference on Scalable Information Systems (INFOSCALE) September 24-26, 2014, Seoul, South Korea.
3. 2014 International Conference on Cloud Computing and Internet of Things (CCIOT2014), Dec. 13-14, 2014, Changchun, China.

Community Information Sources

- Maintained a Grid Computing Information Centre at: <http://www.gridcomputing.com>, whose newsletter mailing list has over 2500 members. This website is often ranked as #2 source for grid computing by Google search engine.
- Maintained a Cluster Computing Information Centre at: <http://www.buyya.com/cluster>

- Co-Moderator for Computing Research Repository (CoRR, <http://arxiv.org/corr/>)’s subject on “Distributed, Parallel, and Cluster Computing”.

By Other Members:

Technical Program Committee Memberships

1. Rodrigo N. Calheiros, 29th Symposium On Applied Computing (ACM SAC 2014) – Operating Systems Track, March 24-28, 2014, Gyeongju, Korea.
2. Rodrigo N. Calheiros, 3rd International Conference on Smart Grids and Green IT Systems (SMARTGREENS 2014), April 3-4, 2014, Barcelona, Spain.

7. International Visitors

1. Ms. Ling Ding, Heifei University of Technology, China, Oct 2012-Oct 2014.
 2. Ms. Deborah Magalhães, Federal University of Ceará, Brazil: July 2013-2014.
 3. Mr. Guilherme da Cunha Rodrigues, Federal University of Rio Grande do Sul (UFRGS), Brazil: Nov. 2013-July-2014.
 4. Patricia Arroba Garca, Universidad Politecnica de Madrid, Spain: Oct 2014-Jan 2015.
 5. Tian Wenhong, University of Electronic Science and Technology of China, Chengdu, China: July 2014-June 2015.
 6. A/Prof. Jing Liu, Inner Mongolia University, China: Sep. 2014-Sep. 2015.
 7. Mr. Hongyou Li, Sichuan University, China: Sep. 2014-Sep. 2015.
 8. Fábio Diniz Rossi, Pontifical Catholic University of Rio Grande do Sul, Brazil: Nov. 2014-Aug. 2015.
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8. Continuing Members Profile and Activities

Member Self Profile: Rodrigo N. Calheiros

I joined the CLOUDS Lab as a Research Fellow in June 2010, after being a research visitor between 2008 and 2009.

In early 2014, as a Research Fellow for ARC Discovery Project, I focused on Energy efficiency in Clouds, where I've been researching methods for reducing power consumption of VMs executing Bag of Tasks applications. Outcomes of this activity were presented in CloudCom 2014 conference in Singapore. I was also involved in the investigation of methods for reducing energy consumption of Clouds subject to workloads similar to Google cluster. This project is being carried by Ms. Sareh Fotuhi Piraghaj, which I am co-supervising in her PhD.

Later 2014, I joined an exciting new ARC Linkage Project, along with CA, on Business goals and analytics driven management of cloud computing. In the early stage of this project, I am focusing in applying advanced anomaly detection methods to detect problems in the operation of cloud data centers. Preliminary results are good, and I believe outcomes of this project will start appearing early next year.

Other of my activities in 2014 was a research project in partnership with Samsung. I am the co-Chief Investigator of this project that investigates utilization of Software Defined Networks in Clouds. As part of this project, we proposed a new vision for "Software-Defined Clouds," as well as extensions on the CloudSim toolkit towards modelling of SDN and networking elements in the toolkit.

Other activities I was involved in 2014 were program committee memberships, and supervision of PhD students.



Member Self Profile: Amir Vahid Dastjerdi

I am currently a research fellow at CloudsLab in the University of Melbourne and my research interests include SLA-aware resource management in SDN-based Cloud environments, service coordination for IoT, and Big data analytics. Please refer to the following publications for more information.

Conference papers:

- Rajkumar Buyya, Rodrigo N. Calheiros, Jungmin Son, Amir Vahid Dastjerdi, and Young Yoon, Software-Defined Cloud Computing: Architectural Elements and Open Challenges, Proceedings of the 3rd International Conference on Advances in Computing, Communications and Informatics (ICACCI 2014, ISBN: 978-1-4799-3078-4, IEEE Press, USA), New Delhi, India, September 24-27, 2014.
- Keynote Paper.
- Mohammed Alokayan, Amir Vahid Dastjerdi, and Rajkumar Buyya, SLA-aware Provisioning and Scheduling of Cloud Resources for Big Data Analytics, Proceedings of the 3rd International Conference on Cloud Computing for Emerging Markets (CCEM 2014, IEEE Press, USA), Bangalore, India, October 15-17, 2014.

Journal papers:

- Amir Vahid Dastjerdi and Rajkumar Buyya, Compatibility-aware Cloud Service Composition Under Fuzzy Preferences, IEEE Transactions on Cloud Computing, IEEE Computer Society Press, USA, 2014 .



Member Self Profile: Linlin Wu

Linlin Wu complete her PhD in March 2014 under the supervision of Professor Rajkumar Buyya in the CLOUDS Laboratory at the University of Melbourne, Australia. She received Master of Information Technology from the University of Melbourne and then worked for CA (Computer Associates Pty Ltd) as Quality Assurance Engineer. Then she joined National Australia Bank (NAB) as a Knowledge Optimization Officer. Here in Melbourne University, she has been awarded with APA scholarship supporting PhD studies. She received the Best Paper Award from AINA 2010 conference for her first publication. Her current re-search interests including: Service Level Agreement, QoS measurement, Resource Allocation, and Market-oriented Cloud computing. She is the Vice Chair of IEEE committee at the University of Melbourne organizing industry and social activities for IEEE members.



Member Self Profile: Adel Toosi

In September 2014, I have submitted my PhD thesis entitled “**On the Economics of Infrastructure as a Service Cloud Providers: Pricing, Markets, and Profit Maximization**”. My thesis was accepted without further amendments by the examiners and nominated for the best thesis award.

After my thesis submission, I have joined Clouds Lab as a research fellow and I started serving the University of Melbourne as a casual lecturer for the “Distributed Systems” course in Semester 1 2015. My current research interests include distributed systems and cloud computing system and specifically different aspects of clouds like pricing and market design, resource provisioning, scheduling, and energy efficiency.

