Australia and New Zealand CRC for Spatial Information
Achievements Report
2013-14

Australian Government
Department of Industry and Science

Business Cooperative Research Centres Programme

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Acknowledgements

The CRCSI wishes to acknowledge images contributed by the broader CRCSI team, the spatial research community and the European Space Agency.

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Contents

At a Glance

- The CRC for Spatial Information (CRCSI) is a joint venture of government, academic and private sector organisations established in 2003 under the Australian Government's Business Cooperative Research Centres Programme. This programme now sits within the Department of Industry and Science.

- The spatial information sciences include positioning (using GPS and other Global and Regional Navigation Satellite Systems), remote sensing from satellites, aircraft, UAVs and ground based platforms, geographic information systems, data analytics, and spatial data infrastructures.

- The emerging spatial information industry contributes around 2.2% to Australian economic activity and employs around 93 000 people (pwc, July 2013).

- The CRCSI undertakes user-led research involving spatial technologies to solve complex problems of national significance for Australia and New Zealand.

- The CRCSI is tackling three major challenges:
  - Solving the technical challenges that will permit Australia and New Zealand to use all global and regional navigation satellite systems to deliver 2cm positioning accuracy to anybody, anywhere outdoors in real-time. This will support the development of Australia's National Positioning Infrastructure

  - Developing our research capability to enable Australia and New Zealand to be world leaders in the generation of semi-automated spatial information products from terrestrial, airborne and satellite sensors, and from existing data sources

  - Identifying and solving the research challenges to build spatial data infrastructures that will enable CRCSI partners to create value-added applications using semantic web technologies.

- The CRCSI research will lead to major innovation and productivity advances in key industry sectors. These are:
  - Agriculture, natural resources and climate change
  - Defence
  - Energy and utilities
  - Health
  - Sustainable urban planning

- The 100 partners include federal and state government agencies, universities, companies and overseas research organisations.

- The CRCSI has a vital partnership with 45 companies through the international SME consortium 43pl. This consortium is an essential participant of the CRCSI.

- The CRCSI has significant membership from New Zealand including a lead government agency, Land Information New Zealand (LINZ), the University of Canterbury, and a number of companies who are members of 43pl.

- Since 2010, the CRSCI has delivered a research impact of AU$119 million. The expected impact as existing project outcomes mature and the longer outlook programs deliver results is AU$750 million.

- The CRCSI is committing resources (cash and in-kind) of over AU$180 million, for eight years until 2018.

- 75% of total CRCSI expenditure is directed to the research program, with the remainder used for business development, education, communication and administration.

- The values of the CRCSI emphasise collaboration in its relationships, excellence in research, and being transformational in its impact.

- The equivalent of 88 full time researchers and staff, drawn from around 300 individuals across Australia, New Zealand, India, Japan, China and the United States are employed by the CRCSI.

- There are 35 post graduate students supported through the CRCSI education program. Three completed their PhDs this year.

2013-14 Strategic Plan

THE CRCSI STRATEGIC VISION IS TO BE WIDELY RECOGNISED FOR UNDERTAKING HIGH IMPACT, COLLABORATIVE RESEARCH THAT LEADS TO ACCELERATED INDUSTRY GROWTH, IMPROVED SOCIAL WELL-BEING AND A MORE SUSTAINABLE ENVIRONMENT.

STRATEGIC OBJECTIVES

The CRCIS has seven strategic objectives that support the outcomes of the three research and development programs. These objectives are:

1 Precise Positioning Program

To conduct research that solves the signal processing and economic impediments for the creation of a sparse, continental-scale, precise positioning multi-GNSS network operating at 2cm (x and y) accuracy.

2 Automated Generation of Spatial Information Products Program

To develop the research capability to enable the CRCSI and its partners to become Australia's leading centre for automated processing of information from terrestrial, airborne and satellite platforms and from existing data sources.

3 Infrastructure for an Australia New Zealand Spatial Marketplace Program

To identify and solve the research issues that will enable the operators of the Australia and New Zealand Spatial Marketplace to construct the infrastructure, operate the marketplace and enable CRCSI partners to create value added applications with new technologies.

4 Applications Program

To include but not be limited to the realisation of high impact use of the CRCSI's research in the following areas:

- Agriculture and Natural Resources affected by Climate Change through the creation of a biomass and carbon monitoring system for high resolution and high frequency application on farms and through improved environmental monitoring
- Defence by adapting the emerging capabilities of the CRCSI's research portfolio
- Energy Utilities to enable remote monitoring of the condition of built assets in near real-time
- Health by helping agencies to spatially enable their clinical databases
- Urban development to build new tools, paradigms and theories including the agglomeration economy and greyfield regeneration to support sustainable urban development.

