Relevant, high impact research in Information and Communication Technologies

swinburne.edu.au/ict
Research excellence – practical solutions for a better future

How can we harness the capability and potential of computing and the internet to shape our future?

This question is at the core of research and education undertaken across many fields at Swinburne University of Technology led by or in partnership with our Faculty of Information and Communication Technologies (ICT).

The Faculty’s research is scientifically advanced, industry relevant, providing practical solutions to modern enterprises, whether they be industry, business, government, health services or not-for-profits.

Computing and the internet have already brought rapid change to our lives – they are integral to how we conduct business, work, communicate, pay bills, shop and access entertainment and information. They continue to transform government, industry and business, education, research and our health services.

Through research and teaching excellence, Swinburne is committed to being at the forefront of scientific discovery and technical innovation that will help ensure Australia maximises the benefits offered by information and communication technologies while also providing the knowledge and tools to improve efficiency and lessen environmental impact.

Four academic groups are the focal points for Swinburne’s ICT research. Each enjoys the benefits of strong international and national reputations, partnerships and collaborations.

This prospectus highlights the expertise and opportunities available to work with these leading research groups to seek solutions to your ICT challenges and take advantage of their research expertise, knowledge and innovative thinking.

Swinburne looks forward to helping you achieve your goals.

Professor Leon Sterling
Dean, Faculty of Information and Communication Technologies
Benefits of a Swinburne partnership

Working with Swinburne gives you access to:

**Quality**
Research independently ranked at world standard*.

**Expertise**
We focus on outstanding ICT knowledge and research expertise in the following strategic areas:

- astrophysics and supercomputing
- computer science and software engineering
- information systems
- telecommunications and network engineering

They provide the capability to capture and apply emerging technologies to develop high-impact, relevant solutions.

**Industry knowledge**
The extensive industry experience of our research leaders helps them understand your requirements and commercial imperatives.

They are supported by Swinburne expertise in business contracts, intellectual property and commercialisation.

*International standard*
In 2011 we were once again listed amongst the world’s top 500 universities by the prestigious Academic Ranking of World Universities and the QS World University Rankings 2011.

In 2011, the Federal Government’s Excellence in Research for Australia (ERA) initiative ranked Swinburne’s research performance in General ICT including Computer Science, Software Engineering and Information Systems at “international standard”.

Our astrophysics research received the highest possible rating of 5 for “performing research at the highest international level”.

swinburne.edu.au/ict
Opportunities for industry

Industry Partnerships

A research partnership with Swinburne provides access to expertise, facilities, resources, training and research networks. This can include:

- Access to advanced technologies, modern equipment and network laboratories including GPU-based supercomputers, Cisco labs and radio telescopes
- Access to internationally recognised research expertise
- Commercialisation and IP expertise
- Collaboration for grant applications
- Staff postgraduate research training
- Access to library collections
- Expert advice and consulting for government

Contract Research

A joint venture with the Victorian Research Labs of National ICT Australia Ltd (NICTA), aims to close the gap between industrial and academic R&D for the benefit of industry, research institutions and the Victorian economy. This joint venture provides high quality, lower cost contracted research capabilities to industry, commerce and government on an as needed basis through flexible, agile, mentored industry driven R&D and technology innovation.

With assistance from the Victorian Government, this R&D Accelerator will provide solutions to shorter term needs and is particularly aimed at small and medium sized enterprises (SMEs), although it is also able to address the research needs of larger organisations.

Energy Management Research Centre (EMRC)

A joint venture with US based GreenWave Reality, the EMRC is being established to conduct leading-edge research, development, demonstration, training and technology transfer of new intelligent solutions for energy management in smart grid to businesses and communities in Australia and internationally.

Commercialisation

The Faculty works with Swinburne Knowledge* and Commercialisation Australia in seeking to commercialise some of its research where this is relevant. A current example we are working on is the commercialisation of cloud computing technology.

