Cloud Computing and Distributed Systems Laboratory and the Cloudbus Project

www.cloudbus.org

Annual Report - 2016

School 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 **Clou**d Computing and **D**istributed **S**ystems (CLOUDS) Laboratory at the University of Melbourne, Australia during the academic year 2016, 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 2016 are:

- The Lab successfully hosted four ARC research projects: Future Fellowship programme, 2 Discovery Projects, and 1 Industry Linkage Project.
- Members of the CLOUDS Lab have authored 43 publications, which include 24 journal papers and 9 conference papers.
- The Lab's flagship Cloudbus Project has released various new modules for Aneka, CloudSim and iFogSim. The new CloudSim Toolkit now contains modules for DVFS, web modelling, MapReduce application and Containers modelling. It has been used by several researchers in academia and industries around the world including Ericsson!
- Members have presented over 30 invited talks that include 4 keynotes delivered at international conferences/seminars held in Australia, China, India, Iran, and Malaysia.
- The Lab successfully hosted research activities of over 25 scholars: 16 PhD students, 6 Research Fellows (4 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. A similar investigation *"International cloud computing literature: A scientometric analysis for 2004–13"* *noted us as #1 in Scientometric Profile of Top 20 Authors in Cloud Computing Research*.
- "**2016 Web of Science Highly Cited Researcher**" recognition from Thomson Reuters for a team member!
- In 2016 alone, our papers have attracted over 8750 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, Denmark, Estonia, Germany, Korea, and UK.
- Our Lab's spin-off company, Manjrasoft has been recognised as one of the Top 5 Cloud Apps companies by the Silicon Review Magazine.
- Members of the Lab have led community efforts such as (a) the organisation of conferences (e.g., UCC 2016 and BDC 2016 in China and (b) 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,

Professor Rajkumar Buyya, PhD
Director, Cloud Computing and Distributed Systems (CLOUDS) Laboratory
School 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
- Dr. Adel Toosi
- Dr. Maria Rodriguez
- Dr. Hasanul Ferdaus

PhD Students

- Ms. Atefeh Khosravi
- Ms. Sareh Fotuhi
- Mr. Yaser Mansouri
- Mr. Chenhao Qu
- Mr. Jungmin Jay Son
- Mr. Bowen Zhou
- Mr. Safiollah Heidari
- Mr. Xunyun Liu
- Mr. Caesar Wu
- Mr. Minxian Xu
- Ms. Sara Kardani Moghaddam
- Mr. Muhammad H. Hilman
- Mr. Redowan Mahmud
- Ms. Imairi Eitiveni
- Mr. Muhammed Tawfiqul

Collaborators
- Colleagues holding research grants with the Director
- International Visitors
- Many collaborators involved in extending and using the Cloudbus software.

International Visitors

- Prof. Satish Narayana Srirama, University of Tartu, Estonia: Jan 2016.
- Prof. Prof. R.K. Shyamasundar, IIT Bombay, June 2016.
- Mr. Leonard Heilig, University of Hamburg, Germany, July 2016.
- Prof. Shangguang Wang, Beijing University of Posts and Telecommunications (BUPT), China, July 2016.
- Prof. Kyong Hoon Kim, Gyeongsang National University, South Korea, July/Aug. 2016.
- Ms. Maria Salama, University of Birmingham, UK, Oct 2016.
- Mr. Artur Pilimon, Technical University of Denmark, Aug-Oct 2016.

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.
- R. Buyya, A. Lachlan, and A. Wierman, Resource management algorithms and software systems for green cloud computing, Discovery Project, ARC, 2013-2016. 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.
- R. Buyya, Algorithms and Software Systems for Management of Software-Defined Clouds, Discovery Project, Australian Research Council (ARC), 2016-2020. Amount: $410,000.

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, 2013-2017. 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, 2013-2017. Amount: $150,000.
- R. Buyya and A. Vahid, "Data Science for Enabling Prediction and Classification of Pedestrians Flows in Melbourne City", Academic Research Grant-Equipment Access, Microsoft, Seattle, USA, 2015-2017. Amount Equivalent: Approx. US$20,000.

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	2015	2016
Books/Proceedings Edited	1	1	1	1	5	4	3	5	2	3	2	2	1	2	3
Journal Papers	6	1	4	5	6	4	10	13	8	9	15	17	17	17	24
Book Chapters	1	0	0	4	4	2	4	11	3	13	3	1	2	3	6
Conference Papers	4	7	9	16	15	24	22	27	15	14	12	6	14	21	9
Magazine/Other Articles	0	0	1	2	4	2	0	1	2	1	0	5	2	3	1
Total	12	9	15	28	34	36	39	57	30	40	32	31	36	46	43

Books/Proceedings Edited

1. Rajkumar Buyya and Amir Vahid Dastjerdi (eds.), Internet of Things: Principles and Paradigms, Morgan Kaufmann, ISBN: 978-0-12-805395-9, Burlington, Massachusetts, USA, May 2016.
2. Rajkumar Buyya, Rodriog N. Calheiros, and Amir Vahid Dastjerdi (eds.), Big Data: Principles and Paradigms, Morgan Kaufmann, ISBN: 978-0-12-805394-2, Burlington, Massachusetts, USA, June 2016.
3. K.R. Venugopal, Rajkumar Buyya, and L.M. Patnaik, Proceedings of the 12th International Conference on Communication Networks (ICCN 2016, August 19-21, 2016, Bangalore, India), Procedia Computer Science, Volume 59, Elsevier Press, Amsterdam, The Netherlands, 2016.

Book Chapters

4. Jungmin Son, Diana Barreto, Rodrigo N. Calheiros, and Rajkumar Buyya, Automatic Provisioning of Intercloud Resources driven by Nonfunctional Requirements of Applications, Encyclopedia on Cloud Computing, S. Murugesan and I. Bojanova (eds), ISBN-13: 978-1118821978, Wiley Press, New York, USA, 2016.
5. Farzad Khodadadi, Amir Vahid Dastjerdi, and Rajkumar Buyya, Internet of Things: An Overview, Internet of Things: Principles and Paradigms, R. Buyya and A. Dastjerdi (eds), Morgan Kaufmann, ISBN: 978-0-12-805395-9, Burlington, Massachusetts, USA, May 2016.
6. Xunyun Liu, Amir Vahid Dastjerdi, and Rajkumar Buyya, Stream Processing in IoT: Foundations, State-of-the-Art, and Future Directions, Internet of Things: Principles and Paradigms, R. Buyya and A. Dastjerdi (eds), Morgan Kaufmann, ISBN: 978-0-12-805395-9, Burlington, Massachusetts, USA, May 2016.
7. Amir Vahid Dastjerdi, Harshit Gupta, Rodrigo N. Calheiros, Soumya K. Ghosh, and Rajkumar Buyya, Fog Computing: Principles, Architectures, and Applications, Internet of Things: Principles and Paradigms, R. Buyya and A. Dastjerdi (eds), Morgan Kaufmann, ISBN: 978-0-12-805395-9, Burlington, Massachusetts, USA, May 2016.
8. Caesar Wu, Rajkumar Buyya, and Kotagiri Ramamohanarao, Big Data Analytics = Machine Learning + Cloud Computing, Big Data: Principles and Paradigms, R. Buyya, R. Calheiros, and A. Dastjerdi (eds), Morgan Kaufmann, ISBN: 978-0-12-805394-2, Burlington, Massachusetts, USA, June 2016.

9. Sareh Fotuhi Piraghaj, Amir Vahid Dastjerdi, Rodrigo N. Calheiros, and Rajkumar Buyya, A Survey and Taxonomy of Energy Efficient Resource Management Techniques in Platform as a Service Cloud, Handbook of Research on End-to-End Cloud Computing Architecture Design, J. Chen, Y. Zhang, and R. Gottschalk (eds), 410-454pp, ISBN13: 9781522507598, IGI Global, Hershey, PA, USA, October 2016.

Journal Editorials

NIL

Journal Papers

10. Raghavendra Kune, Pramod Kumar Konugurthi, Arun Agarwal, Raghavendra Rao Chillarige, and Rajkumar Buyya, The Anatomy of Big Data Computing, Software: Practice and Experience (SPE), Volume 46, Number 1, Pages: 79-105, ISSN: 0038-0644, Wiley Press, New York, USA, Jan. 2016.