5 Education Program

The improved skill capability of the Australian and New Zealand workforces by working with the education providers. As a priority by 2018 the CRCSI will have graduated at least 55 PhD students with university partners.

6 Industry Development and Sustainability Program

To establish a program of assistance for its partners, in particular 43pl, that helps find ways to develop and exploit the CRCSI intellectual property, and to establish a program for 43pl members and industry to improve the management of internal innovation and R&D programs. These programs seek to encourage investment in R&D by spatial businesses.

7 Commissioned Research

Commissioned research is expected to generate an additional AU$10 million of activity in the CRCSI (from January 2010) tackling complex research needs involving multiple partners from both the public and the private sectors. Initially, most of this research will be taken on around the existing core expertise. In time this will grow into new areas of expertise.

Impact

THE IMPACT EXPECTED TO BE ACHIEVED BY THE CRCSI FROM ITS ACTIVITIES SINCE 2010 IS AU$750 MILLION MEANING THAT FOR EVERY AU$1 INVESTED BY THE CRCSI THERE WILL BE A RESULTING BENEFIT OF AU$2.50.

Since 2010 the CRCSI has delivered a research impact of AU$119 million from AU$137 million in costs. This negative benefit will flip over time as existing project outcomes mature and the longer outlook programs deliver replace with outcomes that can be translated to impact.

Much of the benefit results from the CRCSI research delivering outcomes that reduce costs to end-users either in collection, processing, delivery, maintenance or usage.

Program 1 – Positioning
The future impact of the research investment in this program is AU$110 million. The benefits will flow through the accelerated uptake and utilisation of the National Positioning Infrastructure directly relating to the aviation, land management and surveying, location, maritime, mining, transport, and utilities sectors.

Program 2 – Automated Spatial Information
It is estimated this program will deliver AU$324 million in research impact across three areas.

To-date, this program has delivered AU$72 million in benefits through data distribution, improved software technology and labour savings.

Specific benefits have arisen from the National Elevation Data Framework which allows publically downloadable sea level rise maps and visualisation tools; improved software solutions that reduce annual costs in vegetation management in the utilities sector; and labour savings in the processing of government and industry data.

Program 3 – Spatial Infrastructure
AU$122 million in research impact is expected to be achieved in the spatial infrastructure area. Currently the program has delivered AU$36 million through nationally cohesive infrastructure technologies; industry growth from access, rights and governance; and the adoption of creative commons framework.

Program 4 – Application
AU$10 million has been delivered in research impact to-date, with a future benefit of AU$195 million. The research impact focuses on improved health services using geospatial visualisation that informs preventative health; cost savings in sustainable urban development tools and improved skills in spatial analysis.

Education
It is estimated that postgraduate students who have completed studies through the CRCSI education program have delivered a research impact of AU$800,000 mostly through their contribution of labour to projects across the research areas. The overall impact of the program is expected to be AU$8 million – from 55 study completions.

Program Overview

THE CRCSI CENTRAL FOCUS IS DEVELOPING A RESEARCH INFRASTRUCTURE THAT DELIVERS COMMERCIALLY APPLICABLE END-USER IMPACT OUTCOMES. THE THREE RESEARCH THEMES – POSITIONING, AUTOMATED SPATIAL INFORMATION GENERATION, AND SPATIAL INFRASTRUCTURES – ARE SUPPORTED BY FIVE APPLICATION PROGRAM AREAS. THESE PROGRAM AREAS ARE:

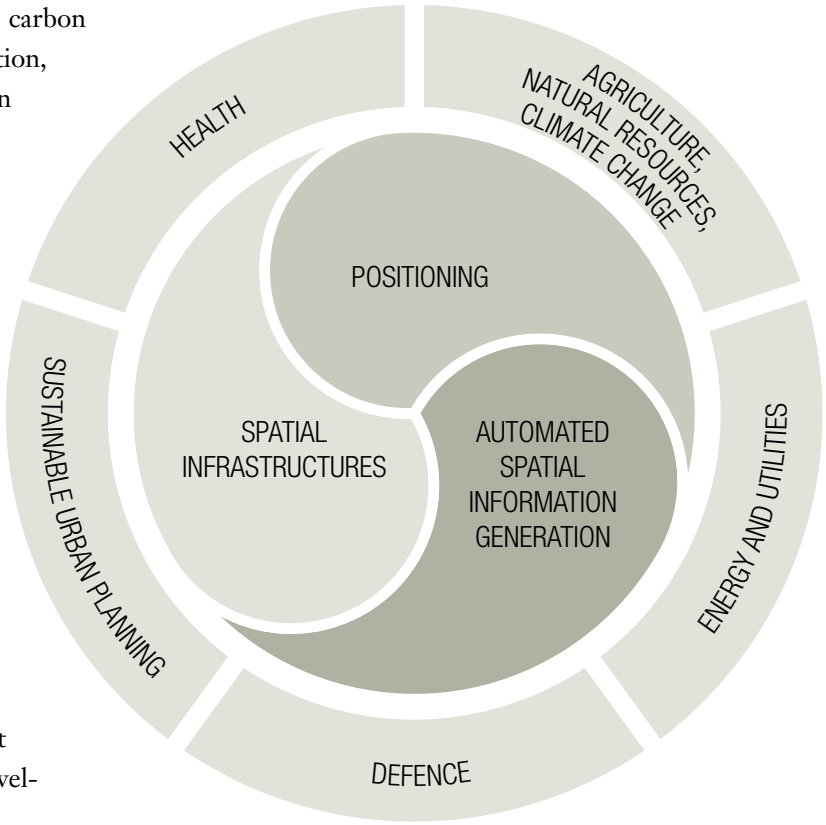
Agriculture, Natural Resources and Climate Change to create a biomass and carbon monitoring system for high resolution, and high frequency application on farms and through improved environmental monitoring.

