Cloud Computing and Distributed Systems (CLOUDS) Laboratory

www.cloudbus.org

Annual Report - 2020

School of Computing and Information Systems
Faculty of Engineering and Information Technology
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 2020, 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-leading researchers in developing innovative solutions for Cloud Computing. The highlights of research activities and outcomes in 2020 are:

- The Lab successfully hosted ARC research projects (Discovery and Linkage Infrastructure Projects) along with hosting two new research projects.
- Members of the CLOUDS Lab have authored 58 publications, which include 36 journal papers and 12 conference papers.
- Three of our papers received “Best Paper Awards” from IEEE/ACM and Elsevier.
- The Lab’s flagship Cloudbus Project has released various new modules for Aneka, CloudSim, iFogSim, and Fogbus. iFogSim, building on CloudSim, has emerged as a de-facto toolkit for modelling and simulation of Fog and Edge computing environments. It has been used by several researchers in academia and industries around the world.
- Members have presented over 26 invited talks that include 19 keynotes delivered at international conferences/seminars held in Australia, India, Singapore, and China.
- The Lab successfully hosted research activities of over 25 scholars, which include 16 PhD students and 3 Research Fellows.
- In 2020 alone, our papers have attracted over 10700 citations (ref: Google Scholar) and we hope this trend will continue!
- The Lab housed several (short and long term) international visitors (academics and PhD students) from China, India, and Norway.
- A list of the world’s top 2% researchers compiled by Stanford University after assessing scientists worldwide for research carried out over their careers across all disciplines ranks us as #1 for citation impact during the single calendar year 2019 and #2 for career-long citation impact up until the end of 2019 in Distributed Computing area.
- Members of the Lab have led community efforts such as (a) the organisation of conferences (e.g., CCGrid 2020 in Australia) and (b) Editor-In-Chief of Journal of Software: Practice and Experience, which was established 50+ 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,

Dr. Rajkumar Buyya, Redmond Barry Distinguished Professor
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/Academics:
- Dr. Adel Toosi
- Dr. Maria Rodriguez
- Dr. Redowan Mahmud

PhD Students
- Mr. Muhammad H. Hilman
- Ms. Imairi Eitiveni
- Mr. Muhammed Tawfiqul
- Mr. Carlos Gomez, University of Birmingham, UK
- Mr. Anit Khan, Monash University, Australia
- Mr. Jaydeep Das, Indian Institute of Technology, Kharagpur
- Mr. Shashikant Ilager
- Mr. TianZhang He
- Mr. Mohammad Goudarzi
- Mr. Zhiheng Zhong
- Ms. Samodha Pallewatta
- Ms. Amanda Jayanetti
- Mr. Rajeev Muralidhar
- Mr. Kwangsuk Song
- Ms. Anupama Mampage
- Mr. Jie Zhao
- Mr. Ming Chen

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

International Visitors
- Dr. Zhicheng Cai, Nanjing University of Science and Technology, China, Aug 2019-Aug 2020.
- Dr. Xiaogang Wang, Shanghai Dianji University, China, September 2019-Sept. 2020.
3. Competitive Grants Funded Projects and Programs - Active

Australian Research Council (ARC)


Other National Grants

- Soumya K. Ghosh (Indian lead) and Rajkumar Buyya (Australian lead), "Spatial Cloud Federation: Orchestration of Multiple Spatial Clouds for Efficient Provisioning of Spatial Services", SPARC (Scheme for Promotion of Academic and Research Collaboration), Ministry of Human Resource Development, Government of India, 2019-2022, Amount: Indian Rupees 52.8 Lakh (52,80,000).