11. Guofu Feng and Rajkumar Buyya, Maximum Revenue Oriented Resource Allocation in Cloud, International Journal of Grid and Utility Computing, Volume 7, Issue 1, Pages: 12-21, ISSN: 1741-847X, Inderscience Publishers, UK, Jan. 2016

12. Deepak Poola, Kotagiri Ramamohanarao, and Rajkumar Buyya, Enhancing Reliability of Workflow Execution Using Task Replication and Spot Instances, ACM Transactions on Autonomous and Adaptive Systems (TAAS), Volume 10, Number 4, Article No.: 30, ISSN:1556-4665, ACM Press, New York, USA, February 2016.

13. Sareh Fotuhi Piraghaj, Rodrigo N. Calheiros, Jeffrey Chan, Amir Vahid Dastjerdi, and Rajkumar Buyya, Virtual Machine Customization and Task Mapping Architecture for Efficient Allocation of Cloud Data Center Resources, The Computer Journal, Volume 59, No. 2, Pages: 208-224, ISSN 0010-4620, Oxford University Press, UK, February 2016.

14. Adel Nadjaran Toosi, Kurt Van Mechelen, Farzad Khodadadi, and Rajkumar Buyya, An Auction Mechanism for Cloud Spot Markets, ACM Transactions on Autonomous and Adaptive Systems (TAAS), Volume 11, Number 1, Article No.: 2, ISSN:1556-4665, ACM Press, New York, USA, February 2016.

15. Joarder Kamal, Manzur Murshed, and Rajkumar Buyya, Workload-Aware Incremental Repartitioning of Shared-Nothing Distributed Databases for Scalable OLTP Applications, Future Generation Computer Systems (FGCS), Volume 56, Pages: 421-435, ISSN: 0167-739X, Elsevier Science, Amsterdam, The Netherlands, March 2016.

16. Syam Kumar Pasupuleti, Subramanian Ramalingam, and Rajkumar Buyya, An Efficient and Secure Privacy-Preserving Protocol Approach for Outsourced Data of Resource Constrained Mobile Devices in Cloud Computing, Journal of Network and Computer Applications (JNCA), Volume 64, Pages: 12-22, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, April 2016.

17. Chenhao Qu, Rodrigo N. Calheiros, and Rajkumar Buyya, A Reliable and Cost-Efficient Auto-Scaling System for Web Applications Using Heterogeneous Spot Instances, Journal of Network and Computer Applications (JNCA), Volume 65, Pages: 167-180, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, April 2016.

18. Suleman Khan, Abdullah Gani, Ainuddin Wahid Abdul Wahab, Mustapha Aminu Bagiwa, Muhammad Shiraz, Samee U. Khan, Rajkumar Buyya, and Albert Y. Zomaya, Cloud Log Forensics: Foundations, State of the Art, and Future Directions, ACM Computing Surveys, Volume 49, No. 1, Article No. 7, ISSN 0360-0300, ACM Press, New York, USA, May 2016.

19. Raghavendra S, Geeta C M, Rajkumar BuyyA, Venugopal K R, S S Iyengar and L M Patnaik, DRSMS: Domain and Range Specific Multi-Keyword Search over Encrypted Cloud Data, International Journal of Computer Science and Information Security (IJCSIS), Vol. 14, No. 5, Pages: 69-78, ISSN 1947-5500, May 2016, USA.

20. Wei Ai, Kenli Li, Shenglin Lan, Fan Zhang, Jing Mei, Keqin Li, and Rajkumar Buyya, On Elasticity Measurement in Cloud Computing, Scientific Programming, ISSN: 1058-9244, Volume 2016, Article ID 7519507, Hindawi Publishing Corporation, New York, USA, June 2016.

21. Wenhong Tian, Guozhong Li, Wutong Yang, and Rajkumar Buyya, HScheduler: An Optimal Approach to Minimize the Makespan of Multiple MapReduce Jobs, The Journal of Supercomputing, Volume 72, Number 6, Pages: 2376-2393, ISSN: 0920-8542, Springer Science+Business Media, Berlin, Germany, June 2016.

22. Jun Tang, Yong Cui, Qi Li, Kui Ren, Jiangchuan Liu, and Rajkumar Buyya, Ensuring Security and Privacy Preservation for Cloud Data Services, ACM Computing Surveys, Volume 49, No. 1, Article No. 13, ISSN 0360-0300, ACM Press, New York, USA, June 2016.

23. Jin Huang, Rui Zhang, Rajkumar Buyya, Jian Chen, and Yongwei Wu, HEADS-JOIN: Efficient Earth Movers Distance Similarity Joins on Hadoop, IEEE Transactions on Parallel and Distributed Systems (TPDS), Volume 27, No. 6, Pages: 1660-1673, ISSN: 1045-9219, IEEE CS Press, USA, June 2016.

24. Uthpala Premarathne, Alsharif Abuadbba, Abdulatif Alabdulatif, Ibrahim Khalil, Zahir Tari, Albert Zomaya, and Rajkumar Buyya, Hybrid Cryptographic Access Control for Cloud-based EHR Systems, IEEE Cloud Computing, Volume 3, No. 4, Pages: 58-65, ISSN: 2325-6095, IEEE Computer Society Press, USA, July-August 2016.

25. Raghavendra S, Nithyashree K, Geeta C.M, Rajkumar Buyya, Venugopal K. R, S. S. Iyengar and L. M. Patnaik, RSSMSO Rapid Similarity Search on Metric Space Object Stored in Cloud Environment, International Journal of Organizational and Collective Intelligence, Volume 6, No. 3, Pages: 32-47, ISSN: 1947-9344, IGI Global, Hershey, PA, USA, July-September 2016.

26. Nikolay Grozev and Rajkumar Buyya, Regulations and Latency-aware Load Distribution of Web Applications in Multi-Clouds, The Journal of Supercomputing, Volume 72, Number 8, Pages: 3261-3280, ISSN: 0920-8542, Springer Science+Business Media, Berlin, Germany, August 2016.

27. Quratulain Alam, Saher Tabbasum, Saif-ur-Rehman Malik, Masoom Alam, Tamleek Ali, Adnan Akhunzada, Samee U. Khan, Athanasios V. Vasilakos, and Rajkumar Buyya, Formal Verification of the xDAuth Protocol, IEEE Transactions on Information Forensics and Security, Volume 11, Number 9, Pages: 1956-1969, ISSN: 1556-6013, IEEE Signal Processing Society, USA, September 2016.

28. Raghavendra S, Chitra S Reddy, Geeta C M, Rajkumar Buyya, Venugopal K R, S S Iyengar, and L M Patnaik, Survey on Data Storage and Retrieval Techniques over Encrypted Cloud Data, International Journal of Computer Science and Information Security (IJCSIS), ISSN 1947-5500, Vol. 14, No. 9, Pages: 718-745, ISSN: 1947-5500, USA, September 2016.

29. Adel Nadjaran Toosi, Farzad Khodadadi, and Rajkumar Buyya, SipaaS: Spot Instance Pricing as a Service Framework and its Implementation in OpenStack, Concurrency and Computation: Practice and Experience (CCPE), Volume 28, No. 13, Pages: 3672-3690, ISSN: 1532-0626, Wiley Press, New York, USA, September 10, 2016.

30. Yaser Mansouri and Rajkumar Buyya, To Move or Not to Move: Cost Optimization in a Dual Cloud-based Storage Architecture, Journal of Network and Computer Applications (JNCA), Volume 75, Pages: 223-235, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, November 2016.

31. Sukhpal Singh, Inderveer Chana, Maninder Singh, Rajkumar Buyya, SOCCER: Self-Optimization of Energy-efficient Cloud Resources, Journal of Cluster Computing, Volume 19, Number 4, Pages: 17871800, ISSN: 1386-7857, Springer, New York, USA, December 2016.

32. Manish Verma, G R Gangadharan, Nanjangud Narendra, Ravi Vadlamani, Vidyadhar Inamdar, Lakshmi Ramachandran, Rodrigo N. Calheiros, and Rajkumar Buyya, Dynamic Resource Demand Prediction and Allocation in Multi-tenant Service Clouds, Concurrency and Computation: Practice and Experience (CCPE), Volume 28, No. 17, Pages: 4429-4442 , ISSN: 1532-0626, Wiley Press, New York, USA, December 2016.

33. Minxian Xu, Amir Vahid Dastjerdi, and Rajkumar Buyya, Energy Efficient Scheduling of Cloud Application Components with Brownout, IEEE Transactions on Sustainable Computing (T-SUSC), Volume 1, Number 2, Pages: 40-53, ISSN: 2377-3782, IEEE Computer Society Press, USA, July-Dec. 2016.