Energy and Utilities to enable remote monitoring of the condition of built assets in near real-time and foster a culture of innovative technologies.

Defence by adapting the capabilities of CRCSI's research portfolio.

Sustainable Urban Planning to build new spatial tools to support sustainable built infrastructure development.

Health by helping agencies to spatially enable organisational clinical databases.



Awards and Research Achievements

EACH YEAR, THE CRCSI HIGHLIGHTS THE AWARDS RECEIVED AND RESEARCH ACHIEVEMENTS OF ITS STAFF, RESEARCHERS AND PARTICIPANTS.

These achievements highlight the impact and collaborative research undertaken by the CRCSI that will lead to accelerated industry growth, improved social well-being and a more sustainable environment.

AWARDS

The CRCSI and its research community received seven awards of national and European significance. These awards provide recognition of the calibre of its research community, global connections and the strong network of programs.

Project	Recipient	Organisation	Award
High Accuracy Real-time Positioning utilising the Japanese Quasi-Zenith Satellite System (QZSS0 Augmentation System	GNSS Research Centre	Curtin University	Recipient of the *European Space Agency Award* for the successful and early Galileo positioning analyses. Awarded the first 50 users of the Galileo System worldwide.
Commercialisation Project	Scanalyse	Scanalyse	Recipient of the *2013 Australian Museum Rio Tinto Eureka Prize* for commercialisation of innovation for the creation of MillMapper and CrushMapper systems.
Capacity building of GIS and spatial data skills for Pacific Island countries	Dr Nathan Quadros and NGIS	CRCSI and 43pl	Recipient of the *2013 WA Spatial Excellence Awards* – People and Community for 'Pacific Islands sea level rise data capacity building program'.
Creation of a web based tool for operationalising the CFI reduction of greenhouse gas emissions through early dry season Savanna burning methodology	Prof Kim Lowell and Spatial Vision	CRCSI and 43pl	Recipient of the 2013 *Victorian Spatial Excellence Awards* and the *2013 Asia Pacific Spatial Excellence Awards* – Environment and Sustainability for 'CFI Savanna Burning Abatement Tool'.
Greening the Greyfields: Precinct visualisation and community engagement	Dr Stephen Glackin	CRCSI and Swinburne University of Technology	Recipient of the *Swinburne University of Technology Vice-Chancellor's Early Career Research Excellence Award*
Multimodal data acquisition and feature extraction from multi-sensor terrestrial mobile mapping systems	Dr Xin Liu	CRCSI and Curtin University	Recipient of the *2013 WA Spatial Excellence Awards* – Postgraduate of the Year for 'The determination of high water mark along the Western Australian coastal line.'
Sustainable Urban Planning Program	Prof Peter Newman	Curtin University	Made an *Officer of the Order of Australia in 2014* for 'distinguished service to science education as an academic and researcher, through contributions to urban design and transport sustainability, and to the community'.

MI Helicopters

RESEARCH ACHIEVEMENTS

This year the CRCSI has seven high profile research achievements. The breadth of these achievements across the CRCSI programs will lead to commercial impacts for its participants, partners and members, and ultimately the broader spatial industry and the community of end-users.

1 Early efficiency gains in airborne power line inspection

The Queensland University of Technology based research team have developed new aircraft turning strategies allowing for the impact of current wind conditions. The potential operating savings are significant with a simulation on powerline networks suggesting up to a 15% reduction in total inspection costs.

