

Reinventing ICT Research

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Information and Communication Technologies (ICT) are vital to Australia. More than a third of our recent GDP growth can be attributed to the adoption of ICT. Future prospects for ICT-led improvements to our quality of life are very exciting as many discoveries and innovations remain to be developed. This is why ongoing R&D in ICT is crucial: substantially more opportunity exists than has been exploited so far and we are still very much at the beginning of the discovery curve for ICT.

The average student leaving high school today will almost certainly require skills in ICT for a successful career – and new curricula across the nation are recognising this by making ICT an integral subject of study for all students.

For Australia to fully capitalise on future opportunities in ICT, it needs to leverage its highly educated population, its reputation for science and engineering excellence and its strategic location on the Pacific rim into a leadership role in applying ICT for the benefit of people, business and the environment.

CSIRO has a long history of research and achievement in information technology and telecommunications. From the early development of Australia's first programmable digital computer, CSIRAC and pioneering developments in RADAR to recent world leading technologies for Wireless LANs and electronic records, CSIRO has been very active in positioning Australia as an innovator in ICT.

Because it is increasingly through productivity gains and wealth created in other sectors that ICT has its major impact, CSIRO has been rethinking its ICT research and development strategy in recent times to ensure it is able to deliver maximum value from its unique position as a broad-based research organisation.

As part of this re-invention of CSIRO's ICT research, the CSIRO ICT Centre commenced operations on 1 September 2003. The Centre brought together researchers formerly spread across three different CSIRO Divisions to create a new focus for CSIRO's ICT research which provides customers and research partners with a single point of access to CSIRO's total ICT research base.

CSIRO's ICT Centre will aim to establish a strong position for CSIRO in ICT research by making sound choices today on where to put research effort to ensure that local ICT innovation drives social and economic benefit for Australia and the world.

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The ICT Centre's aims include:

- To create value for the ICT industry by stimulating strong local growth and export of Australian ICT products and expertise.
- To create value for ICT-dependent industries and industries with potential to reinvent themselves through ICT-enabling.
- To develop ICT solutions that address government priorities by creating ICT-based solutions to national priority issues.
- To ensure that CSIRO's overall research activities are empowered by leading ICT research outcomes.

To deliver on these aims the ICT Centre has been developing and refining its research agenda, with a view to establishing a relatively small number of research themes which will focus on delivering solutions into priority industries such as e-health.

Initial research themes include:

- Wireless and Antennas
- High Performance Networks
- Autonomous Systems
- Information Agility
- Networked Information Systems

The ICT Centre cannot attempt to deliver impact into every sector of the economy so will need to target its industry engagement carefully. This process is still underway but current indications are that we will have significant engagements in several of the areas addressed by CSIRO's National Research Flagships:

- Preventative Health
- Wealth from Oceans
- Food Futures
- Energy Transformed
- Water for a Healthy Country
- Light Metals

As well as these, there are many other CSIRO research areas where ICT has the potential to deliver impact and the ICT Centre will actively pursue opportunities for productive, directed collaboration with CSIRO Divisions.

PARTNERING FOR SUCCESS

Partnering is crucial to all outcome-driven research and particularly so in ICT. One of the reasons CSIRO has created a *Centre* for research in ICT and not a new Division is to emphasise the partnering role of the new entity. The ICT Centre will partner with

- Business and industry – to understand their problems and needs, identify opportunities, create enterprises and provide fast routes to market for innovation.
- Governments – to create critical mass based on regional strengths, to contribute and respond to policy, to solve issues of national significance
- Other research organisations – to leverage respective strengths, build critical mass and grow the total ICT R&D pie in Australia

- CSIRO – to apply ICT-based solutions into the many industries and sectors in which CSIRO operates, adding value to CSIRO research through ICT enabling.

CSIRO is supporting the development of a national ICT research agenda through increased consultation and collaboration with National ICT Australia (NICTA), the Defence Science and Technology Organisation (DSTO) and other major Australian ICT research interests including the Council of ICT CRCs.

The ICT Round Table comprises senior management from each of these organizations and meets several times a year to plan and progress strategies for research collaboration.

In 2003, CSIRO, NICTA, DSTO and the ICT CRCs held the first Australian ICT Outlook Forum (www.ictoutlookforum.com.au) as an annual opportunity for research, academic and industry to meet and explore current trends and opportunities in ICT. The 2004 event built on a the success of the inaugural Forum and future years promise further growth in prominence and quality.