Industry and Melbourne University Grants

4. Publications

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

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Books/Proceedings Edited


Book Chapters


Journal Editorials


Journal Papers


19. Dawei Sun, Shang Gao, Xunyun Liu, Fengyun Li, and Rajkumar Buyya, Performance-Aware Deployment of Streaming Applications in Distributed Stream Computing Systems,


Magazine Papers


Conference Papers


54. Lingxiao Xu, Minxian Xu, Jian Wang, Richard Semmes, Qi Wang, Hong Mu, Shuangquan Gui, He Yu, Wenhong Tian, and Rajkumar Buyya, A Data-driven Approach to Identify Resource Bottlenecks for Multiple Service Interactions in Cloud Computing Environments, Proceedings of the 16th EAI International Conference on Collaborative Computing:


5. Invited Presentations and Outreach

By the Lab Director:

**Keynote Talks at International Conferences**

**National Conferences**

2. FDP on Recent Advances in Computer Science and Allied Domains (RACSAD 2020), Sharda University, Noida, India, June 8-12, 2020.
3. Faculty Development Program (FDP) on Recent Advances in Computational Techniques, College of Engineering and Technology, Bhubaneswar, India, September 20, 2020.

**Seminars - in Cloud Computing area:**

6. Selected Community Services

By the Lab Director:

IEEE Computer Society

1. Advisory Board, IEEE Technical Committee on Scalable Computing

Software: Practice and Experience (Wiley)

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

Journal Editorials


Conference Steering Committee

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.

Conference Organisation/Program Committee Memberships

2. Track Chair, 29th IEEE International Conference on Computer Communications and Networks (ICCCN 2020), August 3 - August 6, 2020, Honolulu, Hawaii, 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 + other Professional Services
* Noted in their profile pages.
7. Members Profile and Activities

**Member Self Profile: Md Redowan Mahmud**

I have received the Doctor of Philosophy (PhD)-Engineering degree from the School of Computing and Information Systems, the University of Melbourne in 2020. In my PhD thesis titled “Quality of Service (QoS)-aware Application Management in Fog Computing Environments”, I have investigated how the service quality of Internet of Things (IoT) software applications can be enhanced by placing them efficiently over highly distributed Edge/Fog computing nodes. This thesis is a very timely contribution to the state-of-the-art as it supports the creation of modular IoT applications for smart city and digital healthcare.

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

I have a strong research background in Cloud computing, IoT software, Fog/Edge computing, and Distributed systems which is evidenced by my 20+ publications in high-quality journals, conferences, and book series. Most of my publications are listed Q1 in SJR ranking and they have already attracted 1300+ Google Scholar citations that help me to attain h-index 12 within a very short period. I have also contributed to FogBus and iFogSim software systems which are being used by many research organizations and academic institutions.

I moved to RMIT University in late 2020 as a Research Fellow in the School of Computing Technologies.

To follow my research activities, please visit:

https://www.researchgate.net/profile/Md_Mahmud14 and  
**Member Self Profile: Shashikant Ilager**

- I joined CLOUDS Lab as a PhD student in March 2017.
- Before joining CLOUDS lab, I received my Master of Technology (M. Tech) in Computer Science from the University of Hyderabad, India in 2016 and Bachelor of Engineering (B.E) from VTU, Karnataka, India in 2013. I also worked for a software company in India for a short period.
- I have recently submitted my PhD thesis on “Machine Learning-based Energy and Thermal Efficient Resource Management Algorithms for Cloud Data Centres”.

Here are my papers published in 2020:


For more information, kindly visit the following pages.

Website: http://www.shashikantilager.com
LinkedIn: https://www.linkedin.com/in/shashikantilager/
Member Self Profile: Tawfiq Islam

I joined CLOUDS lab in 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 “Cost-efficient cloud resource management for Big Data Applications”.

Prior to finishing my BS 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 have 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.

In the year 2020, I have published a journal paper. In addition, another journal paper is currently under review. Here is a list of publications I have finished during of my PhD:


Currently, I am working on the following projects:

- SDN-enabled Intent-based resiliency in tactical battlefield networks. (In collaboration with Dr. Adel Nadjaran Toosi from Monash University)
- RAPID: Real time data analytics platform for interactive data mining. (DST project in collaboration with Prof. Shanika Karunasekera).