Research Funding and Collaboration

With a strong national and international reputation, our ICT researchers have been successful in securing national and international research grants and attracting industry funding for collaborative research, delivering scientifically advanced and industrially relevant outcomes. Of particular relevance to the funding of industry collaborations is the Australian Research Council (ARC) Linkage Program which provides a financially efficient means for companies to invest in collaborative research. In recent years, about 40% of the Faculty’s external research funding has come from the ARC.

The Faculty is a key partner in two flagship Cooperative Research Centres (CRC), namely:

- The Advanced Automotive Technology CRC
- Smart Services CRC

Both Centres have sponsored major research programs at Swinburne. We also participate in defence research with the Defence Science and Technology Organisation (DSTO) and in partnerships with the CSIRO.

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*Swinburne Knowledge

The role of Swinburne Knowledge is to broadly facilitate, support, and monitor the University’s commercialisation activities. This extends to the provision of advice and expertise to managers of units operating or planning commercial activities, and to senior managers.
Our research partners past and present include:

- APNIC
- AusDSRC
- Australian Research Council (ARC)
- Cisco
- Computer Associates (CA)
- Cooperative Research Centres: Smart Services CRC, Smart Internet CRC, AutoCRC
- Defence Science and Technology Organisation
- EU FP6/FP7 Consortia
- Federal and State Government Departments
- General Motors Holden
- GKN Aerospace Engineering Services
- Google
- Infosys
- ITS Australia
- Jeppesen
- National ICT Australia (NICTA)
- Powercor Australia/CitiPower
- SAP Pty Ltd
- Shandong Dareway Software Co, Ltd
- Telstra Corporation
- Thales Group
- Vastpark
- Victoria Department of Transport
- Victoria Police

International research centre collaborators include:

- Anhui University, China
- Behang University, China
- California Institute of Technology (Caltech), California
- Hefei University of Technology, China
- Institute of Software, Chinese Academy of Sciences
- Leipzig University, Germany
- Tallinn University of Technology (TUT), Estonia
Opportunities for research students

Swinburne’s ICT research centres offer excellent opportunities for outstanding PhD candidates to work with highly respected researchers, benefit from our national and international collaborations and our commitment to research excellence.

Swinburne qualifications are highly regarded and research positions in the Faculty of ICT are prized by the academic community.

If you can demonstrate a high standard of academic achievement and want to pursue a research degree, the Faculty of ICT offers Masters by Research and Doctor of Philosophy programs.

Swinburne assists outstanding PhD candidates with a range of scholarships and awards.

For full details visit: swinburne.edu.au/apply

Swinburne Supercomputers

The Green Machine
- Installed May 2007 and provides 10 Tflop/s performance
- 160 Dell PowerEdge 1950 nodes, each with:
  - 2 quad-core Clovertown 2.33 GHz CPUs
  - 16 GB RAM
  - 1 TB disk

gSTAR
- Installed December 2011 and provides over 100 Tflop/s performance
- 50 SGI XE500 nodes, each with:
  - 2 six-core Westmere X5670 CPUs
  - 2 NVIDIA Tesla C2070 GPUs
- Supplemented by 1.8 PB of disk storage with a Lustre file system
Research degrees

Application Process

A research degree can be commenced at any time during the year. Before completing the application form, please be aware of the entry requirements and Australian qualifications that need to be met as well as a chosen research centre and supervisor. For more information, please visit the Faculty of ICT research website – swinburne.edu.au/ict/research/future-students.

To apply for a research degree, please follow the steps below.

1. Decide on a research area of interest

Prepare a 150–200 word outline of the proposed research area of interest that you would like to undertake. This outline should be attached to your application upon submission.

2. Submit an application for admission

To apply for a research degree, download one of the following application forms from the Faculty of ICT research website (see above). You will find:

- Research Degrees Application Form for domestic students
- Research Degrees Application Form for international students

All applicants must supply the following supporting documentation with their application form:

- evidence of prior degree completion [specifically demonstrating research background]
- academic transcripts [certified copies, translated if not in English]
- a current resume outlining any relevant work experience
- a list of your publications

If published:

- a copy of the first page of the published paper
- the title of the journal/conference where published

If unpublished:

- a copy of the first page of the accepted paper
- confirmation of acceptance from conference organisers
- the title of the journal/conference where published

3. What happens next?

Submit your application to the address listed in your application form.