It is reasonable to ask the question: “Why do we have two publicly-funded ICT research agencies in Australia?” While on casual analysis, the two agencies may appear similar, there are some fundamental differences between NICTA and CSIRO that ensure their roles are synergistic rather than competitive.

NICTA has a specific focus on education in ICT, leveraging its strong foundations in academia. CSIRO (‘s focus is on industry facing research – which means we’ll benefit from NICTA’s focus on ed) does have active programs for PhDs and post-doctoral fellowships – but it is not fundamentally an educational organization. Nevertheless CSIRO expects to draw benefit from NICTA-led programs to improve the quantity and quality of graduates with high level skills in ICT.

NICTA has chosen to focus its R&D activities on six industry sectors (financial services, defence, automotive, intelligent transport, biotechnology, digital media).

CSIRO, on the other hand, can potentially leverage the broader industry engagement of the rest of CSIRO across many more domains. This is not to say CSIRO will not focus its activities in certain domains – but the likelihood is that the domains CSIRO chooses to focus on will not significantly overlap with NICTA, and where they do there will most likely be a different technology focus.

CSIRO very much seeks to inform its research through direct engagement with industry. While this is certainly also true of NICTA to an extent, they are also very much involved in bringing cultural change to academia – identifying previously unseen or un-exploitable synergies across different institutions.

Both organisations work with small to medium enterprises (SMEs) but there are differences of emphasis with CSIRO focussing on high technology “star” SMEs with significant growth potential and NICTA providing more broad based opportunities for SMEs to benefit from ICT R&D.

Naturally both organizations have an emphasis on commercialisation and the delivery of innovation to market, and both seek to do this through a range of strategies from spin-off companies to joint ventures to licensing of intellectual property. It is likely that as the respective strengths of NICTA and CSIRO come into sharper focus, there will be increased opportunity for the two organizations to partner not only in research but in its commercial applications.

EARLY SUCCESSES

The ICT Centre has had some notable successes in its first 12 months. In May 2004 the Centre won two Australian Information Industry Association iAwards for the Virtual Critical Care Unit (see below) and for its world-leading search engine, Panoptic (www.panopticsearch.com).

In March 2003, The CSIRO MultiBeam antenna was awarded the 2004 Industry Innovators Award of the Society of Satellite Professionals International (SSPI) for technology developed by the public sector. The MultiBeam antenna is a new concept in antenna design which offers a unique approach to the future needs of satellite communications. Each MultiBeam antenna can communicate simultaneously with up to 19 geostationary satellites over multiple frequency bands. CSIRO MultiBeam antennas have been installed in Luxemburg for Europe's leading direct-to-home satellite operator, SES Astra.

An early partnering success for the Centre is the establishment of the e-Health Research Centre (e-HRC), a \$15M joint venture with the Queensland Government. The e-HRC aims to deliver better access to health services for patients no matter where they are. The venture will deliver significant flow-on benefits to the health industry, as well as deliver healthcare benefits to urban, rural, regional and remote communities in Queensland and the rest of Australia.

For example, doctors from different parts of Australia may soon be able to collaboratively examine patient test results. It will also mean that hospitals, no matter where they are located, can use advanced telecommunications for access to experts to offer specialised services and standards of care currently only available at a big base hospital.

The recent successful spin off of the CSIRO semiconductor business, EpiTactix Pty Ltd, is another recent milestone. EpiTactix represents the culmination of many years of research into novel semiconductor and integrated circuit technologies.

EpiTactix has secured \$5.2 million in start-up funding and support from a syndicate of investors, including the CSIRO and an AusIndustry R&D START Grant. The funding will be used to develop new compound semiconductor production processes and wireless products for the growing high frequency segment of the broadband wireless market. EpiTactix plans to develop products for defence and automotive radar, high bandwidth point-to-point systems and a number of high bandwidth consumer applications.

The spin-off is an example of CSIRO's commitment to giving its intellectual property the best chance of achieving commercial success and impact.

Recently as part of the 2004 International Conference on Auditory Display in Sydney, CSIRO researcher Stephen Barrass produced a unique public event: The Listening to the Mind Listening Concert, a concert of ten pieces of music composed from the brain activity of a person listening to a piece of music. This event was an exciting public expression of a field of emerging research: sonification, which is the science of representing data with sound.

Stephen Barrass is researching ways of delivering critical information in complex data environments using sound to enhance the listener's ability to make sense of competing information streams. The potential applications of sonification are many from stock markets to air traffic control to working in hazardous environments.