Magazine Papers

34. Amir Vahid Dastjerdi and Rajkumar Buyya, Fog Computing: Helping the Internet of Things Realize its Potential, IEEE Computer, Volume 49, Issue 8, Pages: 40-44, ISSN: 0018-9162, IEEE CS Press, USA, August 2016.

Conference Papers

35. Raghavendra S, Geeta Mara, Rajkumar Buyya, Venugopal Kuppanna Rajuk, Sitharama Iyengar and L M Patnaik, DRSIG: Domain and Range Specific Index Generation for Encrypted Cloud Data, Proceedings of the 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT 2016, IEEE Press, USA), New Delhi, India, March 11-13, 2016.
36. Guilherme da Cunha Rodrigues, Rodrigo N. Calheiros, Vincius Tavares Guimares, Glederson Lessa dos Santos, Mrcio Barbosa de Carvalho, Lisandro Zambenedetti Granville, Liane Margarida Rockenbach Tarouco, and Rajkumar Buyya, Monitoring of Cloud Computing Environments: Concepts, Solutions, Trends, and Future Directions, Proceedings of the 31st ACM Symposium on Applied Computing (SAC 2016), Pisa, Italy, April 4-8, 2016.
37. Xiangbo Li, Mohsen Amini Salehi, Magdy Bayoumi and Rajkumar Buyya, CVSS: A Cost-Efficient and QoS-Aware Video Streaming Using Cloud Services, Proceedings of the 16th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid 2016, IEEE CS Press, USA), Cartagena, Colombia, May 16-19, 2016.
38. Safiollah Heidari, Rodrigo N. Calheiros and Rajkumar Buyya, iGiraph: A Cost-efficient Framework for Processing Large-scale Graphs on Public Clouds, Proceedings of the 16th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid 2016, IEEE CS Press, USA), Cartagena, Colombia, May 16-19, 2016.
39. Giannis Tziakouris, Rami Bahsoon, Tom Chothia, and Rajkumar Buyya, Thwarting Market Specific Attacks In Cloud, Proceedings of the 9th IEEE International Conference on Cloud Computing (Cloud 2016, IEEE CS Press, USA), San Francisco, USA, June 27 - July 2, 2016.
40. S Raghavendra, K Nithyashree, C M Geeta, Rajkumar Buyya, K R Venugopal, S S Iyengar, and L M Patnaik, FRORSS: Fast Result Object Retrieval using Similarity Search on Cloud, Proceedings of 2016 IEEE International Conference on Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER 2016, IEEE Press, USA), Surathkal, India, Aug. 12-14, 2016.
41. S. Raghavendra, K. Meghana, P.A. Doddabasappa, C.M. Geeta, Rajkumar Buyya, K.R. Venugopal, S.S. Iyengar, L.M. Patnaik, Index Generation and Secure Multi-user Access Control over an Encrypted Cloud Data, Proceedings of the 12th International Conference on Communication Networks (ICCN 2016, Aug. 19-21, 2016, Bangalore, India), Procedia Computer Science, Volume 89, Elsevier Press, Amsterdam, The Netherlands, 2016.
42. Jaydeep Das, Soumya K. Ghosh, and Rajkumar Buyya, A Geospatial Orchestration Framework on Cloud for Processing User Queries, Proceedings of the 5th International Conference on Cloud Computing for Emerging Markets (CCEM 2016, IEEE Press, USA), Bangalore, India, October 19-21, 2016.
43. Carlos Joseph Mera Gmez, Rami Bahsoon and Rajkumar Buyya, Elasticity Debt: A Debt-Aware Approach to Reason About Elasticity Decisions in the Cloud, Proceedings of the 9th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2016, IEEE CS Press, USA), Shanghai, China, Dec. 6-9, 2016.

5. Invited Presentations and Outreach

By the Lab Director:

Keynote Talks at International Conferences
1. New Innovations in Cloud Computing for Big Data and IoT Applications, 1st International Conference on Internet of Things (ICIoT 2016), Bangalore, India, August 18-19, 2016.
2. New Innovations in Cloud Computing for Big Data Applications, 12th International Multi Conference on Information Processing (IMCIP 2016), Bangalore, India, August 19-21, 2016.
3. New Frontiers in Cloud Computing for Big Data and Internet-of-Things (IoT) Applications, 1st International Conference on Accessibility to Digital World (ICADW 2016), Guwahati, Assam, India, Dec. 16-18, 2016.
4. New Frontiers in Cloud Computing for Big Data and Internet-of-Things (IoT) Applications, International Conference on Advance Computing and Intelligent Engineering (ICACIE 2016), Bhubaneswar, Odisha, India, Dec. 21-23, 2016.

National Conferences
1. A Vedic India View on Economy and Global Unity: Balancing Spiritual and Material Dimensions, Conference on Economic Growth and National Unity, Delhi, India, April 25, 2016.
2. New Innovations in Cloud Computing, One Week National Level Research Oriented Workshop on Cloud and GPU Computing (Cloud-GPU 2016), Jawaharlal Nehru Technological University (JNTU), Kakinada, India, August 8-12, 2016.
3. Research Oriented Workshop on New Innovations in Cloud Computing for Big Data Applications, Sree Vidyanikethan Engineering College, Tirupati, India, August 13, 2016.
4. New Frontiers in Cloud Computing for Big Data and Internet-of-Things (IoT) Applications, 3rd International Research Workshop on Cloud Computing (RWCC 2016), Jawaharlal Nehru University (JNU), Delhi, India, Dec. 22-23, 2016.

Seminars - in Cloud Computing area:
1. New Trends in Cloud Computing, IBM Webinar for Nitte University (Mangalore), Shivalik College Of Engineering, and University of Petroleum and Energy Studies (Dehradun), Feb. 11, 2016, India.
2. New Innovations in Cloud Computing for Big Data Applications, IEEE Region 109 Webinar, April 15, 2016, Asia-Pacific.
3. New Innovations in Cloud Computing for Big Data Applications, Hubei Engineering University, Xiaonan, Xiaogan, Hubei, China, April 18, 2016.
4. Cost-Efficient Deployment of Big Data Workflow Applications in Cloud Computing Environments, Huazhong University of Science and Technology (HUST), Wuhan, China, April 18, 2016.
5. Cost-Efficient Deployment of Big Data Workflow Applications in Cloud Computing Environments, Wuhan University, Wuhan, China, April 19, 2016.
6. New Innovations in Cloud Computing for Big Data Applications, Wuhan University of Science and Technology, Wuhan, China, April 19, 2016.
7. Cost-Efficient Deployment of Big Data Workflow Applications in Cloud Computing Environments, Beijing University of Posts and Telecommunications (BUPT), Beijing, China, April 20, 2016.
8. Cost-Efficient Deployment of Big Data Workflow Applications in Cloud Computing Environments, University of Science and Technology Beijing (USTB), Beijing, China, April 21, 2016.
9. New Innovations in Cloud Computing for Big Data Applications, South Asian University, Delhi, India, April 25, 2016.