If you are interested in my research, please do not hesitate to contact me:
GitHub: https://github.com/tawfiqul-islam
Linkedin: https://www.linkedin.com/in/tawfiqul-islam-1968a721/
Email: tawfiqul.islam@unimelb.edu.au
Member Self Profile: Tianzhang He

I joined CLOUDS lab in Aug 2017, pursuing my PhD position under the supervision of Prof. Rajkumar Buyya and Dr. Adel Nadjaran Toosi.

Before came to Melbourne, I obtained both my bachelor in 2014 in Computer Science and master degree in Computer System in 2017 at Northeastern University (NEU), China. During my graduate time, my research mainly focused on priority-based task scheduling algorithm and response time analysis in real-time systems.

In my current research, the main topic includes Software-Defined Networking (SDN) and Network Function Virtualization (NFV) in terms of resource management in Cloud Data Centers to ensure the SLA.

Projects:

We investigated the live VM migration in SDN-enabled cloud data centers from the perspectives of computing resources, network resources and application’s QoS. This work can benefit the design of SLA-aware multiple live migration planning and live migration cost prediction that used in various resource scheduling policies, such as dynamic VNF/VM placement, consolidation algorithms, scheduled maintenance, etc.


As an emerging area, there is an urgency of evaluating and simulating the new algorithm in the NFV-enabled Clouds. Thus, we developed the CloudSimSDN-NFV for modeling and simulation of NFV and SFC in edge computing. The new version of CloudSimSDN supporting the inter-data center topology and auto-scaling mechanism for Service Function Chaining (SFC) composed of Virtual Network Functions (VNFs). [https://github.com/Cloudslab/cloudsimsdn](https://github.com/Cloudslab/cloudsimsdn)


In the cloud data centers, performing multiple live migrations in arbitrary order can lead to service degradation and violates the real-time demands. We proposed a multiple migration planning algorithm by creating concurrent migration groups based on the impact, deadline, and overheads of each single migration task and on-line scheduler starts the migration tasks based on the group priorities and resource dependency between migrations.
I started PhD degree in Clouds lab since July 2018, following a Samsung Kubernetes project conducted under the supervision of Prof Rajkumar Buyya and Dr Maria Rodriguez. I received my master's degree in cloud computing from the University of Newcastle, UK and bachelor's degree in Information and Computer Engineering from Nanchang University, China. After completing my master's degree in 2015, I worked in Epam System as a software engineer for 6 months. Then I joined Morgan Stanley and worked as a Java Developer until Feb 2018, mainly responsible for development of trade surveillance application, like detecting market manipulation, ramping, handling high volumes of trading data processing.

My current research project is a prototype system for large-scale container orchestration based on Kubernetes platform. We aim to achieve cost efficiency and energy saving by supporting heterogeneous task configurations for container placements, and utilization optimization through cleaning unhealthy VM instances that are continuously suffering from low resource utilization by a rescheduling mechanism. We plan to build more pricing models and clearer benchmarks of QoS requirements in the future.


Member Self Profile: Mohammad Goudarzi

I joined the CLOUDS Lab in July 2018 at the University of Melbourne as a PhD student under supervision of Prof. Rajkumar Buyya and Prof. Marimuthu Palaniswami.

I graduated from Iran University of Science and Technology (IUST), Tehran, Iran, with First-Class Honors degree in M.Sc. in Information Technology, where I was awarded as the exceptional talented student. In My M.Sc. I worked on Mobile Cloud Computing as my thesis, and I published several research articles. Moreover, due to my academic achievements, I was awarded to become a member of Iranian National Elites Foundation, a prestigious organization for recognition and support of Iranian national elites, from which I received a prestigious research Grant. Besides, I have three years of experience working as a project manager of Internet of Things (IoT) and Location-Based Services (LBS) solutions in Iran.