Following submission, your application will be reviewed by the Faculty of ICT. If your application meets our criteria it will be forwarded to Swinburne Research for consideration by the Research Higher Degrees Committee.

Before submitting an application, please email the Postgraduate Coordinator in the relevant discipline to help you identify an appropriate supervisor. Contact details can be found at: www.swinburne.edu.au/ict/research/contact
Astrophysics
The Centre for Astrophysics and Supercomputing (CAS) is one of the largest astronomical Research Centres in Australia. The Centre is dedicated to inspiring a fascination in the universe through research and education. Specific areas of research interest are star and planet formations, pulsars, globular clusters, super massive black holes, galaxy evolution and Big Bang cosmology.

An active program of research and development includes regular telescope time at major observatories including the Anglo-Australian Observatory, the Australian Telescope Compact Array (ATCA), the Gemini Observatory, the Mopra telescope and the Hubble Space Telescope Treasury Program.

In 2008 the Centre signed a landmark agreement with the California Institute of Technology (Caltech) that put Swinburne in the unique position of being the only Australian university to have guaranteed access to the 10m Keck telescopes in Hawaii. While some students travel to Hawaii to observe, other students observe on Keck directly from Swinburne’s Hawthorn campus via the Centre’s remote operations station. This is the longest base-line control room for an optical telescope in the world, providing the same experience and full control over Keck’s instruments as observers in Hawaii.

Capabilities
The following are examples of current major projects that profile the Centre’s capabilities:

The Theoretical Astrophysical Observatory
An online tool to build artificial universes from different cosmological simulations and galaxy formation models to explore and interpret galaxy survey observations.

Massive black holes in dense star clusters
An investigation into the metamorphosis of dense star clusters (containing millions of stars) into massive black holes at the centres of galaxies, using the world’s largest optical telescopes and one of the nation’s fastest supercomputers.

SAGES project
The Centre is taking a leading role in the international SAGES (Study the Astrophysics of Globular clusters in Extragalactic Systems) project which combines HST and Subaru imaging with Keck spectra to better understand globular cluster systems.

Building planets
A project to explore the very first dust grains that formed in our solar system and survey the dust content of planet-forming disks in the solar neighbourhood.

The SKA radio telescope
The Centre astronomers are working towards the next generation radio telescopes in the area of large-scale galaxy survey science, visualisation and data processing.

Diamond planet
Recently Swinburne’s Professor Matthew Bailes [pictured below] announced the discovery of a remarkable planet orbiting a special kind of star known as a pulsar.

“Based on the planet’s density and the likely history of its system, we concluded that it was certain to be crystalline. In other words, we had discovered a planet made of diamond. Following the publication of our finding in the journal Science, our research received amazing attention from the world’s media. The diamond planet was featured in Time Magazine, the BCC and China Daily, to name but a few. Our work is part of the astonishing growth in our knowledge of the universe, made possible by huge leaps forward in instrumentation and telescope technology.”

Simon Mutch
Astronomy PhD student
I have been interested in physics and astronomy from a very young age and studied astrophysics for my undergraduate degree. Having really enjoyed that experience, I wanted to continue my studies and become a professional astronomer.

My program, like most other PhD programs, gives you a lot of freedom. While you sign up with at least a rough idea of what you are going to spend your time researching, this can easily morph into something quite different as time goes on and your own interests develop. Doing a PhD is, in a way, like becoming your own boss but with the security of having your supervisor there to help guide and give you advice.

I hope that my research proves fruitful and that I produce a number of high impact papers. As I aim to continue on in academia, it is also important to me to be known internationally amongst my peers. Most importantly though, I want to keep enjoying what I do.
Swinburne 3D Productions

Swinburne 3D Productions is a production group attached to the Centre for Astrophysics and Supercomputing with over 10 years experience producing stereo-3D films, use of the Swinburne supercomputer and an in-house 2K digital cinema. Clients are based around the globe to produce beautiful scientific and non-science related content for cinema and television release.