10. New Innovations in Cloud Computing for Big Data Applications, Institute for Development & Research in Banking Technology, Hyderabad, India, April 26, 2016.
11. New Innovations in Cloud Computing for Big Data Applications, Osmania University, Hyderabad, India, April 27, 2016.
12. New Innovations in Cloud Computing for Big Data Applications, National Institute of Technology, Warangal, India, April 28, 2016.
13. Cost-Efficient Deployment of Big Data Applications in Cloud Computing Environments, University of Hyderabad, Hyderabad, India, April 29, 2016.
14. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, Maulana Abul Kalam Azad University of Technology (formerly West Bengal University of Technology), Kolkata, India, July 29, 2016.
15. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, JIS College of Engineering, Kalyani, India, August 1, 2016.
16. Cost-Efficient Deployment of Data Workflow Applications in Cloud Computing Environments, Indian Institute of Technology, Kharagpur, India, August 2, 2016.
17. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, C.V. Raman College of Engineering, Bhubaneswar, India, August 4, 2016.
18. New Innovations in Cloud Computing, Siksha 'O' Anusandhan (SOA) University, Bhubaneswar, India, August 6, 2016.
19. New Trends in Computer Science, Siddhartha Institute of Technology, Vijayawada, India, August 9, 2016.
20. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, Vignan University, Guntur, India, August 10, 2016.
21. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, Chirala Engineering College, Chirala, India, August 11, 2016.
22. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, Sri Venkateswara University, Tirupati, India, August 12, 2016.
23. Energy-Efficient Cloud Computing: Opportunities and Open Challenges, Indian Institute of Science, Bangalore, India, August 16, 2016.
24. New Innovations in Cloud Computing for Big Data and Internet-of-Things Applications, MEI Polytechnic, Bangalore, India, August 17, 2016.
25. How to Improve Publications and Enhance their Impact, University Malaya, Kuala Lumpur, Malaysia, Nov. 29, 2016.
26. Energy-Efficient Cloud Computing: Opportunities and Open Challenges, Maulana Abul Kalam Azad University of Technology, Kolkata, India, Dec. 1, 2016.
27. Energy-Efficient Cloud Computing: Opportunities and Open Challenges, Indian Institute Technology (IIT), Kharagpur, India, Dec. 8, 2016.
28. New Frontiers in Cloud Computing for Big Data and IoT Applications, Indian Institute Technology (IIT), Guwahati, Assam, India, Dec. 13, 2016.
29. New Frontiers in Cloud Computing for Big Data and IoT Applications, Indian Institute of Information Technology (IIIT), Guwahati, Assam, India, Dec. 14, 2016.
30. New Frontiers in Cloud Computing for Big Data and IoT Applications, Tezpur University, Tezpur, Assam, India, Dec. 15, 2016.
31. New Frontiers in Cloud Computing for Big Data and IoT Applications, Indian Institute Technology (IIT), Bhubaneswar, Odisha, India, Dec. 20, 2016.
32. New Frontiers in Cloud Computing for Big Data and IoT Applications, GLA University, Mathura, India, Dec. 24, 2016.
33. New Frontiers in Cloud Computing for Big Data and IoT Applications, Jamia Millia Islamia, Delhi, India, Dec. 30, 2016.

6. Selected Community Services

IEEE Computer Society

1. Advisory Board, IEEE Technical Committee on Scalable Computing
2. Coordinator (Australia and New Zealand), Technical Committee on Parallel Processing (TCPP)

Software: Practice and Experience (Wiley)

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

Journal Editorials

1. Editorial Board Member, *International Journal of Parallel, Emergent and Distributed Systems* (IJPEDS), ISSN: 1744-5760, Taylor & Francis Group, UK.
2. Editorial Board Member, *Multiagent and Grid Systems: An International Journal*, ISSN: 1574-1702, IOS Press, Amsterdam, The Netherlands, 2005 onwards.
3. Associate Editor, *IEEE Internet of Things Journal*, IEEE, USA, 2013-2015.
4. Editorial Board Member, *International Journal of Parallel, Emergent and Distributed Systems (IJPEDS)*, ISSN: 1744-5760, Taylor & Francis Group, UK, 2006-2013. IJPEDS), ISSN: 1744-5760, Taylor & Francis Group, UK, 2013-to date.
5. Editorial Board Member, *International Journal of Autonomous and Adaptive Communications Systems*, ISSN: 1754-8632, Inderscience Publishers, Geneva, Switzerland, 2007-to date.

Conference Steering Committee

1. Founder and Chair, IEEE/ACM International Symposium on Cluster, Cloud, and Grid Computing (CCGrid), 2001-to date.
2. Advisory Committee Member, International Conference on e-Science (e-Science), 2011-to date.
3. Advisory Committee Member, IEEE International Conference on Cluster Computing (ClusterXY), 2011-to date.
4. Member, International Symposium on Computer Architecture and High Performance Computing, Brazil, 2005-to date.
5. Founder and Chair, IEEE/ACM International Conference on Utility and Cloud Computing (UCC) series, 2009-to date.

Technical Program Committee Memberships

1. 23rd IEEE International Conference on High Performance Computing, Data and Analytics (HiPC 2016), December 19-22, 2016, Hyderabad, India.
2. 3rd IEEE/ACM International Conference on Big Data Science, Engineering and Applications (BDSEA 2016), December 6-9, 2016, Shanghai, China.
3. IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN 2016), Nov. 7-9, 2016, Palo Alto, California, USA.

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 amongst top #4 sources for grid computing by Google search engine.
- Maintained a Cluster Computing Information Centre at: http://www.buyya.com/cluster

By Other Members:

Technical Program Committee Memberships

1. Rodrigo N. Calheiros, 31st Symposium On Applied Computing (ACM SAC 2016) – Operating Systems Track, April 3-8, Pisa, Italy.
2. Rodrigo N. Calheiros, 9th ACM/IEEE International Conference on Utility and Cloud Computing (UCC 2016), December 6-9, Shanghai, China.
3. Rodrigo N. Calheiros, 2nd IEEE International Conference on Data Science and Systems (DSS 2016), December 12-14, Sydney, Australia.

7. 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 2016, as a Research Fellow for an ARC Linkage Project with CA Technologies as industrial partner, I worked on business goals and analytics driven management of cloud computing. I worked with anomaly detection in cloud data centres, specifically on anomalies in low-level resource consumption by servers and virtual machines. Also aligned with this project, I worked with application workload prediction.

I was also co-CI in a grant from the Department of Industry about Big Data for disaster management. This grant involves partners from CSIRO, University of Melbourne and institutions from India.

Others problems I worked on, along with PhD students, were energy-efficient cloud computing, mobile computing, container virtualization, and Big Data.

I left the Lab in October 2016 to assume a Lecturer position in the University of Western Sydney, Australia.

Member Self Profile: Adel Nadjaran Toosi

I am currently a research fellow at CLOUDS lab and my research interests include networking and resource management in clouds. In 2016, I have been working on energy-aware geographical load balancing in cloud computing environments and data-intensive application scheduling and resource management in clouds. Currently, I am focusing on Software Defined Networking (SDN) in clouds.

During 2016, I have been serving as a peer reviewer for IEEE Transactions on Parallel and Distributed Systems (TPDS), IEEE Transactions on Cloud Computing (TCC), Journal of Network and Computer Applications (JNCA). I have also been a Technical Program Committee member of the 9th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2016), the 8th International Conference on Cloud Computing, GRIDs, and Virtualization (CLOUD COMPUTING) 2017, and the 11th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS) 2017.

Photo description: The year 2016 was full of excitements, joys and happiness. My wife and I welcomed our beautiful daughter who has changed our lives in many interesting and entertaining ways.

Below you can find my selected publications related to my research in 2016:

Atefeh Khosravi, **Adel Nadjaran Toosi,** and Rajkumar Buyya, Online Virtual Machine Migration for Renewable Energy Usage Maximization in Geographically Distributed Cloud Data Centers, Concurrency and Computation: Practice and Experience (CCPE), Wiley, 2017 (in press, accepted on Feb 4, 2017).

Yaser Mansouri, **Adel Nadjaran Toosi,** and Rajkumar Buyya, Cost Optimization for Dynamic Replication and Migration of Data in Cloud Data Centers, IEEE Transactions on Cloud Computing (TCC), IEEE, doi:10.1109/TCC.2017.2659728, 2017 (in press, available online 26 January 2017).

Adel Nadjaran Toosi, Chenhao Qu, Marcos Dias de Assuncao, and Rajkumar Buyya, Renewable-aware Geographical Load Balancing of Web Applications for Sustainable Data Centers, Journal of Network and Computer Applications (JNCA), Vol. 83, pp. 155-168, Elsevier, 2017.

Adel Nadjaran Toosi, Kurt Van Mechelen, Farzad Khodadadi, Rajkumar Buyya, An Auction Mechanism for Cloud Spot Markets, Acm transactions on autonomous and adaptive systems, vol. 11, no. 1, pp. 2:1-2:33, 2016.

My CV and full list of my publications can be found in my cyber homepage at *http://adelnadjarantoosi.info/*

Member Self Profile: Maria Alejandra Rodriguez

I joined the CLOUDS Laboratory in 2012 as a student researching scheduling and resource provisioning algorithms for scientific workflows in cloud environments. I completed my PhD in 2016 and I am now working as a research fellow in the lab.

I am currently working on developing a multi-tenant workflow-as-a-service framework that will enable scientists to easily deploy their applications on the cloud. The aim is to incorporate energy-efficiency and reliability into the techniques and algorithms developed as part of the platform.

I have a bachelor's degree in Computing and Systems Engineering from Los Andes University in Colombia. In 2011 I completed my master's degree at the University of Melbourne (Master of Engineering in Distributed Computing) with first class honors. I have over three years of industry experience gained while working as a software engineer in Colombia and in Tata Consultancy Services in Bangalore, India.