Below you can find list of published and submitted papers in the last year of my PhD:

1. **Adel Nadjaran Toosi**, Member, Kurt Vanmechelen and Rajkumar Buyya “An Auction Mechanism for Cloud Spot Market” submitted to ACM transactions on Adaptive and Autonomous Systems, 2015.
2. **Adel Nadjaran Toosi**, Farzad Khodadadi, and Rajkumar Buyya, “SipaaS: Spot instance pricing as a Service Framework and its Implementation in Open-Stack”, submitted to Software: Practice and Experience (SPE), 2014.
3. **Adel Nadjaran Toosi**, Rodrigo N. Calheiros, Rajkumar Buyaa, “Interconnected Cloud Computing Environments: Challenges, Taxonomy and Survey”, Journal of ACM computing Surveys (ACM CSUR) , volume 47 (1), pages 7:1--7:47, 2014.
4. Saurabh Kumar Garg, **Adel Nadjaran Toosi**, Srinivasa K. Gopalaiyengar, Rajkumar Buyya “SLA-based Virtual Machine Management for Heterogeneous Workloads in a Cloud Datacenter”, Journal of Network and Computer Applications, volume 45, pages 108 – 120, 2014.
5. Mohsen Amini Salehi and **Adel Nadjaran Toosi**, Rajkumar Buyya, “Contention management in federated virtualized distributed systems: implementation and evaluation”, journal of Software: Practice and Experience, volume 44 (3), pages 353-368, 2014.



Member Self Profile: Deepak C Poola



I joined Cloudbus lab in July 2011 as a PhD Student under the supervision of Prof Rajkumar Buyya and Prof Rao Kotagiri. My chosen area of research is "*Robust and Fault-Tolerant Scheduling for Scientific Workflows in Cloud Computing Environments*". My area of interests includes Cloud Computing, Workflows, Scheduling Algorithms, Streaming Applications and Data Warehousing.

As a part of my research, I am investigating into scientific workflow scheduling focusing on robust and fault-tolerant schedules. My research is primarily focussed on Cloud computing environments. I am investigating on workflow scheduling with heterogeneous Cloud resources also working considering different Cloud pricing models (i.e spot and on-demand). As a part of research I have developed two heuristics so far, which have resulted in two papers, which are currently under review.

Prior to Joining Cloudbus Lab, I was working as an Application Developer in J P Morgan Chase, India. I have worked in Java, Spring, Struts, UNIX and web services as a part of my job profile. I have been in J P Morgan for two years from 2009 to 2011.

I have also worked as an Intern in Citrix R&D, Bangalore from Jan 2009 to Jun 2009. During which I worked on the implementation to WBXML parser for their home product Net scalar. Citrix gave me exposure and knowledge of working in a networking company.

I am a proud Alumina of BITS-Pilani, India. I have completed my M.E Computer Science from BITS-Pilani. Prior to which I completed my graduation in B.E Computer science from VISVESWARAIAH TECHNOLOGICAL UNIVERSITY, Karnataka. Apart from this I nourish interests in Poetry, Philosophy and Sports.

For more information on my current and past projects please visit my website:

<http://www.deepakpoola.com>

My Publications include:

- **Robust Scheduling of Scientific Workflows with Deadline and Budget Constraints in Clouds.**
Poola D., Garg S.K., Buyya R., Yang Y., and Rao K., Published in The 28th IEEE International Conference on Advanced Information Networking and Applications (AINA-2014), Victoria Canada.
- **Fault-Tolerant Workflow Scheduling Using Spot Instances on Clouds.**
Poola D., Buyya R. and Rao K., Published in The 13th International Conference on Computational Science (ICCS-2014), Cairns, Australia.
- **Enhancing Reliability of Workflow Execution Using Task Replication and Spot Instances**
Poola D., Buyya R. and Rao K., Submitted to the ACM Transactions on Autonomous and Adaptive Systems. Under Review
- **An Efficient Density Based Incremental Clustering Algorithm in Data Warehousing Environment.**
Navneet Goyal, Poonam Goyal, K Venkatramaiah, Deepak Poola, and Sanoop P S, Published in The 2009, International Conference on Knowledge Discovery (ICKD 2009)

Member Self Profile: Atefeh Khosravi

I joined CLOUDS Lab in March 2012 to pursue my PhD studies under the supervision of Prof. Rajkumar Buyya at the University of Melbourne. My PhD studies is funded by the Australian Postgraduate Award (APA).

Before entering the University of Melbourne, I received my M.Sc. degree of Computer Engineering in 2011 and my B.Sc. degree of Information Technology Engineering in 2008, both from the Amirkabir University of Technology. During my master studies, I have worked as a researcher and consultant on Iran National IP/MPLS Core Network project at Iran Telecommunication Research Center (ITRC).

Currently, I am a third year PhD student and my confirmed thesis subject by the committee is “Energy and Carbon-Efficient Resource Management in Distributed Cloud Data Centers”. It is mainly focused on the development of policies and algorithms for placement of virtual machines by considering data centers’ energy sources, carbon footprint, power consumption, and network distance, while meeting the required quality of service for Cloud users.

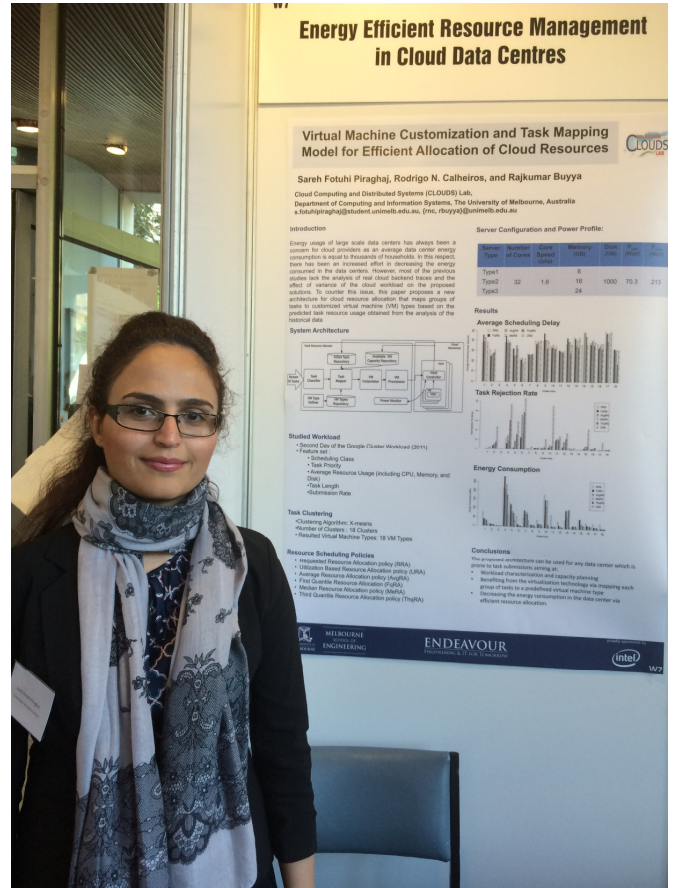
For more information, please visit <http://people.eng.unimelb.edu.au/atefehk>



Member Self Profile: Sareh Fotuhi Piraghaj

I joined CLOUDS Lab at the beginning of 2012 as PhD student. Prior to joining The University of Melbourne, I received my B.Sc. and M.Sc. degree in Electrical engineering from Gilan University and Iran University of Science and Technology (IUST) respectively. My research focus in PhD is on 'Autonomic Energy Efficient Resource Management in Cloud data centres'.