2 Improving to the Australian Geographic Reference Image (AGRI)

The AGRI project produced a nationwide geo-referenced image mosaic comprising almost 10 000 satellite images. The CRCSI developed a new photogrammetric processing approach that reduced the need for ground control by more than 95% and reduced the image registration task from almost 10 000 scenes to just 105 orbit segments resulting in savings of several million dollars in processing costs.

3 Overcoming limitations in the International GNSS Service (IGS) orbits

The IGS provides high accuracy global orbit and clock products for real-time and post processed GPS positioning. The CRCSI research team based at Curtin University in Western Australia have discovered technical problems with the IGS regional orbit products that reduced positional accuracy. This team is now working with the IGS to develop a new international standard for conversion of IGS products into regional frames of reference to be adopted for global use.

4 World first results in integrating GPS and Galileo signals for RTK positioning

The CRCSI research team at Curtin University in Western Australia have achieved a world first by integrating GPS and Galileo signals to demonstrate use for real-time kinematic positioning. This research demonstrates the practical potential and a theoretical foundation for real-time, high accuracy positioning based on signals from multiple GNSS constellations.

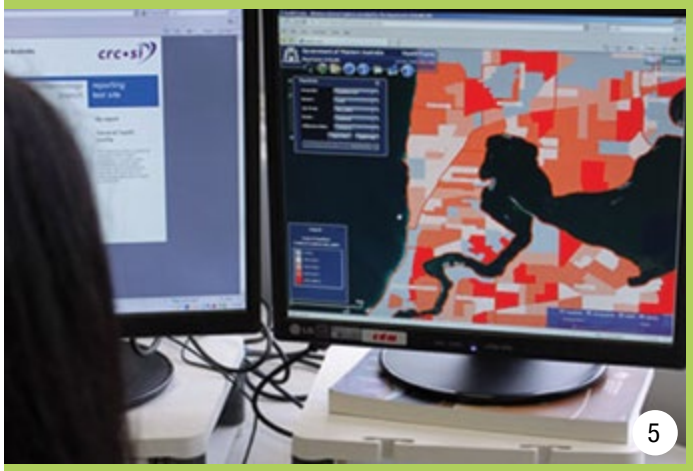
5 Overcoming privacy challenges facing health analysts

CRCSI researchers at Curtin University, in collaboration with the Western Australia Department of Health, Landgate and 43pl members, have further developed the web application Health-tracks™ that visualises complex population health data for epidemiological studies. This data was previously only accessible to a handful of highly trained researchers. Now Healthtracks™ has made data readily accessible to over 100 researchers and managers in the Western Australia Department of Health and other associated organisations. There are other substantial benefits including reduced workload by automating the workflow and removing the need to check that

privacy protocols have been met when disseminating spatial health data across agencies and to the public.

6 Improving understanding of cancer outcomes

Queensland University of Technology located CRCSI researchers have developed novel Bayesian modelling tools to better understand the spatial and temporal variation in the treatment of cancer in the community. They have also examined the optimum location of the provision of cancer treatment services. One model predicts cancer incidence based on factors such as distance to health services, while another assesses the current state of service provision in relation to the demand for services in small areas. These models will assist health policy-makers make more informed decisions for future service promotion and the redistribution of cancer treatment services.



7 A new way to remotely measure crop and pasture biomass

Efficiently measuring and mapping green biomass using remote sensing offers substantial benefits for improved management of pastures. Working with the University of New England, CRCSI researchers validated the use of a cheap lightweight and easily deployable airborne, near infrared and red reflectance sensors to quantify and map pasture biomass using specific spectral indices for use in farm decision management systems.

Education Program

THE EDUCATION PROGRAM FOCUSES ON FUNDING AND FOSTERING PHD AND MASTERS STUDENTS TO INTEGRATE WITH THE SPATIAL INDUSTRY. IT'S ABOUT BUILDING A COHORT OF STUDENTS TO WORK IN THE SPATIAL INFORMATION SECTOR IN AUSTRALIA, NEW ZEALAND AND ACROSS THE WORLD AS THE NEXT GENERATION OF KNOWLEDGE WORKERS TO GROW THE SECTOR.

The CRCSI education objective is to support in conjunction with university partners, at least 55 PhD and masters students through to study completions.

A copy of graduated students work can be found in the CRCSI online library at www.crcsi.com.au/library

CRCSI PHD GRADUATES

There are 35 students currently working within the CRCSI education program. This year three students graduated from their studies, a brief extract follows:

Eldar Rubinov thesis '*Stochastic modelling for real-time GNSS positioning*' was submitted to the University of Melbourne in January 2013. This study developed a new stochastic model using Time Differenced Range Residual, a process that uses empirical noise estimation from raw observations in real-time to establish the positions of earth orbiting satellites. Whilst the new model is proving more realistic precision estimates compared to other approaches, the model requires additional research before practical application.