In the first year of my PhD career, I was awarded the Rowden White Scholarship, a prestigious scholarship provided by the University of Melbourne to talented, high quality PhD students. I have published two research articles: “A fog-driven dynamic resource allocation technique in ultra-dense femtocell networks” in the “Journal of network and Computer Applications”, and “An Application Placement Technique for Concurrent IoT Applications in Edge and Fog Computing Environments” in “IEEE Transactions on Mobile Computing”. Currently in the third year of my PhD career, I am working on adoption of Deep Reinforcement Learning techniques in Fog/Edge computing Environments. I submitted a research article “A Distributed Deep Reinforcement Learning Technique for Application Placement in Fog and Edge Computing Environments” in “IEEE Transactions on Mobile Computing”. Besides, I am actively working on development of second version of FogBus framework, called FogBus2, which offers dynamic scheduling, scalability, profiling, and resource discovery in fog/edge computing environments.

My research interests include IoT, Cloud/Fog/Edge Computing, Distributed Systems, Machine Learning, and Deep Reinforcement Learning.

Further information can be found in my LinkedIn Profile and Google Scholar page.
https://www.linkedin.com/in/mgoudarzi90/
https://scholar.google.com/citations?user=a7XqS_QAAAAJ&hl=en
Member Self Profile: Muhammad Hafizhuddin Hilman

I joined CLOUDS Lab as a PhD student in January 2016 under the 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 the workflow as a service platform. Directly, putting scientific workflow computation into service that provides utility leasing for scientific users. I work on several algorithms on dynamic scheduling and resource provisioning for multiple workflows and modeling the workflow-as-a-service environment. List of my works during PhD are as follows.


I now joined back to Faculty of Computer Science, Universitas Indonesia. I got the scholarship from the Indonesian Government to pursue a PhD at the University of Melbourne. I got my bachelor and master degree from Universitas Indonesia in 2010 and 2012.

For further information, please refer to my Linkedin page https://www.linkedin.com/in/muhammadhilman/
Member Self Profile: Samodha Pallewatta

I joined CLOUDS lab in February 2019, to pursue my PhD under the supervision of Prof. Rajkumar Buyya and Prof. Vassilis Kostakos at University of Melbourne.

Before starting my PhD, I obtained my bachelor’s degree from University of Moratuwa majoring in Electronic and Telecommunication Engineering, in 2017. Afterwards I worked as a Software Engineer in Sri Lanka for almost 2 years, before joining CLOUDS lab.

My areas of interest include, Fog computing, Internet of Things, Fog computing resource and application scheduling and microservice-based application development. In my PhD research, I’m working on efficient application scheduling policies in Fog computing environments, I specially focus on challenges related to scheduling microservices-based IoT applications within Fog environments. Explored areas include QoS-aware scheduling, mobility-aware scheduling and reliability-aware scheduling of applications.

For more information please refer,

https://linkedin.com/in/samodha-pallewatta
Member Self Profile: Amanda Jayanetti

I joined CLOUDS lab in February 2019, as a PhD student at the University of Melbourne, under the supervision of Prof. Rajkumar Buyya and Prof. Saman Halgamuge.

I received my bachelor’s degree in Computer Science and Engineering from University of Moratuwa, in 2017. Prior to commencing my PhD studies, I worked as a Cloud engineer for 2 years at a leading IT organization that operates worldwide.

My areas of research include energy-efficient resource management in heterogeneous cloud computing environments. I’m particularly interested in harnessing the capabilities of artificial intelligence techniques for enhancing the resource-efficiency of cloud data centres.

In the first year of my PhD, I have worked on the following publication,

Member Self Profile: Anupama Mampage

I joined CLOUDS Lab as a PhD student in February 2020 under the supervision of Prof. Rajkumar Buyya and Prof. Shanika Karunasekera. I completed by BSc Engineering (Hons) degree, specialized in Electronic and Telecommunication Engineering from the University of Moratuwa, Sri Lanka in 2017 and worked in the Software Industry as part of a Research and Development team at a large Telecommunication Provider in the country, prior to joining the lab.