During my research I participated in deploying OpenStack on the available hardware using the KVM Hypervisor. This results in a technical report as a step by step installation guide for OpenStack. In addition, I have been working on workload characterisation of Google workloads and the impact of efficient resource allocations on energy consumption of a data center. During 2014, my main focus was on energy efficient container hosting and management in the newly introduced Container as a Service (CaaS) cloud service model.



Member Self Profile: Nikolay Grozev

I joined CloudsLab as a PhD candidate in 2012. I hold a bachelor's degree in Informatics and a master's degree in Software Engineering from the University of Sofia "St. Kliment Ohridski". I have also specialised at the Mälardalen University in Sweden, where I worked on my master's thesis.

My industry experience includes working as a Software Engineer at various companies participating in projects ranging from large scale enterprise systems to R&D products. Currently I am working at Microsoft, Operating Systems Group in Redmond, Washington.

In my current research I investigate how to architect 3-tier applications so they can utilise multiple Cloud data centres. This will make them more resilient to data centre outages and provide end users worldwide with high Quality of Experience (QoE). Moreover, it will allow for building cost efficient systems that are legislation compliant in multiple regulatory regions.

Besides publishing academic papers, I also try to disseminate my research through blogging to reach a wider audience. Additionally, I participate in the development and maintenance of several open source projects like CloudSim and CloudSimEx, which include prototypes based on my research work.



- Web Site - <http://www.nikgrozev.com/>
- Blog - <https://nikolaygrozev.wordpress.com/>
- GitHub - <https://github.com/nikolayg>
- Twitter - <https://twitter.com/nikolaygrozev>
- LinkedIn - <https://www.linkedin.com/in/nikolaygrozev>

Member Self Profile: Maria Alejandra Rodriguez

My name is Maria Alejandra Rodriguez and I am from Bogota, Colombia. I came to Melbourne on February 2010 to start my master's degree, Master of Engineering in Distributed Computing, at the University of Melbourne. I completed the degree on December 2011 with first class honours. In October 2012 I joined the Cloud Computing and Distributed Systems (CLOUDS) Laboratory as a PhD student under the supervision of Prof. Rajkumar Buyya.



Before coming to Australia, I finished my Bachelor's degree in Computing and Systems Engineering at Los Andes University in Bogota, Colombia.

I worked as a software engineer for over two years in Colombia and for one year in Tata Consultancy Services in Bangalore, India.

During my master's research project, I investigated the execution of scientific workflows on distributed environments, specifically on grids and clouds. I am now expanding on this topic and my knowledge of cloud computing. I am researching resource provisioning and scheduling algorithms for large-scale scientific workflows on Clouds. I have developed several heuristics that target IaaS Clouds and its pricing model while taking advantage of some of their more promising characteristics: elasticity, heterogeneity and auto-scaling. I am also working on improving and extending the capabilities of the Cloudbus Workflow Management System used to deploy scientific workflows in cloud computing environments.

Member Self Profile: Yaser Mansouri

I am a Ph.D. student under supervision of Prof. Rajkumar Buyya in the Department of Computing and Information, University of Melbourne. I joined Cloud Computing and Distributed Systems (CLOUDS) laboratory in August 2012. I received the B.Eng. and M.Sc. degrees from Shahid Beheshti University and Ferdowsi University of Iran, respectively.

My research interests cover the broad area of Distributed Systems, with special emphasis on data replication and management in data grids and data cloud systems. Specifically, I am interested in designing new data placement algorithms and analysing their performances. My recent publications are as follows:

[1] Yaser Mansouri, Adel Nadjaran Toosi and Rajkumar Buyya, Brokering Algorithms for Optimizing the Availability and Cost of Cloud Storage Services, Proceedings of the 5th IEEE International Conference on Cloud Computing Technology and Science (IEEE CloudCom 2013, IEEE CS Press, USA), Bristol, UK, Dec. 2-5, 2013.

[2] Yaser Mansouri, Minimizing Cost of K-Replica in Hierarchical Data Grid Environment, Proceedings of the 28th IEEE International Conference on Advanced Information Networking and Applications (AINA-2014), Victoria, Canada, May 13-16, 2014.



Member Self Profile: Chenhao Qu

I joined the CLOUDS lab in Feb 2013 under the supervision of Professor Rajkumar Buyya and Dr Rodrigo N. Calheiros. Before came to Australia, I graduated from Fudan University, China in 2012 with a bachelor degree on Software Engineering. In my research, I investigate how to deploy and manage applications on multi-clouds, which involves service discovery and selection, application monitoring, auto scaling, and SLA management. The aim of the research is to facilitate cost-efficient usage of cloud resources and in the meantime ensure high quality of service for application end users.



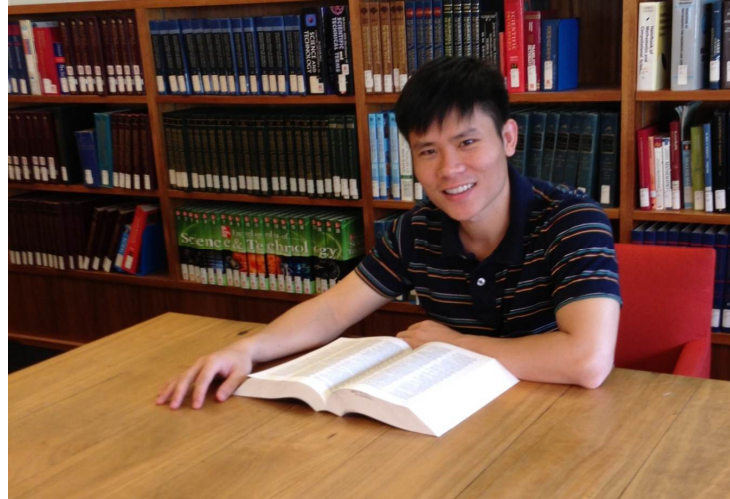
Member Self Profile: Le Tan Chanh Nguyen

I joined Clouds lab in June 2013 when I started my PhD program under the supervision of Professor Rajkumar Buyya and Dr Rodrigo N. Calheiros at University of Melbourne.