Xin Liu thesis '*Determination of the high water mark and its location along a coastline*' was submitted to Curtin University in April 2013. Using space and time, this study determined the high water mark by integrating water and land information. The outcomes of this research will guide future coastal hazard management in property and infrastructure protection from storm surge and sea level rise. The model allows for re-calculation over time as coastal conditions alter.

Steven Mills thesis '*Visual guidance for fixed-wing unmanned aerial vehicles using feature tracking*' was submitted to the Queensland University of Technology in September 2013. Using unmanned aerial vehicles to collect data over large areas has automated the inspection of infrastructure. This study replicated and provides solutions to performance, guidance and control issues to now enhance the stability of the vehicle and reduce data collection errors. The testing was carried out in a simulated environment that included turbulence and wind gusts.

The CRCSI education objective is on track to support at least 55 PhD and masters students through to study completions.

Governance and Management

THE CRCSI IS AN UNINCORPORATED JOINT VENTURE UNDER THE TERMS AND CONDITIONS SET OUT IN THE COMMONWEALTH AGREEMENT AND THE ESSENTIAL PARTICIPANTS AGREEMENT.

The CRCSI is governed, managed and operated by a single unlisted public company limited by guarantee – Spatial Information Systems Research Limited (SISR) – that acts as trustee of the CRCSI Intellectual Property, employs the management staff, undertakes contract research work and manages the CRCSI operations.

Essential Participants may be a member of SISR of which seven have currently chosen to do so. These participants are:

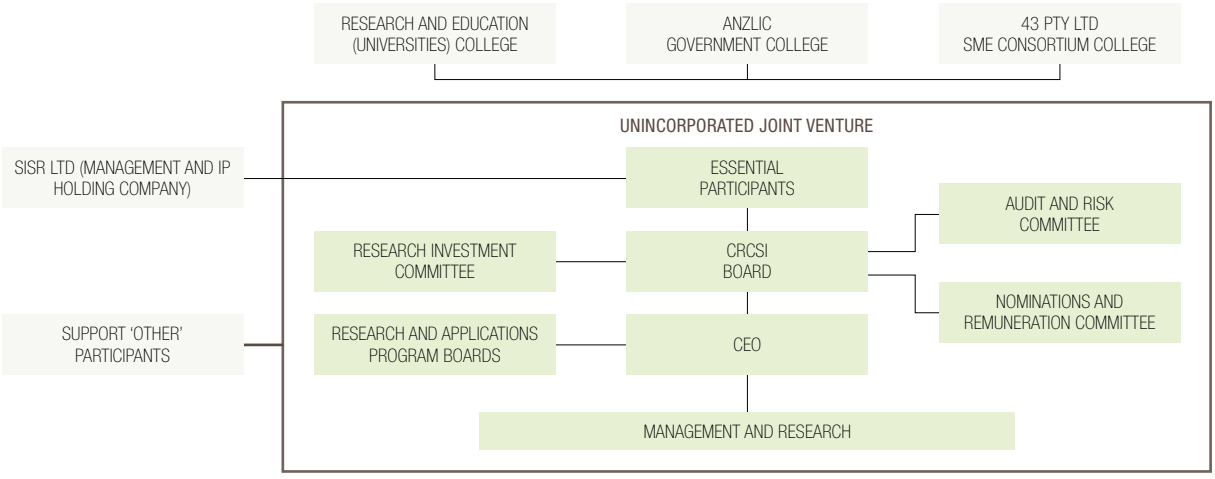
- 43pl (43pl Version 2 Pty Ltd)
- Curtin University of Technology
- Department of Environment and Primary Industries, VIC
- Department of Finance and Services, Land and Property Information, NSW
- Landgate, WA
- Queensland University of Technology
- University of New England

There are 71 formal participants and partners in the CRCSI from the government, private and research (university) sectors. 31 other organisations are collaborating with the CRCSI on a less formal basis – some as short term project partners, through memoranda of understanding or letter agreements. All participants contributed either cash or in kind support to the organisation during the year.

Formal participants and partners have been formed into three Colleges, one representing each of these three sectors; 43pl (with 45 SMEs from the private sector), the Research and Education College (primarily universities), and the Government Agencies College managed by ANZLIC (the Australia New Zealand Land Information Council made up of government agencies at federal, state and territory levels).

The Colleges operate independently of each other and help represent the views of its respective members especially in the formation of policy, the development of strategy, nominations of candidate directors to the Board and the admittance of new participants. This structure also provides a vital mechanism for feedback and communication.