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 web 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. I am also interested in energy-efficiency of data centers and scalable deployment of stream applications in Clouds.

Recently, I submitted my thesis on web application management in Clouds and completed the following two works:

1. Chenhao Qu, Rodrigo N. Calheiros, and Rajkumar Buyya, "Mitigating Impact of Short-term Overload on Multi-Cloud Web Applications through Geographical Load Balancing", Concurrency and Computation Practice and Experience (Under Review), 2016.
2. Chenhao Qu, Rodrigo N. Calheiros, and Rajkumar Buyya, "A Taxonomy and Survey of Auto-scaling Web Applications in Clouds", ACM Computing Surveys (Under Review), 2016

• Blog - http://chenhaoqu.blogspot.com.au/
• LinkedIn - https://au.linkedin.com/in/quchenhao
• GitHub - https://github.com/quchenhao
• Website – http://www.quchenhao.info

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 (will be appeared).

[3] Yaser Mansouri and Rajkumar Buyya, To Move or Not to Move: Cost Optimization in a Dual Cloud-based Storage Architecture, Journal of Network and Computer Applications (JNCA), Volume 75, Pages: 223-235, ISSN: 1084-8045, Elsevier, Amsterdam, The Netherlands, November 2016.

[4] Yaser Mansouri, Adel Nadjaran Toosi, and Rajkumar Buyya, Cost Optimization for Dynamic Replication and Migration of Data in Cloud Data Centers, IEEE Transactions on Cloud Computing (TCC) (accepted in 2017).

[5] Yaser Mansouri, Adel NadjaranToosi, and Rajkumar Buyya,"Data Management in Cloud Environments: Taxonomy and Survey," *ACM Computing Surveys*, ACM Press, New York, USA, 2017 (under review).

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 are 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 (Tehran Polytechnic), Iran.

As part of my industry experience, I worked as a Researcher and Consultant on Iran National IP/MPLS Core Network project at Iran Telecommunication Research Center (ITRC). Currently I am working as a Research Scientist at Amazon Web Services, Sydney.

My PhD research is on "Energy and Carbon-Efficient Resource Management in Geo-Distributed Cloud Data Centers". It is mainly focused on the development of policies and algorithms for placement and migration 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 https://www.linkedin.com/in/atefeh-khosravi-01b83131/

Member Self Profile: Jungmin Son (Jay)

I started PhD degree in Clouds lab since 2014, following a master thesis project conducted under the supervision of Prof Buyya and Dr Calheiros in 2013. I studied master's degree in Information Technology from the University of Melbourne and bachelor's degree in Information and Computer Engineering from Ajou University, South Korea. After completing my bachelor's degree in 2006, I had worked in Samsung Electronics as a software engineer for several years where I was in charge of researching and developing the multimedia software for various Samsung mobile phones.

In my current research, main topic includes how to apply SDN to cloud data centres to ensure SLA and energy efficiency. I investigate VM placement policies that aware network resources and network flow control for providing QoS. This work can help to design cloud data centre in energy-efficient fashion, while guaranteeing SLA. Also, I am interested in network flow management using SDN controller which will provide users efficient network performance while cloud providers can still save costs.

- Web site: https://sites.google.com/site/jungminjayson/
- Github: https://github.com/fogony/cloudsimsdn
- LinkedIn: http://au.linkedin.com/pub/jungmin-jay-son/4b/369/bab/

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, and then joined CLOUDS lab in February 2014.

Currently, I am in third year of my PhD and doing research in Mobile cloud computing area. One of my research interests is providing solutions for seamless mobile cloud services in the heterogeneous mobile cloud environment that requires new platforms, scheduling algorithms, models, etc. I am also interested to look into the area of mobile device hosted IOT systems in the recent future. My recent publications are as follows:

[1] Bowen Zhou, Amir Vahid Dastjerdi, Rodrigo N. Calheiros, Satish Narayana Srirama, and Rajkumar Buyya, A Context Sensitive Offloading Scheme for Mobile Cloud Computing Service, Proceedings of the 8th IEEE International Conference on Cloud Computing (Cloud 2015, IEEE CS Press, USA), New York, USA, June 27 - July 2, 2015.

[2] Bowen Zhou, Amir Vahid Dastjerdi, Rodrigo N. Calheiros, Satish Narayana Srirama, and Rajkumar Buyya, mCloud: A Context-aware Offloading Framework for Heterogeneous Mobile Cloud, IEEE Transactions on Services Computing (TSC), ISSN: 1939-1374, IEEE Computer Society Press, USA.

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 more than three years of experiences working as a software engineer in different companies in Iran and also as a university lecturer.
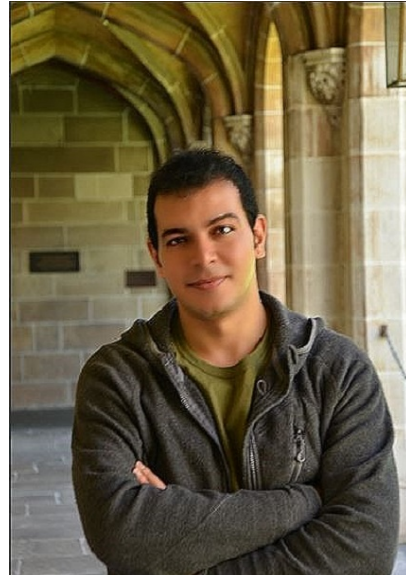
At CLOUDS Lab, I'm investigating resource provisioning, workflow scheduling and network aspects of large-scale graph-processing systems, Big Data and social networks on cloud environments. We have developed iGiraph which is a novel Pregel-like graph processing framework for minimizing the monetary costs and computation time of processing on large-scale graph datasets. iGiraph's paper was appeared in CCGrid 2016 conference in Colombia and also won the Google Ph.D. travel prize at University of Melbourne and the runner-up prize for the best student paper from IEEE Victorian Section.

Currently, I am working on improving iGiraph by considering network factors such as bandwidth, traffic, computation capacity, latency, etc. which will even decrease the costs of processing large-scale graphs even more. At the same time, I wrote a taxonomy on graph processing systems that comprehensively investigates different aspects of these emerging solutions.

In terms of voluntary works, I was involved in different activities. I had the chance to represent The University of Melbourne's student branch, with other 2 students, in the IEEE Region 10 Congress that was held in beautiful India. That was a great opportunity to find new friends and be exposed to various ideas and views from all over region 10. We were also awarded as the exemplary student branch in the whole region.

Member Self Profile: Xunyun Liu

I joined Clouds lab at University of Melbourne in Sept. 2014, under the supervision of Professor Rajkumar Buyya and Dr. Rodrigo N. Calheiros. In 2015, Dr. Benjamin Rubinstein joined my supervisory committee and I confirmed as a formal PhD student.

I graduated from National University of Defense Technology with a master and a bachelor degree on Computer Science and Technology. My research at that time mainly focused on High Performance Computing (HPC) and compiler optimization. In my Master thesis I designed a fault-tolerance MPI protocol for running scientific applications on the TH supercomputer.

After transferring to the research on Cloud computing, I am now interested in stream processing of big data on cloud, including the resource provisioning and scheduling issues related to it. Starting with Apache Storm, I have been actively working towards SLA-oriented streaming processing on cloud.

Member Self Profile: Sara Kardani Moghaddam

I joined CLOUDS Lab as a PhD student in September 2015, under the supervision of Prof. Buyya and Prof. Kotagiri at the University of Melbourne.

Prior to joining the CLOUDS Lab Group, I received my Bachelor's degree with First Class Honors from Shiraz University of Technology and after that I completed a master degree in Information Technology at Sharif University of Technology. Before starting my PhD studies, I also worked for 3 years as a Software Designer and Developer in Iran.

Currently, I'm investigating the concepts of Big Data analytics and how we can exploit these capabilities to find better ways of Resource Provisioning and Auto scaling in Clouds computing environment.

Member Self Profile: Minxian Xu

I joined CLOUDS lab in October 2015, pursuing my PhD position under the supervision of Prof. Rajkumar Buyya at University of Melbourne.

Before coming to Melbourne, I obtained both my bachelor and master degree at University of Electronic Science and Technology of China (UESTC), majoring in Software Engineering. During my graduate time, my research mainly focused on resource scheduling and load balancing in Cloud data centers.