Before arriving at university of Melbourne, I have completed my master degree with the first class honour in Computer Science at Tsinghua University, Peking, China in June 2012 with the research project related to data mining and deep web. Previously, I received my bachelor degree in Software engineering at HCM

university of Technology, Viet Nam in 2009. Beside the academic experience, I have also worked in industry for one year after receiving bachelor degree. In during that time, I worked for a USA outsourcing company located at Ho Chi Minh city, Viet Nam in some projects related to business web services.

After investigating in Cloud computing research area in few months, I pursued my idea utilizing data mining techniques developing approaches aim at predicting future resource demand and anomaly detection in Cloud. Currently, I'm working on the combination approach in which the classification technique cooperates with machine learning algorithms modelling efficiently short-term host load predicting in Cloud infrastructure.



Member Self Profile: Yali Zhao

I joined Clouds lab in December 2013 to pursue my PhD studies under the supervision of Prof. Rajkumar Buyya. My current research focuses on SLA-based resource scheduling for big data analytic applications. My PhD studies are funded by Melbourne International Research Scholarship (MIRS) and Melbourne International Fee Remission Scholarship (MIFRS).

I obtained my bachelor degree of Software Engineering from Harbin Institute of Technology (HIT) in July 2011. I joined the international master program between HIT and University of Bordeaux 1 (UB1) and obtained my master degree of Software Engineering from HIT and master degree of Enterprise Computing and Engineering (Master Productique International) from UB1 in October 2013.

I joined the Research Center of Intelligent Computing for Enterprise & Service (ICES) in my first master year at HIT. I participated in the Intelligent Home Service System (IHSS) Project and accomplished the design and implementation of the subproject Health Service System (HSS). I conducted research topic, at UB1, on Service Brokering Mechanism, which is based on the wisdom of Service Composition. During my second master year, I undertook half year internship at Distributed System Group in Vienna University of Technology (TUWIEN) and derived my master thesis on "Design and Implementation of Workflow Scheduling Mechanism based on Resource Allocation".



Member Self Profile: Jungmin Son (Jay)

I started my PhD degree in Clouds lab since 2014, following a master thesis project conducted under the supervision of Prof Buyya and Dr Calheiros in 2013. For the master thesis, I designed and implemented automated decision system to efficiently select and allocate resources for multiple cloud providers.

Previously, I completed my bachelor degree in Information and Computer Engineering at Ajou University, South Korea. After completing my bachelor's degree in 2006, I had worked in Samsung Electronics as a software engineer for 4 years. I had contributed to develop multimedia softwares for various Samsung mobile phones.

In my PhD research, I investigate how to apply SDN to cloud data centers to ensure SLA and energy efficiency. It includes VM placement policies that aware network resources and network flow control for providing QoS. This work can help to design cloud data center in energy-efficient fashion, while guaranteeing SLA. Moreover, network flow management using SDN controller can give users more satisfactory network performance while cloud providers can still save costs. I am also interested in simulation and modelling for cloud data center.



Member Self Profile: Farzad Khodadadi

Farzad Khodadadi is a second year PhD candidate under supervision of Prof. Rajkumar Buyya in the CLOUDS laboratory at The University of Melbourne.

He received Bachelor of Engineering in Information Technology from Shiraz University of Technology and Masters of Science in IT from Sharif University of Technology.

After joining CLOUDS lab on February 2014, he started researching about recent trends in Cloud Computing such as Green Computing, but later changed his research focus to the emerging "Internet of Things" topic. Proposing an efficient architecture for integrating cloud services with IoT was the first milestone to be achieved. Regarding his previous experiences in scheduling and resource provisioning in distributed systems, providing solutions for meeting cloud-based IoT resource provisioning requirements are considered as future research directions.

The outcome of his recent works in this area is as follows:

[1]Farzad Khodadadi, Amir Vahid Dastjerdi, and Rajkumar Buyya, "Simurgh: A Framework for Effective Discovery, Programming, and Integration of Services Exposed in IoT", International Conference on Recent Advances in Inter-net of Things (in press).

[2] Farzad Khodadadi, Rodrigo N. Calheiros, and Rajkumar Buyya, "A Data-Centric Framework for Development and Deployment of Internet of Things Applications in Clouds", The International Conference on Intelligent Sensors, Sensor Networks and Information Processing (in press).



Member Self Profile: Bowen Zhou

My name is Bowen Zhou and I am from Harbin, China. I joined CLOUDS Lab in the Department of Computing and Information System in University of Melbourne in February 2014 under the supervision of Prof. Rajkumar Buyya and Dr. Rodrigo N. Calheiros and an external supervisor Prof. Satish Narayana Srirama in university of Tartu.

I received my Bachelor degree on information security in Harbin Institute of Technology in 2013. I had an internship in network security lab in HIT during the last year to develop pattern recognition algorithms for network traffic. Currently, I am doing research in Mobile cloud computing area. The work is related to developing framework and offloading policies for mobile code offloading.



Member Self Profile: Safiollah Heidari

I joined CLOUDS Lab in Jun 2014 at the University of Melbourne as a PhD student under the supervision of Prof. Rajkumar Buyya and Dr. Rodrigo N. Calheiros.

Previously I have graduated from K. N. Toosi University of Technology, Tehran, Iran, with First Class Honors degree in M.Sc. in Information Technology and I have published a number of papers during my studies. I am also member of Iran's National Elites Foundation, a prestigious organization for recognize, organize and support Iran's elite national talents. I have about two years of experiences working as a software engineer in different companies in Iran and also as a university lecturer.

As a first year PhD student I'm investigating resource provisioning, workflow scheduling and network aspects of large-scale graph-processing systems, Big Data and social networks on cloud environments.



Member Self Profile: Xunyun Liu

I joined Clouds lab in Sept. 2014 pursuing my PhD under the supervision of Professor Rajkumar Buyya and Dr Rodrigo N. Calheiros at University of Melbourne.

Before coming here I graduated from National University of Defense Technology with a master and a bachelor degree on Computer Science and Technology. At that time my research mainly focused on High Performance Computing such as MPI applications and fault-tolerance issues on TH supercomputer.

After transferring to Cloud computing research area for a few months, I am now interested in stream processing of big data on cloud and the resource provisioning and scheduling topic related to it. Starting with Apache Storm I have been actively working towards using cloud resources more efficiently and wisely.



Member Self Profile: Diana Barreto

I started my work with CloudLabs in 2013 while I was pursuing my Master in Information Technology (Distributed system stream). Under the supervision of Professor Rajkumar Buyya and Dr. Rodrigo N. Calheiros I completed satisfactorily my master's project and learned many aspects related with cloud computing foundations and resource provisioning. After finished the master I started to work as a Researcher in CloudLabs and during 2014 I have working extending Aneka, which is a multi-cloud platform that allow developing and deploying of distributed applications in multiple cloud providers. During this time I also worked as tutor of the master's subject Distributed Algorithms.