Governance structure



Organisational Structure

THE CRCSI HAS AN ORGANISATIONAL STRUCTURE THAT SUPPORTS THE RESEARCH AND BUSINESS DEVELOPMENT ASPECTS OF THE ORGANISATION IN A STRATEGIC AND COHESIVE MANNER.

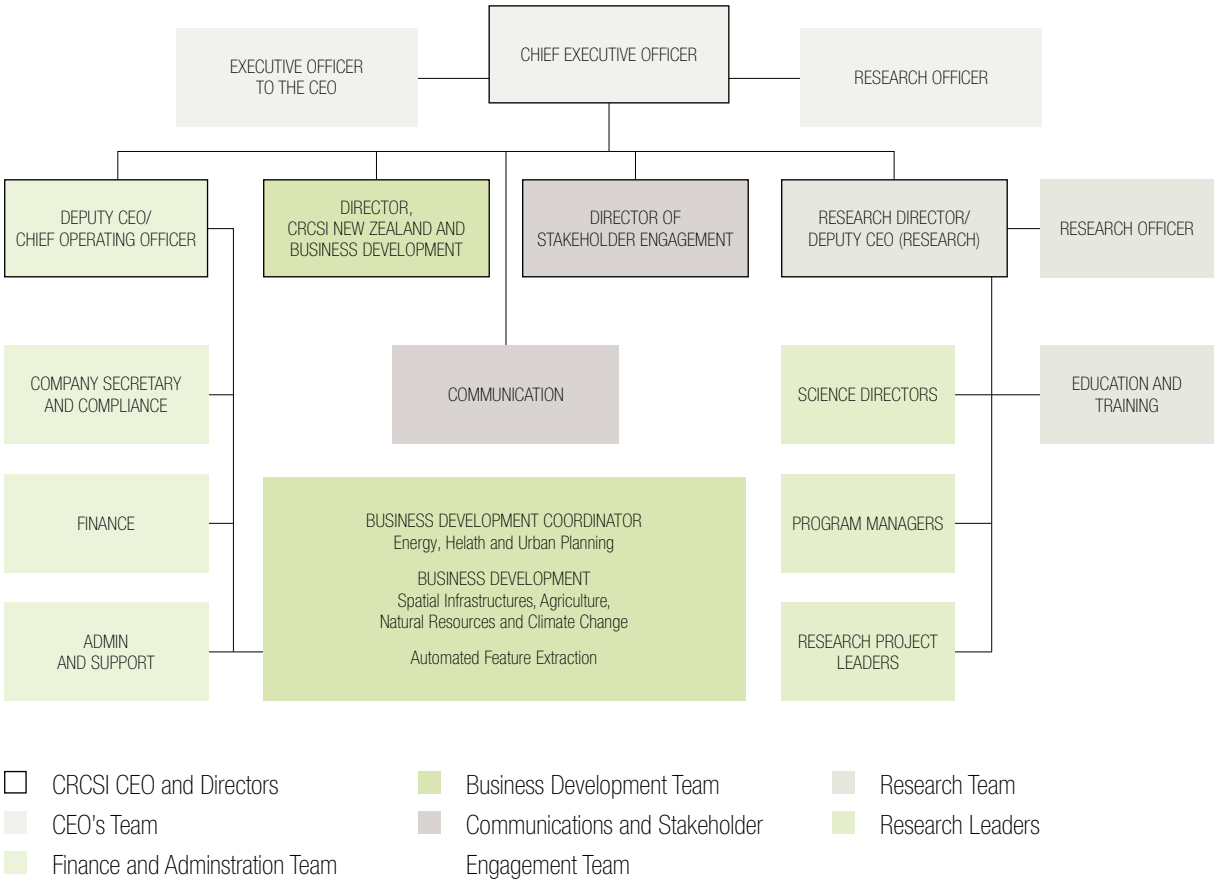
The CEO is supported by a New Zealand Operations Director, two deputy CEO's and the director of stakeholder engagement.

The Research Director is supported by the education and training program along with Science Directors, Program Managers for each program area, and Research Project Leaders.

The Chief Operating Officer is supported by compliance, finance, and three Business Development Managers.

In total the CRCSI has the equivalent of 88 full time researchers and staff drawn from around 300 individuals across Australia, New Zealand, India, Japan, China and the United States along with 35 full time PhD and masters candidates embedded in projects.