In my PhD research, I'm still working on resource scheduling, especially investigating energy efficient scheduling for Clouds. I have submitted two papers related to resource scheduling in 2016, which are still under review. If you have interest, please find them below:

- Xu, Minxian, Amir Vahid Dastjerdi, and Rajkumar Buyya. "Energy Efficient Scheduling of Cloud Application Components with Brownout." IEEE Transactions on Sustainable Computing (T-SUSC), Volume 1, Number 2, Pages: 40-53, ISSN: 2377-3782, IEEE Computer Society Press, USA, July-Dec. 2016.
- Xu, Minxian, Wenhong Tian, and Rajkumar Buyya. "A Survey on Load Balancing Algorithms for VM Placement in Cloud Computing." arXiv preprint arXiv:1607.06269 (2016).

Member Self Profile: Muhammad Hafizhuddin Hilman

I joined CLOUDS Lab as a PhD student at January 2016 under supervision of Prof. Rajkumar Buyya and Dr. Amir Vahid Dastjerdi. I am working on Scientific Workflow Management under direct supervision from Research Fellow, Dr. Maria A. Rodriguez. My area of interest includes Cloud Computing, Scientific Workflows, Cloud Scheduling and Cloud Resource Management.

As part of my PhD research, I investigate into workflow-as-a-service environment. Simply, putting scientific workflow computation into service that provide utility leasing for the scientific users. I work on several algorithms on dynamic scheduling and resource provisioning for multiple workflows and modelling the workflow-as-a-service environment.

I am currently staff-on-leave from Faculty of Computer Science, Universitas Indonesia. I got scholarship from Indonesian Government to pursue Ph.D at University of Melbourne. I got my bachelor and master degree from Universitas Indonesia at 2010 and 2012.

For further information, please refer to my Linkedin page
https://www.linkedin.com/in/muhammadhilman/

Member Self Profile: Md. Redowan Mahmud

I completed my BSc from *Department of Computer Science and Engineering, University of Dhaka, Bangladesh* in 2015. Later I was appointed as a lecturer in *Department of Computer Science and Engineering, United International University, Bangladesh*.

I have joined *Cloud Computing and Distributed Systems (CLOUDS) Laboratory, Department of Computing and Information Systems, University of Melbourne, Australia* in February, 2016. Here, I have been awarded with Melbourne International Research Scholarship (MIRS) and Melbourne International Fee Remission Scholarship (MIFRS) for supporting my studies.

Now, I am in second year of my PhD candidature and investigating different resource management policies in Fog computing.

To follow my research activities, please visit https://www.researchgate.net/profile/Md_Mahmud14

Member Self Profile: Caesar Wu

I am one of the telecommunication veterans. I worked for Telstra Corporation over 18 years. Before I joined Telstra, I had worked for many companies and crossed many different industries: software (Intelligent System Research group limited), naval architecture (Ship Design & Management P/L and Sigma Marine P/L), Electronics Goods (Email Electronic Ltd), telecommunication (Visionstream Pty Ltd), civil engineering (Lincoln Scott) and space industry (Shanghai Space Bureau). I received my B. Eng. degree in 1983 in Shanghai Jiao Tong University China for Electrical Electronic and Mechanics Engineering. I was also a part time student of Monash University in 1993 for Master of Engineering Science.

In July 2015, I joined Computing and Information Systems/School of Engineering/The University of Melbourne as a PhD student under the supervision of Professor Ramamohanarao Kotagiri and Professor Rajkumar Buyya.

My research interests include cloud data center cost modeling, IT vendor management, IT capacity planning, data mining, machine learning, artificial intelligence, IT solution architecture, IT service delivery and project management.

In Mar/2015, I was able to publish the book: Cloud Data Center Cost Modeling based on my many years experiences in Telstra as one of two co-authors (Professor Rajkumar is other co-author) http://www.amazon.com.au/Cloud-Data-Centers-Cost-Modeling-ebook/dp/B00UJBCSA0

In 2016, I published a book chapter: Big Data Analytics = Machine Learning + Cloud Computing" as one of three co-authors.

Member Self Profile: Muhammed Tawfiqul Islam

I have joined CLOUDS lab on July, 2016 as a PhD student. I am also a Lecturer at the Department of Computer Science & Engineering, University of Dhaka, Bangladesh and currently I am on a study leave. My research focus in PhD is on "QoS-aware cloud resource management for Big Data Applications".

Prior to finishing my BSc. and MS studies, I have worked as a software engineer in REVE systems, where I developed VOIP servers in H.323 and SIP protocols. In my MS research, I worked in collaboration with Internet Society (ISOC) to fight for the cause "Net Neutrality". I developed end-user applications to detect any blocking/shaping to Internet bandwidth/ services by their Internet Service Providers (ISP) and this project was funded by ISOC Netherlands. Currently, I am working on developing efficient resource allocation techniques for Apache Spark.

Member Self Profile: Satish Narayana Srirama

I am an associate professor and the head of the Mobile & Cloud Lab (http://mc.cs.ut.ee/) at the Institute of Computer Science, University of Tartu, Estonia. I have been collaborating with CLOUDS Laboratory since 2010. In 2016, I visited the CLOUDS lab during January. We have been collaborating in the Mobile Cloud, Internet of Things and Fog computing domains.

This year our collaboration has resulted in the following publications:

- C. Chang, S. N. Srirama, R. Buyya: Mobile Cloud Business Process Management System for the Internet of Things: A Survey, ACM Computing Surveys (CSUR), ISSN: 0360-0300, 49(4):Article 70, 2016. ACM. DOI: http://dx.doi.org/10.1145/3012000

- B. Zhou, A. V. Dastjerdi, R. N. Calheiros, S. N. Srirama, R. Buyya: mCloud: A Context-aware Offloading Framework for Heterogeneous Mobile Cloud, IEEE Transactions on Services Computing, ISSN: 1939-1374. IEEE. DOI: 10.1109/TSC.2015.2511002 (In Print)

Regarding, other professional activities, this year I joined the editorial board of Wiley Software: Practice and Experience, a 40+ year old Journal, as an Editor, where Prof. Rajkumar Buyya is an editor.

Detailed information about my activities in 2016 is available at http://kodu.ut.ee/~srirama/

Member Self Profile: Kyong Hoon Kim

I received my PhD, MS, and BS degrees in Computer Science and Engineering from POSTECH, Korea in 2005, 2000, and 1998, respectively. I was a post-doc researcher at CLOUDS lab from September 2005 to August 2007. The main research topic during the post-doc research was VO (Virtual Organization)-based resource sharing, power-aware resource management in Cloud computing, real-time services of Cloud computing, etc.

Due to research activity in CLOUDS lab, I got a faculty position at Gyeongsang National University (GNU), Jinju, South Korea, in 2007. I currently work as an associate professor at the department of Informatics of GNU. The research topics include real-time systems, security, and Cloud computing. More information can be found by visiting my research lab website (http://rts.gnu.ac.kr).

I visited at CLOUDS lab in July/August of 2009 for power-aware Cloud computing research. We discussed many research issues about power-aware computing in Clouds and developed power-aware components in CloudSim toolkits. In July/August of 2016, I visited at the lab again. In this period, I discussed about power-aware resource management in Fog Computing. Based on the discussion, I have been worked on resource management in Fog Computing.

Member Self Profile: Leonard Heilig

I am a PhD candidate at the Institute of Information Systems at the University of Hamburg (Germany) and joined CLOUDS Lab in July 2016 as a Visiting Research Scholar under the guidance of Prof. Rajkumar Buyya. I hold a B.Sc. (University of Münster, Germany) and a M.Sc. (University of Hamburg, Germany) in Information Systems. My research interest is centered around the adoption and utilization of cloud computing in contemporary enterprises with the focus on IT governance, algorithms and decision support, mobile cloud applications, big data, and the application of cloud computing in maritime logistics. In 2014 and 2015, I organized and partly gave a half-day workshop on the topic "Cloud Computing and Decision Analytics" at the INFORMS Annual Meeting and at the Hawaii International Conference on System Sciences (HICSS-48). Currently, I am serving as a guest editor for a special issue on Metaheuristics in Cloud Computing in the Wiley journal Software: Experience and Practice (SPE). My industry experience in cloud computing include working at Airbus, Adobe Systems, and Fiducia & GAD IT, one of the largest IT providers in Germany, focusing on cloud-based system and application development.

During my one-month research stay, I designed, developed, and implemented an extension of the CloudSim toolkit to integrate business-oriented geo-aware virtual machine selection algorithms in multi-cloud environments using metaheuristics.