Prior my Masters I finished a graduate diploma in Software Construction in 2008 in La Universidad de los Andes and I got my bachelor's degree in system engineering in 2006 in La Pontificia Universidad Javeriana, both of them in Bogota Colombia. Moreover, I worked in the industry as software consultant for around 6 years, performing roles of software developer, business analyst and programming team leader.

Mainly I worked developing customized IT solutions for telecommunications and financial companies. I was involve with Java technologies and distributed applications in j2ee. Additionally I also gained some experience with Delphi and .Net and with the integration of different platforms. This experience makes me love middleware infrastructure and allow me to take the decision of starting new studies at The University of Melbourne.

Member Self Profile: Roland Padilla

Roland Padilla is uniquely positioned as an information systems (IS) practitioner-academic. As an IS professional he had worked for global organisations representing systems integration (SI), information technology (IT) consulting, and business process outsourcing (BPO). Most recently, he is recognised by the Australian Computer Society (ACS) as a senior ACS certified professional or MACS (Snr) CP, someone in professional practice for at least 10 years and has been in a senior ICT management position for at least 5 years.



He rose from the ranks as a PABX (Private Automatic Branch Exchange) Engineer involved in patching cables to a General Manager responsible for global operations. Roland has demonstrated success and proven an ability to lead people and manage numerous functions, consisting data networking from CISCO Systems (Engineer), IT systems integration from FUJITSU (Manager), resource management from Headstrong (Manager), IT service management from Netmarks (General Manager), and project management from NEC (Team Leader). These senior leadership and management functions from multi-national corporations provided an opportunity to engage in diverse industry segments, comprising telecommunications, semiconductor, automotive, banking, government, and utilities. Additionally, Roland has demonstrated global experiences, having undertaken projects, collaborations, and skills trainings in several countries such as Japan, US, Philippines, Hong Kong, Singapore, and UK.

Apart from real world and broad industry perspectives, Roland is deepening his viewpoint within the academic world. In 2010, he earned his master's degree in IS, and obtained a First-Class Honours (H1) or High Distinction (HD) equivalent. He had the honour and privilege to deliver the valedictory address on Graduation Day. In less than a month, he joined CISCO Systems in Sydney, and won 1st Place in its Asia-Pacific and Japan internship competition. Currently, Roland is finishing his doctoral dissertation, exploring how to measure service value in business-to-business cloud computing. Economies are increasingly dominated by the service sector. More than ever, research is needed to address approaches that measure and optimise service. His research journey examines service value within an interdisciplinary context, and focuses on the effective use of computing and information technologies by organisations. His thesis seeks to address the essential research question of how service value, as a higher-order formative measure, is investigated within the business-to-business context of cloud computing. The research project argues that a reliable conceptualisation of the service value construct is of critical relevance in the optimisation and measurement of the cloud computing phenomena.

In transitioning from Masters to PhD, Roland was awarded an Australian Postgraduate Award (APA), a scholarship awarded to local students with exceptional research potential and proven academic excellence. This scholarship supports him via fee remission and living allowance throughout this worthwhile intellectual journey. Apart from this scholarly pursuit, Roland is occupied as a Convenor of the cloud computing special interest group (SIG) of the ACS, and a Board Member of the ACS Victorian Branch.

For more information, please visit <http://linkedin.com/in/rolandpadilla>

Member Self Profile: Jing Ding

I'm Jing Ding, from Anhui Province of China. From October 2012, I became a visiting student supervised by Rajkumar Buyya in Cloud Computing and Distributed Systems (CLOUD) Laboratory at University of Melbourne. My visit is sponsored by Chinese Scholarship Council (CSC).

I am a second year PhD student at Hefei University of Technology in China. Before I came to University of Melbourne, I participated in projects on Cloud Computing, exploring decision making process and information service system architecture in Cloud Computing environment.

My current research focuses on Cloud services, in order to provide better infrastructure, platform and software services in Cloud Computing environment.

I wish to have vibrant and enjoyable study life in Melbourne.



Member Self Profile: Deborah Maria Vieira Magalhães

I am a third year PhD student in the Department of Teleinformatics Engineering at the Federal University of Ceará, Brazil. I joined CloudsLab in July 2013 supervised by Prof. Rajkumar Buyya and Dr. Rodrigo Calheiros as a visitor student at the University of Melbourne, sponsored by the Brazilian agency CNPq through the project Medical Applications Assisted by Scientific Computing (MACC). Since then I have worked with modeling and characterization of web and medical applications for analysis and simulation of cloud computing environments, providing an opportunity for the development of management policies and capacity planning of the physical resources according to the profile of resource usage and users behavior.



I am part in the Group of Computer Networks, Software Engineering and Systems (GREat) where I worked with cloud tasks scheduling through hierarchical and nonhierarchical clustering statistical methods considering the metrics throughput and response time and I also developed strategies for dynamic resource allocation in virtualized computing environments in order to reduce energy consumption without compromising performance requirements concerning availability and SLA violation during my master degree.

Before my master degree, I work in a project that provides latency tests in order to contribute to the operation of an advanced computational infrastructure to attend the academic, business and government through the development of simulations and data processing in areas such as meteorology, petroleum, automotive industry and Bioinformatics. This project has the collaboration of several universities throughout Brazil.

Member Self Profile: Guilherme da Cunha Rodrigues

I joined CLOUDS Lab in November 2013 to accomplish my partial doctoral under the supervision of Prof. Rajkumar Buyya and Dr. Rodrigo Calheiros at the University of Melbourne.

Before join the CLOUDS Lab, I received my MSc degree in Computer Science in 2008 from Pontifical University Catholic of Rio Grande do Sul (PUCRS). Currently, I'm PhD candidate at Federal University of Rio Grande do Sul (UFRGS) Brazil, under the supervision of Prof. Lisandro Granville at Computer Networks Group. Moreover, I'm professor at Federal Institute of Education, Science and Technology Sul Rio Grandense (IFSUL). I have worked in computer networks, network management and distributed systems.