Currently I am in the second year of my PhD studies and my research is focused on the aspect of autonomous resource management in Serverless Computing environments. I am interested in studying ways to optimize resource scheduling and scaling for applications deployed under this new computing model both in the cloud and fog environments. My research objectives are to identify resource management techniques which involve minimum user intervention and meet the QoS requirements of the user while maintaining high resource efficiency at the provider.

The first paper of my PhD research titled, “Deadline-aware Dynamic Resource Management in Serverless Computing Environments”, is to be published in the proceedings of the CCGrid2021 conference.

LinkedIn: www.linkedin.com/in/anupama-mampage
Member Self Profile: Jie Zhao

I joined CLOUDS Lab in July 2020 at the University of Melbourne as a PhD student, under the supervision of Prof. Rajkumar Buyya and Dr Maria Rodriguez Read. My study is funded by the Melbourne Research Scholarship (MRS).

In 2005, I received my bachelor degree in Electronic Engineering and Information Technology from Shanghai Normal University. After graduation, I worked for two years as a software engineer in Shanghai and Beijing until 2007. In July 2007, I came to Australia and completed a master degree in Information Technology at the University of Melbourne in 2009.

Before joining the CLOUDS lab, I worked ten years for a mid-size IT retailer enterprise in different roles as a senior software engineer, an IT infrastructure manager and a CTO. I’m also an AWS certified solution architect. During my industry experience, I used hybrid-cloud and multi-cloud strategies to empower critical infrastructure and business applications, adopted Kubernetes and various cloud-native technologies, and successfully transform a monolithic architecture into a modern microservice oriented architecture.

During my industry career, I developed vital interests in resource management and cloud computing. Remembering inspirations gave Prof. Buyya during my master degree study, I came to him for pursuing a PhD. Currently, my research interest lies in the middle ground of cloud computing, resource management, artificial intelligence and operations research. The broad goal is to identify and fill research gaps in AI/ML-powered autonomous workload management, resource management and operation in cloud computing environments.

Publications:


Profiles:
Linked In: https://www.linkedin.com/in/jie-zhao-64843765/
Website: https://jiezhao.net/
Email: zhao.j4@student.unimelb.edu.au or j.z@ieee.org
I joined the CLOUDS Laboratory in Sep. 2019 as a part time PhD student. I work full time at Amazon Web Services as a Principal Solutions Architect in the area of IOT, AI/ML/edge computing.

I have worked in the industry for over 20 years now, and have a background in several technology areas - energy efficient systems, IOT/M2M devices/platforms, energy efficient AI/ML, software-defined networks, networking and supercomputing/high performance computing. During 2018-2019, I was a Principal IOT Architect in Telstra's Mobility and IOT Group. Prior to this, I spent 18 years at Intel across multiple locations in US and India. As Principal Engineer in Intel's Client & IOT Architecture Group, I had the privilege to work with some terrific and smart people delivering several generations of energy efficiency technologies for several industry defining products like the Amazon Echo Show, Google Nexus Player, Google Glass, TAG Hauer smartwatch, and several others. I also spent several years in Intel Architecture and Research Labs during 2000-2005 working on the foundations of software-defined networking, network processor stacks, and protocols, standards and architectures for quality of service in the internet. During this time, I had the opportunity to actively participate in, and drive several industry standards/consortiums - networking standards at the IETF and Network Processing Forum, NANOG, low power standards at IEEE, and some key components of the Linux power and thermal management subsystems.

I have a Bachelor of Eng from NIT, Surathkal (India) and Master of Science from Rutgers University, both in Computer Science. I have about 30 US patents (granted) and have published over 25 conference/journal papers.

I like collaborating with researchers in academia on forward looking problems. I am a Senior Member of the IEEE and I am part of the steering / program committee of the IEEE International Conf on High Performance and Big Data Computing. I like to work with, and mentor graduate/undergraduate students and early career professionals.

Here are some of my works in 2020:

Member Self Profile: Ming Chen

I joined CLOUDS lab as a PhD student at Dec. 2020 under the primary supervision of Prof. Rajkumar Buyya and second supervision of Dr. Maria Alejandra Rodriguez.