By supporting research in emerging fields like sonification CSIRO is maintaining the pipeline of innovation that turns today's left field idea into tomorrow's core technology. Without a balanced portfolio of research in emerging science, mature science and commercial delivery, there is a real danger of losing relevance on the one hand or failing to derive sufficient benefit for CSIRO and the nation on the other.

CSIRO is a foundation and leading partner in CeNTIE the Centre for Networking Technologies for the Information Economy. CeNTIE is supported by the Australian Government through the Building on IT Strengths (BITS) Advanced Networks Program (ANP) of the Department of Communications, Information Technology and the Arts and is building an advanced network to enable research into the new networking technologies required for the next generation business systems of the information economy.

Four business system testbeds are being constructed on collaboration with a number of key end users in telehealth, information brokering, telecollaboration and media systems. Working with networking research engineers, the users identify the technological, economic and social impediments to implementing new economy business systems. Solutions which overcome these impediments are developed and trialled and implemented on the CeNTIE network.

One of the major projects in telehealth is the Virtual Critical Care Unit (ViCCU™) which uses a high bandwidth network to provide a system which allows a medical specialist located at one hospital to supervise an intervention team located at a peripheral hospital.

In the first instance, the central hospital is Nepean Hospital, on the western outskirts of Sydney. The peripheral hospital is Blue Mountains District Hospital, located 60km further west in Katoomba.

ViCCU™ is designed so that all information required by the specialist to make judgements on patient treatment is available in real time, as if he or she were present at the peripheral hospital. This is achieved by transmitting several high quality digital video channels, high quality audio, vital signs data, written notes and medical images. Two-way high bandwidth video permits natural, low-latency “telepresence” interaction with the specialist. The system is designed to be robust, fault-tolerant and easy to use in the highly stressful atmosphere of the Emergency Department.

Recognising the significant achievements of CeNTIE in its first three years of operation, the Australian Government recently announced a renewal of CeNTIE funding to enable it to continue its groundbreaking work in advanced networking.

An example of the sort of big e-science projects that can be enabled by ICT is Australia’s bid to host the ‘Square Kilometre Array’ a major international Radio Astronomy facility. This massive \$2 billion project would have significant flow on benefits not just to ICT but to other sciences and the manufacturing, engineering and electronics industries.

SOME OF CSIRO’S ACHIEVEMENTS IN ICT

The ICT Centre is built on CSIRO’s strong history of achievement in ICT research and development.

Wireless LAN

High speed wireless networks mean easy connection of computers, video cameras, televisions and many kinds of portable devices. CSIRO has been working in the wireless LAN area since 1991. In 1997, CSIRO licensed its wireless LAN technology to Radiata Communications Pty Ltd who developed one of the first chipsets for high speed wireless local area networks.

In 2001, the world’s biggest networking equipment company, Cisco Systems Inc, completed development of a wireless chipset to conform to the WiFi (IEEE 802.11a) standard based on technology and patents licensed from CSIRO.

Electronic Records Management.

The Victorian Electronic Records Strategy (VERS), a framework for the capture, retrieval and long term preservation of electronic records, was developed by CSIRO in conjunction with Ernst & Young and the Public Record Office of Victoria. VERS ensures both the accessibility and authenticity of records. VERS is currently being implemented across the Victorian Government. CSIRO is managing the technical aspects of implementation including the revision, extension and explanation of the VERS standard, managing software development, and supporting the acquisition of equipment.

The Continuous Media Web (CMWeb)

Web users may soon be surfing video and audio content as easily as text and images with CSIRO's CMWeb. CMWeb will make time-based media such as audio and video as interactive as the rest of the Web. With CMWeb, users can activate hyperlinks within and between video and audio files

Annodex™ format media is the term coined by the researchers to describe the crucial twin processes of indexing and annotating content, the secret to fully integrating rich media content into the Web.

CSIRO has developed conventions for inserting hyperlinks into streaming media and specified a file format for combining anchor (link), metadata and media information in a single file. They have also developed tools for creating Annodex™ format media files and created the first CMWeb browser. Currently the team are demonstrating search and delivery of Annodex™ format media via mobile phones.

Panoptic Search

Recent studies show that poor enterprise search costs organizations millions of dollars per year. Panoptic is a high performance enterprise search engine, developed by CSIRO and the Australian National University, which can dramatically improve the effectiveness of information retrieval for an organization's customers and staff.

Panoptic offers a unique combination of metadata and full text indexing and can handle collections of millions of documents in a variety of formats. Benchmarking studies show that Panoptic significantly outperforms its competitors when retrieving key pages from enterprise webs, being up to twice as effective as most installed search engines.