My PhD research is on Cloud Monitoring, more specifically about the relationship among several cloud monitoring requirements such as scalability, accuracy, adaptability, and timeliness. In addition, I have contributed in research from other PhD candidates at UFRGS. My 2014 publications come below:

- Márcio Barbosa de Carvalho ; Rafael Pereira Esteves ; RODRIGUES, Guilherme da Cunha ; Clarissa Cassales Marquezan ; Lisandro Granville ; Liane Tarouco . Efficient Configuration of Monitoring Slices for Cloud Platform Administrators. In: IEEE Symposium on Computers and Communications, 2014, Madeira, Portugal. Proceedings of IEEE Symposium on Computers and Communication, ISCC 2014, Madeira, Portugal, 2014.
- RODRIGUES, Guilherme da Cunha ; Santos, G. L. ; Guimaraes, V. T. ; Lisandro Granville ; Liane Tarouco . An Architecture to Evaluate Scalability, Adaptability and Accuracy in Cloud Monitoring Systems. In: The International Conference on Information Networking, 2014, Phuket, Thailand. ICOIN 2014, 2014. p. 46-51.
- Guimaraes, V. T. ; Santos, G. L. ; RODRIGUES, Guilherme da Cunha ; Lisandro Granville ; Liane Tarouco . A Collaborative Solution for SNMP Traces Visualization. In: The International Conference on Information Networking, 2014, Phuket, Thailand. ICOIN 2014, 2014. p. 458-463.

Member Self Profile: Wenhong Tian

Since July 2014, Dr. Wenhong Tian is a visiting scholar with CLOUDS lab at the University of Melbourne. As part of his visit, he has been collaborating with Prof. Buyya in the Department of Computing and Information Systems on the Australian research project entitled “Dynamic resource provisioning for autonomic management of cloud computing environments”. Dr. Wenhong Tian is working with Prof. Buyya on manuscripts “On Minimizing Total Energy Consumption in the Scheduling of Virtual Machine Reservations”, “Analyzing Energy-efficiency of Scheduling Policies for Compute-Intensive Applications on Cloud” submitted, and a few related topics.



Member Self Profile: Jing Liu

I'm Jing Liu, Associated Professor of Inner Mongolia University in China. I received my Ph.D. degree in computer science from Institute of Computing Technology, Chinese Academy of Sciences in 2011. From Sep. 2014, I became a visiting researcher with Professor Rajkumar Buyya in the Cloud Computing and Distributed Systems (CLOUD) Laboratory at the University of Melbourne. My one-year visit here is sponsored by the Chinese Scholarship Council.



Before I came to the CLOUD lab, my research interests mainly focused on model-based software testing theory and applications, and Petri nets-based software modelling and verification methods. In the end of 2013, a "Cloud Computing and Services Software Laboratory" has been established in Inner Mongolia University and an elementary private cloud infrastructure was built. As a core member of this lab, I changed more research focus into cloud computing-related topics. As a freshman in the cloud computing field, I am very lucky to start research works under the guidance of Prof. Raj in the CLOUD lab. Now, my research interests include fault tolerance mechanism of cloud applications and elasticity testing in cloud computing environments. Besides, I also make efforts to integrate model-based software testing studies with cloud computing technologies effectively.

I really enjoy every happy day in Melbourne, and wish everyone in our harmonious CLOUD lab to have promising achievements.

Member Self Profile: Hongyou Li

I am a lecturer in the college of computer science at Sichuan University, China. I received my Ph.D. degree in computer science in December 2014 from Sichuan University. I became a visiting researcher supervised by Professor Rajkumar Buyya in the Cloud Computing and Distributed Systems (CLOUDS) Laboratory at the University of Melbourne from Sep. 2014. My visit is sponsored by Sichuan University.

After completing my bachelor's degree in 2006, I have been working for more than 8 years at Sichuan University. And I am a core member of the Mobile and Distributed Computing Lab at the university. My current research focuses on resource management of cloud systems and mobile cloud computing.



Member Self Profile: Patricia Arroba

I received my M.Sc. degree in 2011 in Telecommunication Engineering and my M.Sc. in Electronic Systems Engineering in 2012 both from the Technical University of Madrid (Universidad Politécnica de Madrid), Spain.

By the end of 2012 I started my PhD studies in the Department of Electronic Engineering from the same University, working in the areas of power modeling and energy optimization in Cloud data centers.

I joined CLOUDS Lab. in October 2014 as a visitor student at the University of Melbourne under the supervision of Professor Rajkumar Buyya. My research stay was sponsored by the *European Network of Excellence on High Performance and Embedded Architecture and Compilation* (HiPEAC).



My current research focuses on the design and development of algorithms and novel techniques that are also aware of non-traditional parameters, as frequency and temperature, to optimize the energy consumption of Cloud infrastructures.

During 2014, I was able to publish the following co-authored articles:

P. Arroba, J. L. Risco-Martín, M. Zapater, J. M. Moya and J. L. Ayala, “Enhancing Regression Models for Complex Systems using Evolutionary Techniques for Feature Engineering,” *Journal of Grid Computing*, 2014, DOI 10.1007/s10723-014-9313-8.

P. Arroba, J. L. Risco-Martín, M. Zapater, J. M. Moya, J. L. Ayala and K. Olcoz, “Server Power Modeling for Run-time Energy Optimization of Cloud Computing Facilities,” *Energy Procedia*, Volume 62, 2014, Pages 401-410, ISSN 1876-6102, DOI 10.1016/j.egypro.2014.12.402.

P. Arroba, M. Zapater, J. L. Ayala, J. M. Moya, K. Olcoz, and R. Hermida, “On the Leakage-Power modeling for optimal server operation,” in *Innovative architecture for future generation high-performance processors and systems (IWIA)*, 2014.

M. Zapater, **P. Arroba**, J. L. Ayala, J. M. Moya, and K. Olcoz, “A novel energy-driven computing paradigm for e-health scenarios,” *Future generation computer systems*, vol. 34, pp. 138-154, 2014. doi:10.1016/j.future.2013.12.012.

9. Selected Projects/Programs

Cloudbus: A Toolkit for Market-Oriented Cloud Computing

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

The Cloud Computing and Distributed Systems (CLOUDS) Laboratory is a software research and innovation group at the University of Melbourne, Australia. The Lab is actively engaged in design and development of next-generation computing systems and applications that aggregate by dynamically leasing services of distributed resources depending on their availability, capability, performance, cost, and users' QoS requirements. The lab is working towards realizing this vision through its two flagship projects: Gridbus and Cloudbus.

The Cloudbus project, an initiative that started in 2008 by the CLOUDS lab at the University of Melbourne, facilitates the realization of the above vision. The project developed innovative solutions for market-oriented Cloud computing. The current innovative developments include: (i) Aneka, a platform for developing and managing Cloud computing applications from market-oriented perspective; (ii) InterCloud, a framework for internetworking of Cloud service providers, dynamically creating federated computing environments, and scaling of distributed applications; (iii) CloudSim, a simulation framework that allows researchers to control every aspect of a Cloud environment: algorithms, platforms, and infrastructure; and (iv) Workflow Engine, a management platform that facilitates the creation, deployment and monitoring of complex applications modeled in a systematic and orderly manner in Cloud computing environments.

