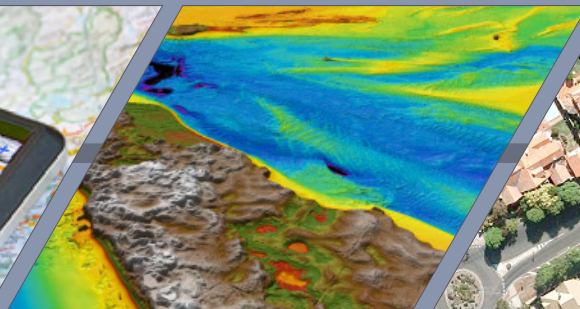
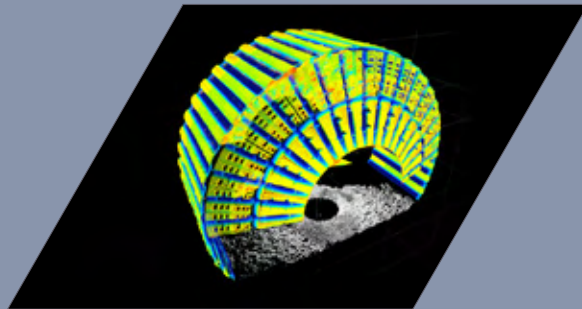
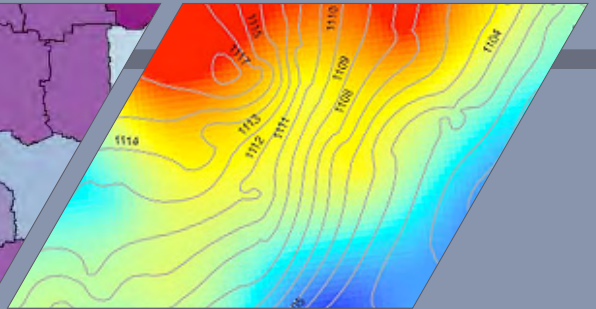
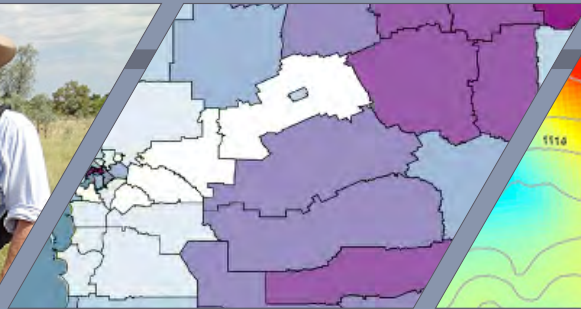


ANNUAL REPORT 2011-12



■ Essential participants

43 Version 2 Pty Ltd

Curtin University of Technology

Department of Natural Resources and Mines (QLD)

Department of Sustainability and Environment, VIC

Ergon Energy Corporation Limited

Geoscience Australia

**Land and Property Information (LPI) of the Department of
Finance and Services, NSW**

Landgate, WA

Queensland University of Technology

The University of New England

University of Canterbury

University of Melbourne



An Australian Government Initiative



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■ Statement of Purpose¹

The Cooperative Research Centre for Spatial Information (CRCSI) is an unincorporated joint venture set up under the Cooperative Research Centres Program of the Australian Commonwealth Government admitted through the Department of Industry, Innovation, Science, Research and Tertiary Education. The purpose of the CRCSI is to build critical mass in research ventures between end users and researchers tackling clearly articulated, major challenges for the end users using the fundamental spatial technologies of global navigation satellite systems, spatial data infrastructures, data fusion and spatial feature extraction. The CRCSI brings powerful collaboration on all critical research and education issues that involve a spatial aspect. In doing so the CRCSI seeks to accelerate the take-up of spatial science in key end users, spawning major innovation and productivity advances in the key industry sectors of Health, Defence, Energy & Utilities, Sustainable Urban Development and Agriculture, Natural Resources and Climate Change.

This report has been prepared in accordance with the 2011-12 Cooperative Research Centres Program Annual Report Guidelines and is submitted to comply with the requirements of Section 4 of the Guide.

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¹ Commonwealth Agreement 23 December 2009

1 Executive Summary

1.1 Achievements

Research

The CRCSI met all of its research output milestones in 2011-12. Activity in the CRCSI's research programs is guided by the user led Program Boards and a full suite of projects are well underway in three of the four programs. Research activity has yielded over 110 separate publications, including three book chapters, 34 refereed journal articles and 48 papers in refereed conference proceedings. In addition the CRCSI had nine of its postgraduate students complete their studies.