Organisational Structure



Finance Summary

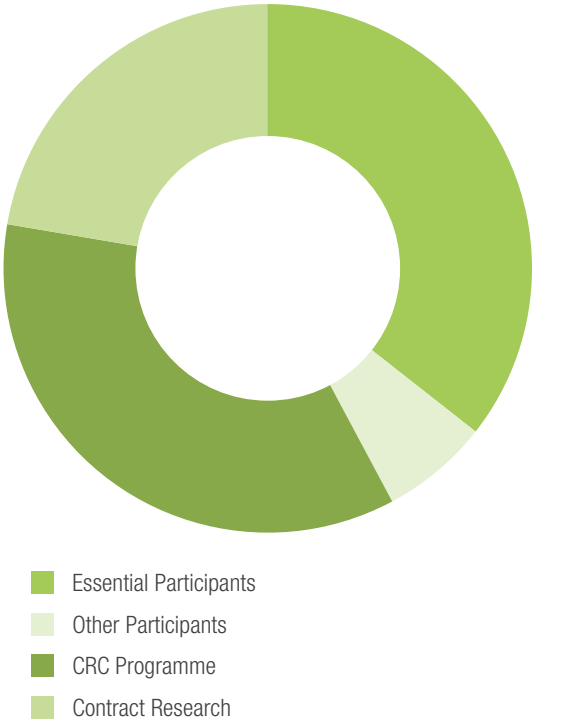
THE CRCSI REMAINS IN A POSITIVE CASH POSITION AND HAS RECEIVED ADDITIONAL CONTRIBUTIONS FROM PARTNERS OF AU$900 000 FOR NEW LEVERAGED RESEARCH PROJECTS, INCLUDING THE DEVELOPMENT OF THE MULTI-GNSS ANALYSIS CENTRE SOFTWARE AND THE ECONOMIC VALUE OF EARTH OBSERVATION FROM SPACE TO AUSTRALIA.

Commissioned and contract research income of AU$2.3 million has also been received during the year relating to various projects.

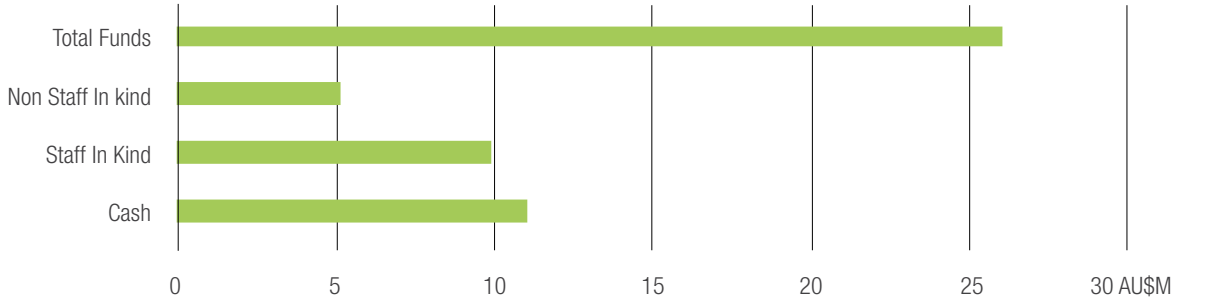
Total cash and in kind contributions were AU$26.1 million for the period.

The sources of the CRCSI cash funding are evenly spread between participant contributions, CRC Programme funds and contract research.