The Cloudbus project

The Cloudbus project is engaged in the creation of open-source specifications, architecture and a reference Cloud toolkit implementation of market-oriented cloud computing. Some of our technologies serve as foundation for industrial solutions offered by Manjrasoft to its customers worldwide.

The research probes include:

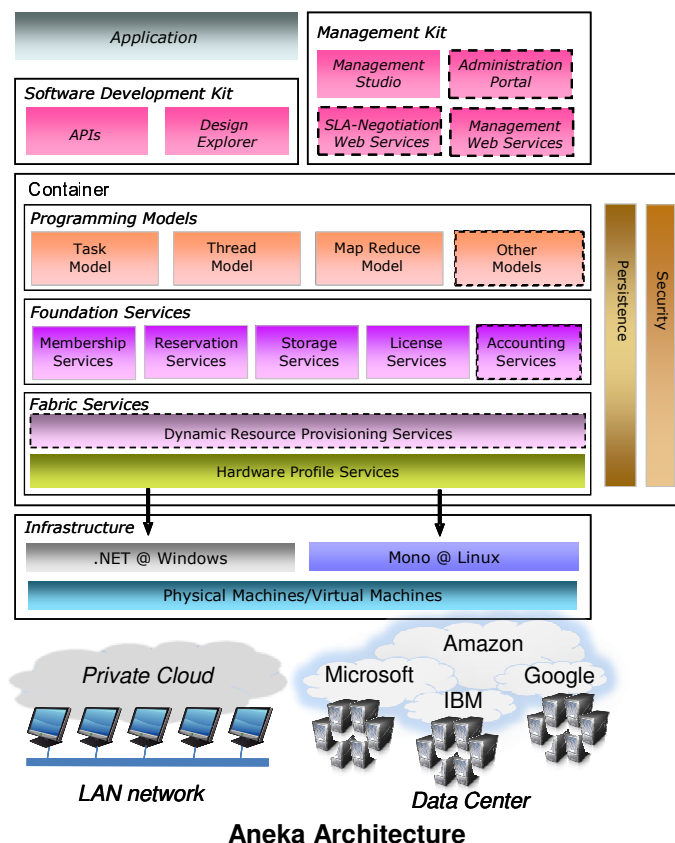
- Market Oriented Cloud Architecture
- Enterprise Cloud Application Platform (Aneka)
- Cloud Service Broker
- Cloud Workflows and Scheduling
- Service Level Agreements & Resource Allocation Systems (Libra).
- Energy-Efficient Data Centers and Clouds
- Cloud Simulation Toolkit (CloudSim).
- Application Development Environments
- Application Targets include: ECG Monitoring and Analysis, Data Mining and Business Analytics, Brain Imaging (Dartmouth Medical School), and Geophysics (*Intrepid*).
- Open SensorWeb Architecture
- InterCloud – Peering and Federation of Clouds
- Content Delivery Networks

Aneka: .NET-based Cloud Computing

Web: <http://www.manjrsoft.com>

ANEKA provides a set of services that make construction and development of Clouds and their applications as easy as possible without sacrificing flexibility, scalability, reliability and extensibility. It is now commercialized through Manjrsoft, a startup company of the University of Melbourne. The key features supported by ANEKA are:

- A configurable and flexible execution platform (container) enabling -
 - Pluggable services;
 - Security implementations - multiple authentication / authorization mechanisms such as role-based security and Windows domain-based authentication;
 - Multiple persistence options including RDBMS, SQL Express, MySQL and flat files;
- SDK (Software Development Kit) supporting multiple programming models including –
 - Object oriented thread model,
 - Task model for legacy applications
 - Map Reduce model for data-intensive applications
 - Custom tools such as Design Explorer for parameter sweep studies
- Easy to use management tool for SLA and QoS negotiation and resource allocation.



QoS-Oriented Cloud Workflow Engine

Web: <http://www.cloudbus.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.

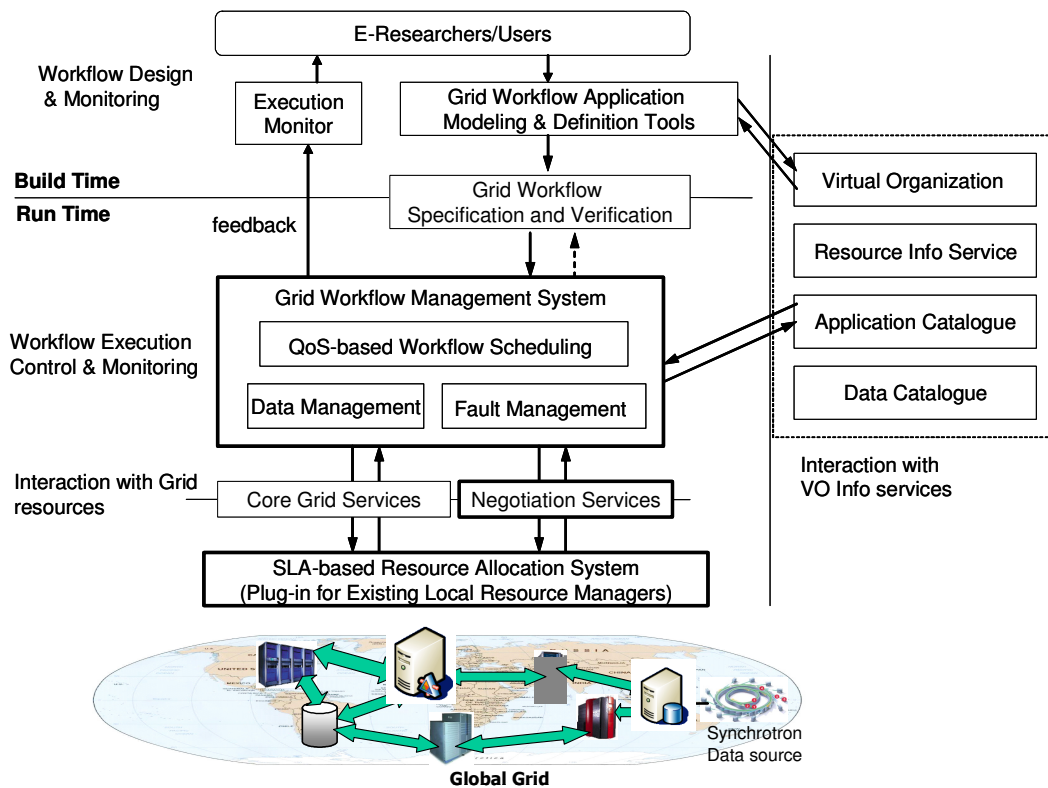


Fig. 1: Architecture of QoS-based workflow management and resource allocation system.