Before my PhD journey, I obtained my Bachelor’s degree in Engineering from Hunan University in 2016, after which I worked as a research engineer and project manager at Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences. My previous working fields include speech recognition, FinTech, Cloud Robotics, etc.

At Melbourne University, I would mainly work in the areas of distributed systems and machine learning. My hobbies include photography and hiking.

Selected publications:

Self-Profile: Qifan Deng

I obtained a bachelor of science at Beijing Institute of Technology, as well as a bachelor of management.

I joined the CLOUDS Laboratory in November 2019, as a master majoring in computer science at University of Melbourne.

I am doing research under the supervision of Rajkumar Buyya, working on a scalable distributed framework for scheduling and processing Internet of Things requests.

I hope my work can help with people's efficiency and creativity, thus, leave a small footprint as a contribution to human civilization progress.

Home Page: https://qifan.dev
GitHub: https://github.com/pancak3
Member self-profile: Siddharth Agarwal

I joined CLOUDS lab as a Master of Science (Computer Science) student in March 2020, under the supervision of Dr. Buyya and Dr. Maria Rodriguez at The University of Melbourne.

Prior to joining the CLOUDS Lab Group, I received my Bachelor of Technology degree with Honours from Jaypee Institute of Information Technology (JIIT), India, where I gained initial experiences in the field of AI/ML along with practical implementations. After graduating, I worked with IBM India for 15 months as an Associate System Engineer at Bangalore, India, with a focus towards software development and management of CMS (Content Management System) applications. Currently, as part of my Master of Science degree research component, I’m investigating and exploring the concepts of Serverless Computing and exploiting the AI/ML techniques to optimise the Cold Start challenges in the Function as a Service offerings of Cloud Computing. I have submitted a research work “A Reinforcement Learning Approach to Reduce Serverless Function Cold Start Frequency”, accepted at the workshop on Serverless To Serve more at Scale (STEERS ’21/CCGrid 2021). I am working towards the completion of my MSc. thesis and will be finishing my coursework by June 2021.

For further information, please refer to my LinkedIn page: www.linkedin.com/in/siddharth26agarwal
**Member Self Profile: Zhicheng Cai**

I joined the CLOUDS Laboratory in September of 2019 as a Visiting Scholar. I’m currently also an Associate Professor of Nanjing University of Science and Technology, China. And I completed my PHD in 2015 at Southeast University, China.

In 2019, I’m working on resource management in Cloud Computing systems, including developing feedback and feedforward control methods to minimize resource rental costs of Web applications while guaranteeing Qos and developing scheduling algorithms to minimize rental costs or execution times of workflow applications.

In 2020, I and coauthors have got the following papers published/written:


For more information, please visit:
ResearchGate: [https://www.researchgate.net/profile/Zhicheng_Cai2](https://www.researchgate.net/profile/Zhicheng_Cai2)
Visitor Self Profile: Linna Ruan

I joined the CLOUDS Laboratory in Sep. 2019 as a visiting student researching resource allocation and service computation offloading in edge-cloud environment. I’ve returned to the Beijing University of Posts and Telecommunications (BUPT, China) in Sep. 2020 and continued my PhD.

I am currently working on edge and cloud cooperation and its application in smart grid. Edge AI is envisioned as a useful tool to predict electricity demand. The function can be realized with edge server and attract more people to join demand response which can drive people to cut or shift demand. I focus on the interaction mechanism design between consumer and supplier and also think about virtual resource allocation with the aim of guaranteeing response time and promote consumers to achieve high participation in demand response process as soon as possible.

I have a bachelor’s degree in Communication Engineering from Beijing Information Science and Technology University in China. Now, I am taking successive postgraduate and doctoral program since 2016 in BUPT.