Panoptic is enjoying a growing reputation in Australia, powering searches on more than 20 sites including the Australian Broadcasting Corporation (ABC), nineMSN, Australia Stock Exchange and the Research Finder portal for Australian research capabilities.

Virtual Reality

Virtual reality, and in particular haptic (touch sense) virtual reality, is a key technology for advanced approaches to training, education, entertainment, business and manufacturing. CSIRO's haptic workbench is a desk sized virtual reality workstation that allows the user to see, feel and manipulate three dimensional virtual objects.

CSIRO is working with the Royal Australasian College of Surgeons to research and develop surgical training modules using this technology. In collaboration with CeNTIE, CSIRO is exploring the possibilities for remotely linked haptic workbenches for mentoring and other collaborative activities.

Ka-band transponder for FedSat

A CSIRO-developed transponder, launched in 2002 aboard Australia's first satellite in 30 years, FedSat may be an important step in improving electronic service delivery to remote communities.

FedSat is a low Earth orbit satellite, built by the Cooperative Research Centre for Satellite Systems, in which CSIRO is a core partner. The transponder will investigate the propagation and communication characteristics of the new experimental high frequency, high capacity Ka-band (20/30 GHz) of the radio spectrum. Future, more powerful satellites may use the Ka band to provide better services to remote communities.

The transponder uses CSIRO designed and fabricated monolithic microwave integrated circuits to process signals to and from the ground.

Robotics

Draglines are an essential part of large scale surface mining operations. CSIRO is applying robotic technologies to achieve performance improvements by moving material intelligently, swiftly and smoothly, without increasing the load on the dragline. Thanks to the CSIRO Robotics team, dragline operators and mine planners now have access to the data and tools they need to ensure that a dig is proceeding to plan and that any design rehandle is minimised.

Digital Terrain Maps (DTMs) generated from the dragline in real-time can now be used to aid both the operators and the mine planners in moving the overburden intelligently and correctly (according to plan). DTMs are also used by our Dragline Swing Assist system to “see” the local terrain in real-time as the dragline swings from dig to dump and to “see” the top of the spoil pile as it grows with each swing and hence allow the automatic adjustment of the dump height.

Ultra fast Integrated Circuits

In 2002 CSIRO recognised the work of its researchers in the field of ultra fast Integrated Circuits with the award of a CSIRO Medal. The award recognised the development of advanced millimetre-wave Indium Phosphide Integrated Circuits (MMICs) and their application to radio astronomy, telecommunications and passive imaging.

These MMICs set new international performance benchmarks at millimetre-wave frequencies and enabled the upgrade of CSIRO’s Australia Telescope, making it the only Southern Hemisphere millimetre-wave radio-telescope array and the first in the world to use cryogenically-cooled MMIC front-ends. The agreement also enabled CSIRO to become a key provider of advanced MMIC technology in a range of collaborative international radio astronomy projects.

For more information: www.ict.csiro.au

BIOGRAPHICAL NOTES

Dr Alex Zelinsky is Director of Information and Communication Technology (ICT) Centre for CSIRO. The CSIRO ICT Centre with 200 research professionals is responsible for developing ICT technologies that deliver the benefits of innovation to industry and position Australia to compete globally.

Prior to joining CSIRO in July 2004, Dr Zelinsky was Chief Executive Officer of Seeing Machines Pty Limited and a Professor at the Australian National University, in the Research School of Information Sciences & Engineering. He received his BSc (1983) and PhD (1991) degrees in computer science and electrical engineering from the University of Wollongong, Australia.

He has worked as a Research Scientist in Japan (1992–1995) at the University of Tsukuba and the Electrotechnical Laboratory. In 1996 he joined the Australian National University to lead the Robotics Systems Laboratory. His primary research interests are in mobile robotics, multi-robot systems, human robot interaction and real-time computer vision systems. In recent years the focus of his work has moved to building systems that are suitable for reliable deployment in the real-world, with the ultimate goal of developing robotic technology for mass-market applications. Seeing Machines was established to commercialise computer vision technology for the automotive industry.



Alex Zelinsky

Alexander Zelinsky is a senior member of IEEE Robotics and Automation Society, and is a past president of the Australian Robotics and Automation Society (1997–99). In 1997 he founded and organized the first of a series of biannual academic meetings to promote the development of robotics technology for non-industrial applications through the International Conference on Field and Service Robotics (FSR). He is a member of the Editorial Board of IEEE Robotics and Automation Magazine and International Journal of Robotics Research.