I consider my research stay as very inspiring, productive and successful and I would like to thank in particular Prof. Rajkumar Buyya, Dr. Adel Toosi and Dr. Rodrigo N. Calheiros for the fruitful discussions.

Contact: https://www.bwl.uni-hamburg.de/iwi/team/mitglieder/leonard-heilig.html

ResearchGate: https://www.researchgate.net/profile/Leonard_Heilig

LinkedIn: https://www.linkedin.com/in/leonard-heilig

Member Self Profile: Maria Salama

I received B.Sc. in Computer Science and Post-Graduate Diploma in Management Information Systems from Sadat Academy for Management Science, Cairo, Egypt in 2001 and 2003 respectively. I received M.Sc. in Computer Science from Arab Academy for Sciences and Technology in 2011. During my research master, I had a good number of publications in prestigious venues. I was assistant lecturer in the British University in Egypt. Prior to joining the BUE, I had solid experience in the industry, stepping from web development to project leading. Generally, my research interests are Software Engineering and Cloud Computing.
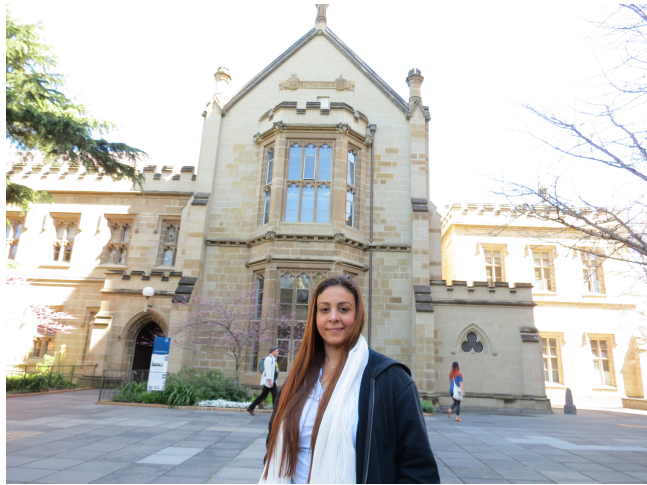
By the end of 2013, I started my PhD studies at the University of Birmingham UK, working in the areas of self-adaptive and self-aware architectures for cloud-based software systems. My PhD thesis focuses on investigating the notion of stability during run-time for self-aware cloud architectures. I joined the CLOUDS Lab in September 2016 as a visitor research student at the University of Melbourne under the supervision of Professor Rajkumar Buyya. My research visit was sponsored by the U21 Scholarhip, and extended by Professor Buyya. During my visit, I successfully developed and evaluated *SAwCloudSim* – an extension for CloudSim for self-aware and self-adaptive cloud-based software systems. A new joint work has also emerged in collaboration with Dr. Maria A. Rodriguez, employing the proposed self-aware architecture in processing scientific workflows. The joint works between the CLOUDS Lab and the School of Computer Science at Birmingham are planned for joint publications.

For more information and publications, please visit my webpage: http://www.cs.bham.ac.uk/~mxs512/index.html

8. 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 realising 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
- Open SensorWeb Architecture
- InterCloud – Peering and Federation of Clouds
- Content Delivery Networks
- Software Defined Networks
- Big Data
- Internet of Things (IoT)
- Fog Computing
- Application Targets include: ECG Monitoring and Analysis, Data Mining and Business Analytics, Brain Imaging (Dartmouth Medical School), and Geophysics (*Intrepid*).

Aneka: .NET-based Cloud Computing

Web: http://www.manjrasoft.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 Manjrasoft, 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.

- Cloudbrusting of application tasks across multiple Clouds (e.g., Azure and AWS)

Aneka Architecture

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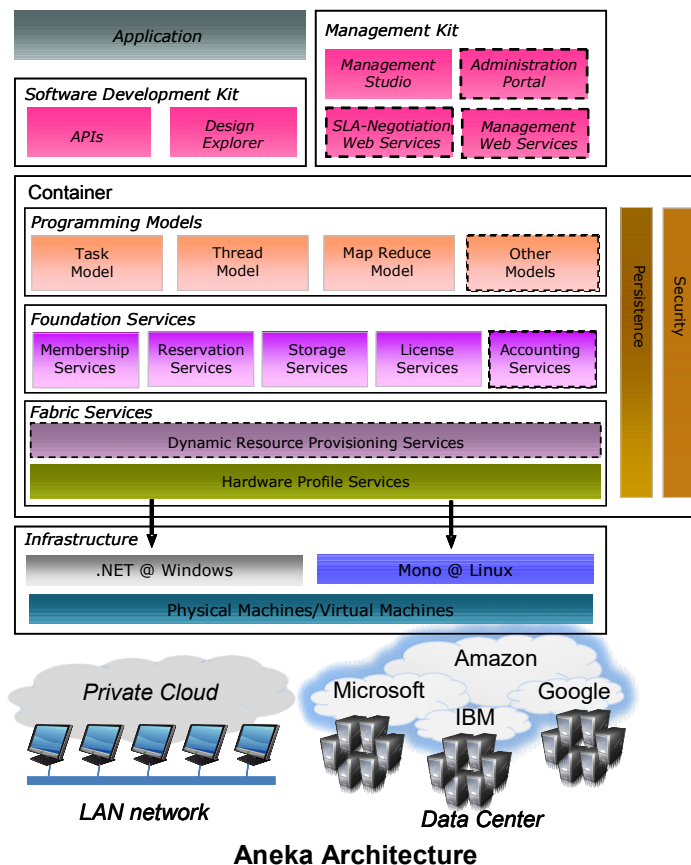
QoS-Oriented Cloud Workflow Engine

Web: http://www.cloudbus.org/workflow

Infrastructure-as-a-Service (IaaS) clouds offer several advantages for the deployment of scientific workflows. They enable Workflow Management Systems (WMSs) to access a flexible and scalable infrastructure by leasing Virtual Machines (VMs). This allows workflows to be easily packaged and deployed and more importantly, enables WMSs to access a virtually infinite pool of VMs that can be elastically acquired and released and are charged on a pay-per-use basis. In this way, cloud resources can be used opportunistically based on the number and type of tasks that need to be processed at a given point in time. This is a convenient feature as it is common for the task parallelism of scientific workflows to significantly change throughout their execution. The resource pool can be scaled out and in to adjust the number of resources as the execution of the workflow progresses. This facilitates the fulfilment of the quality-of-service (QoS) requirements by allowing WMSs to fine-tune performance while ensuring the available resources are efficiently used.

In this project we extend the Cloudbus WMS as a PaaS (Platform-as-a-Service) to support the cloud-computing paradigm. Specifically, the project aims to:
- Define an architectural framework and principles for the development of QoS-based workflow management in cloud environments,
- Develop QoS-based algorithms for scheduling scientific workflow applications,
- Develop policies and resource management algorithms tailored for the cloud resource model,
- Implement a prototype system by incorporating the algorithms and policies developed above, and
- Develop real world demonstrators in various scientific domains such as astronomy.
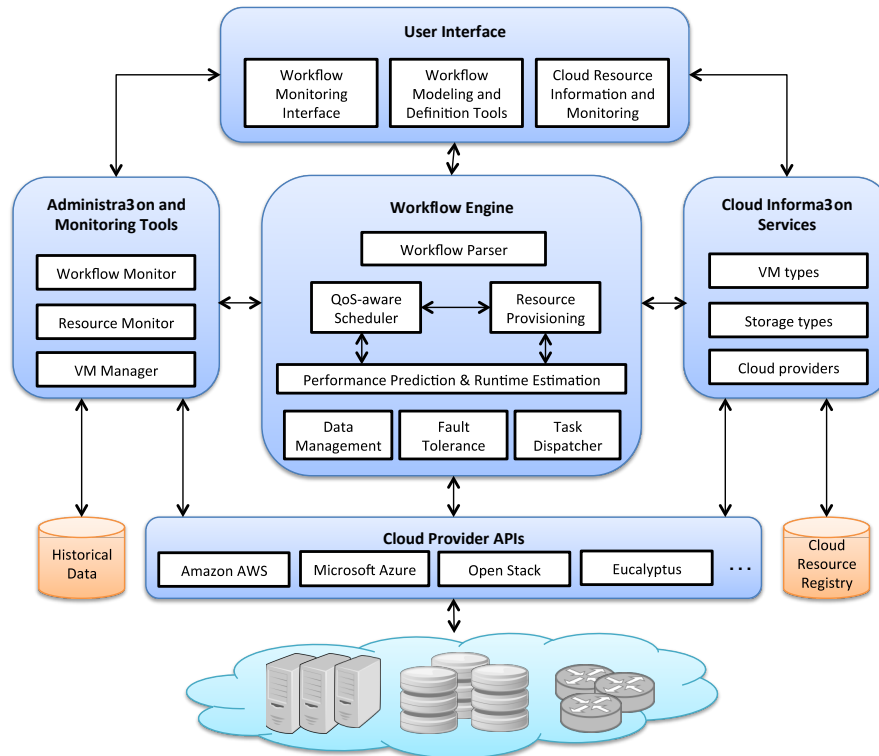

Fig. 1: Architecture of QoS-based workflow management and resource allocation system.