My recent work is listed as below:

The full list of my publications can be found at:
https://www.researchgate.net/profile/Ruan-Linna
Visitor Self Profile: Xiaogang Wang

I joined the CLOUDS lab in September 2019 as a visiting scholar under the supervision of Professor Rajkumar Buyya. Before came to Australia, I obtained my Ph.D. degree in computer science and technology from Shanghai Jiao Tong University, China. I am currently an associate professor with the School of Electronics and Information, Shanghai Dianji University, China. I have published or been accepted over 20 papers in some journals and conferences such as the IEEE Transactions on services computing, the Journal of Systems and Software, WI-IAT, APSCC, CSCWD, and ICSAI. My current research interests include cloud resource prediction, provisioning and scheduling, service computing, big data analysis and multi-agent systems. Professor Rajkumar Buyya is a very passionate and inspired mentor, he often gives us some meaningful research guidance at the weekly group meeting, and I also obtains a lot of valuable advices.

My 2020 work led to publication of a paper:

Member Self Profile: Dongcheng Zhao

I joined the CLOUDS Lab as a visiting Ph.D. in Oct 2019, the visit will last about 1 year.

I'm pursuing his Ph.D. degree in Communication and Information System at University of Electronic Science and Technology of China. My research interests include network function virtualization, Cloud computing, fog computing and 5G mobile networks.

Below you can find my selected publications related to my recent work:

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 toolkit implementation for 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
- InterCloud – Peering and Federation of Clouds
- Software Defined Networks
- Big Data
- Internet of Things (IoT)
- Fog and Edge Computing
- Application Targets include: Deed Learning, ECG Monitoring & Analysis, Data Mining & Business Analytics, and Brain Imaging (Dartmouth Medical School).
- Artificial intelligence (AI) for Next-Gen Cloud Computing

Future Research is Driven By:

A Manifesto for Future Generation Cloud Computing: Research Directions for the Next Decade.
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 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)
- In 2020, we released Aneka 5.0 edition.
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 fulfillment of the quality-of-service (QoS) requirements by allowing WMSs to fine-tune performance while ensuring the available resources are efficiently used.

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.
Some References:


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:

Cloud computing emerged as the leading technology for delivering reliable, secure, fault-tolerant, sustainable, and scalable computational services, which are presented as Software as a Service (SaaS), Infrastructure as a Service (IaaS), or Platform as a Service (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.

- In 2020, we released CloudSim 5.0

Some References:

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:

FogBus: A Blockchain-based Lightweight Framework for Edge and Fog Computing

The requirement of supporting both latency sensitive and computing intensive Internet of Things (IoT) applications is increasing the necessity for integrating Edge, Fog and Cloud infrastructures. Since, the integrated environments are distributed, centralized management of its resources is not feasible when latency sensitive data load is very high. Heterogeneity of resources and communication model further obstruct smooth execution of applications in integrated environments. In addition, Security of data and resources is also a very major concern of integrated Fog-Cloud environments.

There exist several works implementing software frameworks for integrating IoT-enabled systems, Fog and Cloud infrastructure. They;

- Barely support simultaneous execution of multiple applications and platform independence.
- Offer narrow scope to application developers and users to tune them framework according to individual requirements.
- Apply centralized techniques that eventually increase management time and service delay.
- Considers a few security aspects.

To overcome these problems, we have developed a lightweight framework for integrating IoT devices, Fog Computing and Cloud infrastructures. It offers platform independent application execution and node-to-node interaction overcoming resource heterogeneity. Moreover, it incorporates a Platform-as-a-Service (PaaS) model that assists both application developers and services providers. Based on FogBus, we have also developed a prototype application system for Sleep Apnea analysis in integrated IoT-Fog-Cloud environment. Furthermore, for ensuring data security, FogBus implements Blockchain, encryption and digital signature techniques.

References:


9. Moments with Visitors, Colleagues and International Hosts

A snap of CLOUDS lab members taken during Jay’s PhD completion seminar.

A Zoom session snap with some of the students of Semester 1, 2020 subject COMP90015: Distributed Systems

International Conference on Modelling Simulation and Optimization (CoMSO-2020), August 3-5, 2020