The Green Cloud Project: Innovative Solutions for Energy-Efficient Cloud Computing

Web: <http://www.cloudbus.org/greencloud>

Traditionally, high-performance computing (HPC) community has focused on performance (speed). Since early 2000, several companies have started building Data Centers inspired by commodity HPC (cluster computing) systems-architecture for hosting/powering industrial applications including search engines such as Google. At the same time microprocessor vendors have not only doubled the number of transistors (and speed) every 18-24 months, but they have also doubled the power densities. That is, the tremendous increase in computer performance has come with an even greater increase in power usage. As a result operational cost of HPC systems including industrial Data Centre is rapidly growing. This is reflected from a statement by CEO of Google (Eric Schmit): "what matter most to Google is not speed but power, because data centers can consume as much electricity as a city."

The aim of Green Cloud Project is to develop high-end computing systems such as Clusters, Data Centers, and Clouds that allocate resources to applications hosting Internet services (e-Services) to meet not only users' quality of service requirements, but also minimise consumption of electric power. That is to, to improve power management and consumption by dynamically managing and configuring power-aware ability of system devices, such as processors, disks, and communication links.

Selected Publications:

- Anton Beloglazov, Jemal Abawajy, and Rajkumar Buyya, Energy-Aware Resource Allocation Heuristics for Efficient Management of Data Centers for Cloud Computing, *Future Generation Computer Systems*, Volume 28, No. 5, Pages: 755-768, ISSN: 0167-739X, Elsevier Science, Amsterdam, The Netherlands, May 2012.
- Anton Beloglazov and Rajkumar Buyya, Optimal Online Deterministic Algorithms and Adaptive Heuristics for Energy and Performance Efficient Dynamic Consolidation of Virtual Machines in Cloud Data Centers, *Concurrency and Computation: Practice and Experience*, Volume 24, No. 13, Pages: 1397-1420, ISSN: 1532-0626, Wiley Press, New York, USA, September 10, 2012.
- Saurabh Garg and Rajkumar Buyya, Green Cloud Computing and Environmental Sustainability, *Harnessing Green IT: Principles and Practices*, 315-340pp, S. Murugesan and G. Gangadharan (eds), ISBN: 978-1-1199-7005-7, Wiley Press, UK, October 2012.
- Anton Beloglazov and Rajkumar Buyya, Managing Overloaded Hosts for Dynamic Consolidation of Virtual Machines in Cloud Data Centers Under Quality of Service Constraints, *IEEE Transactions on Parallel and Distributed Systems (TPDS)*, Volume 24, No. 7, Pages: 1366-1379, ISSN: 1045-9219, IEEE CS Press, Los Alamitos, CA, USA, July 2013.
- Atefeh Khosravi, Saurabh Kumar Garg, and Rajkumar Buyya, Energy and Carbon-Efficient Placement of Virtual Machines in Distributed Cloud Data Centers, *Proceedings of the 19th International European Conference on Parallel and Distributed Computing (Euro-Par 2013)*, Springer, Berlin, Germany), Aachen, Germany, August 26-30, 2013.
- Tom Guerout, Thierry Monteil, Georges Da Costa, Rodrigo Neves Calheiros, Rajkumar Buyya, Mihai Alexandru, Energy-aware simulation with DVFS, *Simulation Modelling Practice and Theory*, ISSN: 1569-190X, Elsevier Science, Amsterdam, The Netherlands, 2013. (in press, accepted on April 30, 2013).

CloudSim: A Framework for Modeling and Simulation of Cloud Computing Infrastructures and Services

Web: <http://www.cloudbus.org/cloudsim>

Recently, cloud computing emerged as the leading technology for delivering reliable, secure, fault-tolerant, sustainable, and scalable computational services, which are presented as Software, Infrastructure, or Platform as services (SaaS, IaaS, PaaS). Moreover, these services may be offered in private data centers (private clouds), may be commercially offered for clients (public clouds), or yet it is possible that both public and private clouds are combined in hybrid clouds.

These already wide ecosystem of cloud architectures, along with the increasing demand for energy-efficient IT technologies, demand timely, repeatable, and controllable methodologies for evaluation of algorithms, applications, and policies before actual development of cloud products. Because utilization of real testbeds limits the experiments to the scale of the testbed and makes the reproduction of results an extremely difficult undertaking, alternative approaches for testing and experimentation leverage development of new Cloud technologies.

A suitable alternative is the utilization of simulations tools, which open the possibility of evaluating the hypothesis prior to software development in an environment where one can reproduce tests. Specifically in the case of Cloud computing, where access to the infrastructure incurs payments in real currency, simulation-based approaches offer significant benefits, as it allows Cloud customers to test their services in repeatable and controllable environment free of cost, and to tune the performance bottlenecks before deploying on real Clouds. At the provider side, simulation environments allow evaluation of different kinds of resource leasing scenarios under varying load and pricing distributions. Such studies could aid the providers in optimizing the resource access cost with focus on improving profits. In the absence of such simulation platforms, Cloud customers and providers have to rely either on theoretical and imprecise evaluations, or on try-and-error approaches that lead to inefficient service performance and revenue generation.

The primary objective of this project is to provide a generalized and extensible simulation framework that enables seamless modeling, simulation, and experimentation of emerging Cloud computing infrastructures and application services. By using CloudSim, researchers and industry-based developers can focus on specific system design issues that they want to investigate, without getting concerned about the low level details related to Cloud-based infrastructures and services.

CloudSim is powered by jProfiler.

Main reference: Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, Cesar A. F. De Rose, and Rajkumar Buyya, CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms, Software: Practice and Experience (SPE), Volume 41, Number 1, Pages: 23-50, ISSN: 0038-0644, Wiley Press, New York, USA, January, 2011.

11. Moments with Visitors, Colleagues and International Hosts



At CCGrid 2014, Chicago, USA with Panel Members: Andrew Baptist (VP of Technology, Cleversafe), Kirk Cameron (Virginia Tech), Satoshi Matsuoka (Tokyo Institute of Technology), Ion Stoica (University of California, Berkeley), and Xian-He Sun (Illinois Institute of Technology) – May 2014.



With founders of ComputeNext.com during visit to Seattle, USA (June 2014)



Witt Dr. Tony Hey during visit to Microsoft Research, Seattle, USA (June 2014)



During inauguration of IEEE INDICON 2014 in Pune with *Vijay Bhatkar*, Rajat Moona, Tom Conte (IEEE CS President) and others. (Dec. 2014)



Celebrating "IEEE Fellowship" hosted by members of CLOUDS lab (Nov 2014).



During visit to IIT, Kanpur (Sept 2014).



During visit to Clemson University hosted by Amy Apon (May 2014).



With participants of 5th International Conference on Information and Communication Systems (ICICS 2014), April 1-3, 2014-Irbid, Jordan.