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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 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, 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.
- Anton Beloglazov and Rajkumar Buyya, OpenStack Neat: A Framework for Dynamic and Energy-Efficient Consolidation of Virtual Machines in OpenStack Clouds, Concurrency and Computation: Practice and Experience (CCPE), Volume 27, No. 5, Pages: 1310-1333, ISSN: 1532-0626, Wiley Press, New York, USA, April 2015.
- Sareh Fotuhi Piraghaj, Rodrigo N. Calheiros, Jeffrey Chan, Amir Vahid Dastjerdi, and Rajkumar Buyya, Virtual Machine Customization and Task Mapping Architecture for Efficient Allocation of Cloud Data Center Resources, The Computer Journal, Volume 59, No. 2, Pages: 208-224, ISSN 0010-4620, Oxford University Press, UK, February 2016.
- Minxian Xu, Amir Vahid Dastjerdi, and Rajkumar Buyya, Energy Efficient Scheduling of Cloud Application Components with Brownout, IEEE Transactions on Sustainable Computing (T-SUSC), Volume 1, Number 2, Pages: 40-53, ISSN: 2377-3782, IEEE Computer Society Press, USA, July-Dec. 2016.

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

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

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 such as Virtual Machines and Containers. CloudSim now support simulation of SDN and containers.

Some References:

- 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.
- Jungmin Son, Amir Vahid Dastjerdi, Rodrigo N. Calheiros, Xiaohui Ji, Young Yoon, and Rajkumar Buyya, CloudSimSDN: Modeling and Simulation of Software-Defined Cloud Data Centers, Proceedings of the 15th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid 2015), Shenzhen, China, May 4-7, 2015.
- Sareh Fotuhi Piraghaj, Amir Vahid Dastjerdi, Rodrigo N. Calheiros, and Rajkumar Buyya, ContainerCloudSim: An Environment for Modeling and Simulation of Containers in Cloud Data Centers, Software: Practice and Experience, Volume 47, Number 4, Pages: 505-521, ISSN: 0038-0644, Wiley Press, New York, USA, April 2017.

iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments

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

Internet of Things (IoT) aims to bring every object (e.g. smart cameras, wearable, environmental sensors, home appliances, and vehicles) online, hence generating massive amounts of data that can overwhelm storage systems and data analytics applications. Cloud computing offers services at the infrastructure level that can scale to IoT storage and processing requirements. However, there are applications such as health monitoring and emergency response that require low latency, and delay caused by transferring data to the cloud and then back to the application can seriously impact their performances. To overcome this limitation, Fog computing paradigm has been proposed, where cloud services are extended to the edge of the network to decrease the latency and network congestion.

To realize the full potential of Fog and IoT paradigms for real-time analytics, several challenges need to be addressed. The first and most critical problem is designing resource management techniques that determine which modules of analytics applications are pushed to each edge device to minimize the latency and maximize the throughput. To this end, we need an evaluation platform that enables the quantification of performance of resource management policies on an IoT or Fog computing infrastructure in a repeatable manner.

We developed a simulator, called iFogSim, to model IoT and Fog environments and measure the impact of resource management techniques in terms of latency, network congestion, energy consumption, and cost.

Some References:

- Harshit Gupta, Amir Vahid Dastjerdi , Soumya K. Ghosh, and Rajkumar Buyya, iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments, Technical Report CLOUDS-TR-2016-2, Cloud Computing and Distributed Systems Laboratory, The University of Melbourne, Australia, June 6, 2016.
- Amir Vahid Dastjerdi and Rajkumar Buyya, Fog Computing: Helping the Internet of Things Realize its Potential, IEEE Computer, Volume 49, Issue 8, Pages: 40-44, ISSN: 0018-9162, IEEE CS Press, USA, August 2016.
- Luiz F. Bittencourt, Javier Diaz-Montes, Rajkumar Buyya, Omer F. Rana, and Manish Parashar, Mobility-aware Application Scheduling in Fog Computing, IEEE Cloud Computing, Volume 4, No. 2, Pages: 34-43, ISSN: 2325-6095, IEEE Computer Society Press, USA, March-April 2017.

9. Moments with Visitors, Colleagues and International Hosts

March 24, 2016: Visit of Dr Vijay Bhatkar (Father of Indian Supercomputers) and Recipient of Padma Shri and Padma Bhushan awards from the President of India to CLOUDS Lab.
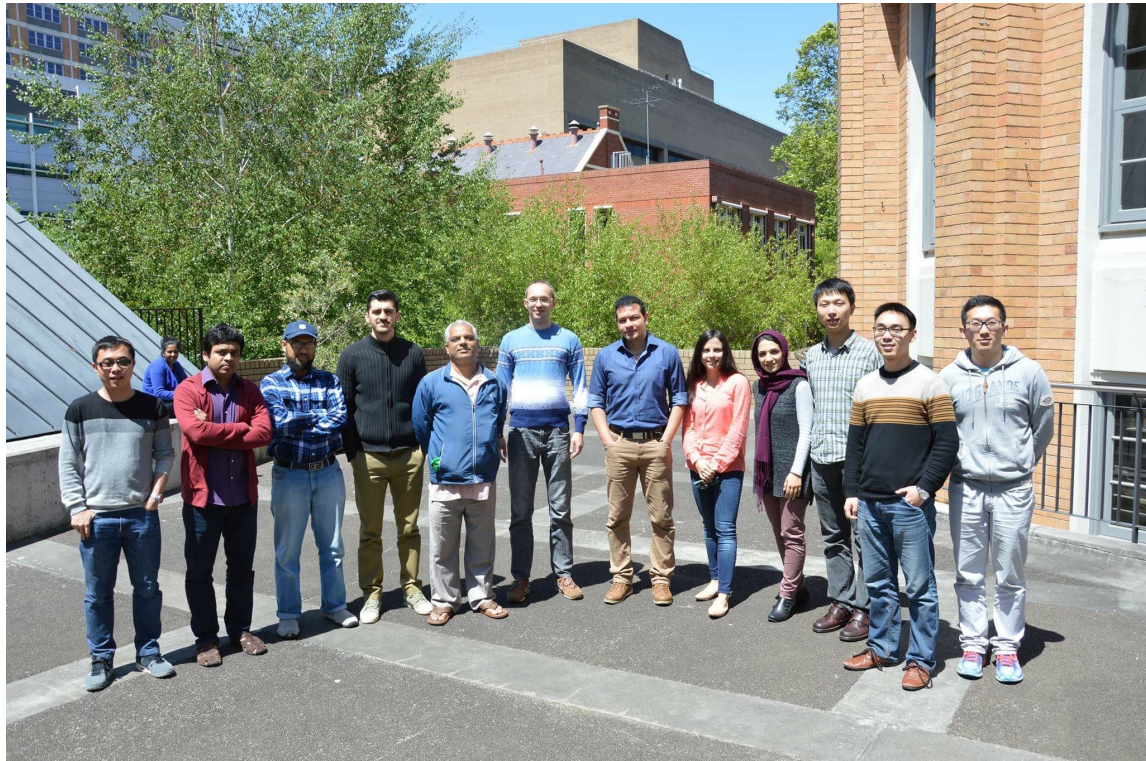

Professor Buyya receiving Mahatma Gandhi and Bharat Nirman Awards at the Conference on Economic Growth and National Unity by the Friendship Forum of India (April 2016).

Visit to Hubei Engineering University, China (April 2016)

A snap of CLOUDS lab members taken during Chen Hao's PhD completion seminar (Nov 2016)

A snap of CLOUDS lab members (Nov 2016)

During a distinguished lecture with Vice Chancellor of JMI, Delhi (Dec 2016)