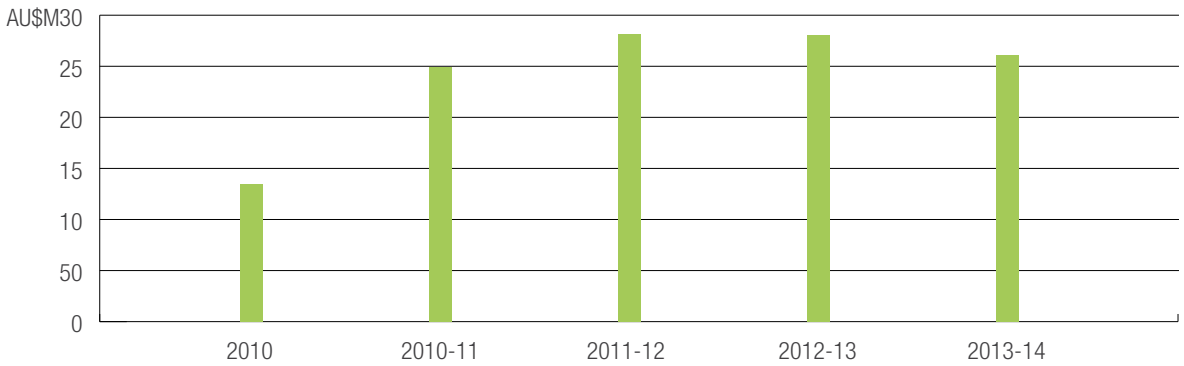
Cash Funding 2013-2014



Total Contributions 2013-14



Total Funds (cash and in kind) since operations began in January 2010



Participants and Partners

THE CRCSI BRINGS TOGETHER AUSTRALIA AND NEW ZEALAND'S LEADING UNIVERSITY RESEARCHERS, AND FEDERAL AND STATE AGENCIES RESPONSIBLE FOR GENERATING AND PROVIDING MUCH OF THE NATION'S SPATIAL INFORMATION DATA, ALONG WITH THE COMMERCIAL CAPABILITIES OF LEADING AUSTRALIAN COMPANIES IN THIS EMERGING INDUSTRY. WITH THIS USER-DRIVEN APPROACH, THE CRCSI FORMS STRONG PARTNERSHIPS TO ADDRESS OPPORTUNITIES IN WAYS NOT AVAILABLE TO INDIVIDUAL ORGANISATIONS.

Since 2003 the CRCSI has conducted key research for its partners, commercialised intellectual property, generated spin-off companies, brought industry sectors together, produced numerous PhDs and helped create a more cohesive global spatial information community.

By working in partnership with the CRCSI – either as a participant or partner– organisations are open to gain significant benefits. Some of these benefits are:

BENEFITS

- Intellectual Property access for commercialisation and internal business improvement
- Networking across the technical, business and international spectrum including the CRCSI conference
- Funding for research and development, business improvement, and tender opportunities on CRCSI projects
- Access to experts in markets and emerging technologies
- A brokerage service for public-private partnerships, and facilitated access to innovation, seed funding and venture capital
- Direct funding for projects.

PARTNERING

There are a number of ways to partner with the CRCSI. These are:

- As a member of 43pl, this entry level engagement with SMEs allows a collaboration of voice, and research and development direction
- Essential participants are usually state government agencies and research organisations
- Support partners are often regional government and non-profit organisations
- Less formal collaboration and partnering including; short term project partners, memoranda of understanding or letter agreements.

The following table is a list of formal participants and partners involved with the CRCSI this year.

The CRCSI invites organisations to become a participant or partner by contacting the CRCSI Chief Operating Officer Dr Graeme Kernich on gkernich@crcsi.com.au.

Further information can be found at www.crcsi.com.au/partners

Essential participants	Support partners
43pl (43pl Version 2 Pty Ltd)	Australian Geospatial Organisation
Curtin University of Technology	Department of Health, WA
Department of Natural Resources and Mines, QLD	Land Information New Zealand
Department of Environment and Primary Industries, VIC	Department of Environment Climate Change & Water, NSW
Department of Finance and Services, Land and Property Information, NSW	Delft University of Technology
Ergon Energy Corporation Limited	Energex Limited
Geoscience Australia	Open Geospatial Consortium Inc
Landgate, WA	Murray-Darling Basin Authority
Queensland University of Technology	Royal Melbourne Institute of Technology University
University of New England	Swinburne University of Technology
University of Canterbury	Telethon Institute for Child Health Research, WA
	The University of New South Wales
	University of Melbourne
	Western Australian Agricultural Authority
	Wuhan University

43pl members	
AAM	Mercury Project Solutions
Alexander Symonds	Milne Agricultural Group
Amristar Solutions	Nearmap
Business Aspect	NGIS Australia
Brazier Motti	Omnilink
Brown & Pluthero	Fugro Satellite Positioning
C R Kennedy & Co	FARMpos (Precision Agriculture)
Critchlow	Photomapping Services
CTF Solutions	PSMA Australia
Eco Logical Australia	RPS Mapping
e-Spatial	Septentrio Satellite Navigation
ESRI Australia	Sinclair Knight Merz
EOMAP	Spatial Information Technology Enterprises
Fitzroy Basin Association	Spatial Vision Innovations
Fugro LADS Corporation	Sundown Pastoral Co
Fugro Spatial Solutions	Superair
Gaia Resources	Think Spatial
GeoSmart Maps	Trimble Navigation Australia
GHD	Twynam Agricultural Group
GPSat Systems Australia	VPAC
Insight GIS	Whelans (WA)
Land Equity International	
Leica Geosystems	
Lester Franks Survey & Geographic	

Resources

To learn more about the CRCSI and its work, please visit www.crcsi.com.au – the website is a rich resource for the spatial industry in its content and hosts a range of publications and reports.

KEY CONTACTS

The CRCSI has a breadth of team members across Australia and New Zealand, with the head office located in Melbourne.

Details of specific team members can be found at www.crcsi.com.au/about/our-people

CEO

Dr Peter Woodgate
e. pwoodgate@crcsi.com.au

GENERAL ENQUIRIES

e. info@crcsi.com.au

CRC for Spatial Information
Level 5, 204 Lygon Street
Carlton, Victoria, 3053
Australia
+61 3 8344 9200
info@crcsi.com.au

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