Our content is seen by over 150,000 people each year in theatres around the world. From moon landings to large volume datasets, Swinburne Astronomy Productions can produce High Definition (1080p) animations in Stereo 3D or 2D to suit any topic.

Movies include:

- Star Voyager: Exploring Space on Screen – On Mars 3D brings breathtaking Martian data to life for an ACMI Exhibition.
- Dora the Explorer: Explores Wanted – Swinburne Astronomy Productions team up with Nickelodeon to send Dora the Explorer to the moon.
- Apollo 11 Moon Landing – 40th Anniversary Animation. To celebrate the 40th anniversary of the first moon landing, a team of animators from Swinburne University have created a re-enactment of the event.

Computer science and software engineering

Swinburne University Centre for Computing and Engineering Software Systems (SUCCESS) brings together some of the strongest computing, software research and teaching expertise in the Southern Hemisphere to:

- provide innovation in software research, education and industry driven R&D
- invent and promulgate new techniques and tools in our foci areas
- conduct research and scholarship in computing education
- engage with and significantly impact industrial software in R&D
- provide research students with the best possible preparation for their future careers
- attract high-performing students to our software degree programs
- interact with designers

The Centre has four technical research groups, complemented by a computing education research focus area. This includes the following:

Software Analysis and Testing
Focusing on quality pure and applied research that has a significant impact.

The Nature of Software in Research and Education
Developing a comprehensive understanding of the principles, techniques, and socio-economic elements underlying the specification, implementation, analysis, use, and maintenance of modern evolving software systems.

Next Generation Software Platforms
Conducting research on provision of leading edge software platforms for productive software development and applications, focusing on cloud computing, software services, methods, techniques and quality.

Knowledge and Data Intensive Systems
Developing efficient and effective software systems that provide valuable information from raw data, learn useful knowledge from obtained information and use learned knowledge for achieving goals in various applications, with focuses on advanced query processing and web data management, multiagent systems, service computing and workflow management, evolutionary computation, data analysis and knowledge discovery.

While each member associates with a primary focus area, members are encouraged to collaborate with other groups.

Capabilities

The following are examples of current major projects that profile the Centre’s capabilities:

Novel cloud computing based workflow technology for managing large numbers of process instances
This ARC funded project aims at proposing a novel cloud workflow architecture and its corresponding innovative mechanisms including data and services management schemes, scheduling algorithms and exception handling strategies. The key research outcomes are applicable to many e-business and e-government processes.

Context-aware vehicle
With support from the Cooperative Research Centre for Advanced Automotive Technology (AutoCRC), a research team is investigating a new context-aware pervasive computing platform for seamlessly managing and integrating in-vehicle functions and external services.

Cloud Broker
Supports cloud users in comparing options and selecting the most appropriate cloud configuration, providers, and conditions that best suit their requirements. It is based on three technology solutions for benchmarking, comparing and brokerage that can be used to offer three business services of consulting, referring and reselling the most appropriate cloud resources, respectively. The technology solutions have been developed by Swinburne researchers with partial support from Smart Services CRC. It is currently being commercialised with the assistance of Swinburne Knowledge.

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Rajiv Vashist
Information systems PhD student

My research interest was in the area of problem analysis for Information Systems (IS), therefore I realised the community of researchers at RISO would provide me with the support I would need to pursue my research interests. The experienced group of senior researchers make RISO a vibrant learning community, as it gives students the opportunity to interact with the national and international network of scholars.

‘A Communities-of-Practice Perspective on Roles and Practices of Business IS analysts’ is the current project I’ve been working on, which aims to understand what is involved in the work of business IS analysts. The project is motivated by the need to understand the practice of business IS Analysts so that IS academic research can be made more relevant to IS practitioners and to students who are aspiring to be IS practitioners.

What I hope to gain from RISO is the much needed insights into the knowledge, skills, attitudes, methods and tools that may be required for meeting the challenges of business analysis. I would encourage interested students to come and participate in the weekly RISO meetings and discuss their research interests with the group. This will help them understand how their research interests may be related to the research interests of others in the group.

Amani Ibrahim
Computer science PhD student

I undertook my research with SUCCESS because of its high calibrated research results in computing and software systems. SUCCESS offers all resources and facilities I need for my research. The weekly research seminars help in sharing knowledge and gaining experience from others. Supervisors at SUCCESS assist students in achieving their goals, and learn how to present highly qualified research. I hope to gain more experience in my research field through the great publications and thesis.
Towards energy efficient computing

Worldwide, the internet currently draws as much as 20 or 30 gigawatts of power – in terms of greenhouse gas emissions, this is roughly the same as the airline industry.

“We simply can’t keep increasing our activity because the rate at which we use energy is going to have to decline,” says Dr Lachlan Andrew, Associate Professor at Swinburne’s Centre for Advanced Internet Architectures (pictured below).

Drawing on funding from his Australian Research Council Future Fellowship, Dr Lachlan Andrew is researching ways in which the efficiency of the internet can be improved to lessen its environmental impact.

His research, in collaboration with Swinburne and US colleagues, aims to develop the knowledge and tools to support decision making by IT network managers wrestling with the desire to improve energy efficiency while maintaining the performance required by the business.

He hopes his work will raise people’s awareness of the environmental impact of computer use.

Telecommunications and network engineering

The focus of the Centre for Advanced Internet Architectures (CAIA) is on identifying, characterising and developing solutions to the engineering problems facing the internet as it grows to support a more mobile and demanding customer base.

The Centre conducts industry-relevant research in:

- broadband Internet Protocol (IP) architectures
- IP network resilience and security
- mobile networking
- energy efficient networking

This is supported by expertise in prototyping solutions and developing real-world simulations to prove or disprove ideas.

The Centre provides a world-class, stimulating and flexible research and teaching environment.

Capabilities

The following are examples of current major projects that profile the Centre’s capabilities:

**Global Research into Energy Efficient Networking (GREEN)**

Determining how to adapt capacity to dynamically varying Internet workloads to balance network energy consumption and delay.

**Mobile Applications and Global Internet Communications (MAGIC)**

Theoretical and empirical work exploring new techniques to enhance the service quality over wireless and to enable emerging applications with IP mobility. A major focus is the development of an Intelligent Transport System (ITS) to improve traffic safety and flow.

**NEWTCP**

With funding from global networking corporation Cisco, this research has led to the development of modular congestion control support for FreeBSD with New Reno and H-TCP algorithm modules; tools to support experimental research using FreeBSD, including Statistical Information for TCP Research (SIFTR) and Deterministic Packet Discard (DPD) for fine grained Dummynet packet drop control.

**Surveying The Internet’s NAT Growth (STING)**

With the imminent exhaustion of the IPv4 address pool, this project seeks to identify the allocated address space in use, and to inform new strategies for distribution of remaining IPv4 addresses. The project team is also quantifying the amount of devices using IP addresses to connect to the internet to be able to plan proper IPv6 address distribution.

Lawrence Stewart
Telecommunications engineering PhD student

CAIA’s focus on applied and practical data networking related research was an ideal fit for my telecommunications and software engineering background. The diverse range of people, projects and equipment ensures I never get stale. The Centre’s research aligns well with industry’s medium to long term technology time scales, which has resulted in the Centre developing strong ties with industry. Both aspects combine to create an engaging, relevant environment in which to study and work, ensuring that I am gaining skills and contacts that will serve me well for the rest of my career.

Since 2001, I have undertaken various roles at Swinburne and abroad whilst completing my undergraduate and now postgraduate studies. At Swinburne, I have taught data networking/programming subjects, worked on industry funded R&D projects, published software/academic papers and presented work at international academic and technical conferences/forums.

My PhD scholarship took me abroad for 6 months in 2009 as a visiting researcher to the University of Cambridge’s Computer Laboratory in the UK and Google Inc. in Mountain View, California. In 2011 I completed a 3.5 month software engineering internship with the network software team at Google in Sydney, working on prototyping proprietary network monitoring technology. I am now back to completing my PhD whilst doing a small amount of R&D project work on the side at CAIA.

Lawrence Stewart
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