There were a number of notable achievements built directly on the work of the CRCSI researchers:

- A world first in integrating GPS and Galileo signals to demonstrate their use for real-time kinematic positioning. This research demonstrates for the first time the practical potential and a theoretical foundation for real-time, high accuracy positioning based on signals from multiple Global Navigation Satellite System constellations.
- Development of a long-strip adjustment technique for georeferencing satellite imagery which was then incorporated into the Barista software tool and used to develop the Australian Geographic Reference Image (AGRI) released by Geoscience Australia. It delivered automated 1-pixel accuracy georeferencing of PRISM imagery, with the requirement for ground control being reduced by more than 95%. The long-strip adjustment rendered the AGRI project feasible in time, logistics and cost. The resulting production time savings were substantial, and the cost savings in the creation of AGRI over traditional methods exceeded several million dollars. As an added bonus, the long-strip adjustment technique broke new ground scientifically.
- The continued use of CRCSI intellectual property in the Unlocking the Landsat Archive (ULA) Project, where Geoscience Australia will transfer its

archive of Landsat data to the National Computing Infrastructure and make it freely available under a creative commons licence. The ULA represents a shift from on-demand processing of raw data to the automated generation of standard products including surface reflectance, and a land cover classification scheme endorsed by the International Organisation for Standardisation. This data will populate the National Nested Grid (NNG) which will enable advanced analysis of the processed archive. The NNG, developed by CRCSI, is intended to become a fundamental component of eResearch infrastructure in Australia.

- The further development of automated cornering procedures for fixed-wing aircraft being flown to inspect power line infrastructure and their subsequent inclusion in flight assist system guidance software for Ergon Energy's Remote Observation Automated Modelling Economic Simulation Program.
- Continuing activity in the Urban Digital Elevation Management (UDEM) Project which has implemented a model of improved management and governance of a fundamental, national elevation dataset. This multi-year project, administered by the CRCSI for the Federal Department of Climate Change and Energy Efficiency on behalf of the Coalition of Australian Governments has delivered world-class elevation models for most of built-up coastal Australia to substantially improve Australia's ability to manage its vulnerability to rising sea levels and flooding due to coastal inundation. This project has improved discoverability and access to elevation data via a national portal (www.nedf.ga.gov.au), consistent with national guidelines for the collection and processing of high resolution elevation data implemented as industry standards, and over 60,000 km² of high resolution elevation data covering major urbanised coastal areas of Australia. It is available for whole-of-government use through streamlined licensing arrangements, sea level rise communication products that

have been widely accessed by governments, community and the private sector, and substantial research to improve the quality and accuracy and DEMs. The tool has 350 registered user organisations accessing up to 40,000 web hits per month. To date there have been over 300,000 map downloads. Involving about 100 organisations all three levels of government, the private and research sectors, the UDEM project has demonstrated the benefits of developing the right partnerships that can support delivery of a robust technical approach that is responsive to the policy needs of government.

- The completion of a multi-year project in conjunction with Australian and Papua New Guinea Governments for the protection and sustainable use of the natural and cultural resources of the Owen Stanley Ranges region including the Kokoda Track. The joint Australian Kokoda Taskforce and PNG National Taskforce identified three critical datasets as requirements for the land use planning work for the 40,000 square kilometre Kokoda Initiative:
 - 1 High Resolution Digital Elevation Model (DEM) for use in deriving key terrain attributes such as slope, aspect, drainage and susceptibility to erosion;
 - 2 Current land use maps for delineating the Kokoda Track and broader heritage values and Interim Protection Zone; and
 - 3 Forest cover change and biomass assessment using synthetic aperture radar from satellites . The CRCSI project team delivered these products for use in PNG.
- Assistance to Geoscience Australia in Development of the National Positioning Infrastructure Plan. The plan will facilitate coordinated access to critical space-based positioning infrastructure; enable a nationwide positioning capability through informed public and private investment and international cooperation; and enhance the nation's capacity to develop and deliver integrated, reliable and

sustainable position infrastructure applications and services. The Plan is now before Federal Cabinet.

- Completion of carbon monitoring validation research to support the International Forest Carbon Initiative (IFCI). An initiative of the Department of Climate Change and Energy Efficiency (DCCEE), the IFCI forms a key part of Australia's leadership in reducing emissions from deforestation and forest degradation in developing countries. A critical component of the IFCI is the development of a global carbon monitoring system that has the capability to use advanced satellite imaging using synthetic aperture radar and optical sensors to measure rates of deforestation and forest degradation by monitoring, reporting and verifying emissions of greenhouse gases. The CRCSI in a joint venture with CSIRO has evaluated the feasibility of using optical and radar imagery interchangeably in the same carbon monitoring system, established concepts and demonstrated results of different accuracy assessment procedures for single data forest/non-forest maps and multi-temporal maps showing deforestation and regeneration; authored a Forest Carbon Tracking guide on accuracy assessment of remote sensing products; and contributed research into the ongoing use of emerging remote sensing-derived biophysical parameters for improved forest characterization (forest type, structure, biomass, function), and identification of forest disturbance and degradation events.
- Several short term reports were delivered by CRCSI researchers to partners during 2011-12. These included: Priorities for Investment in Remote Sensing Satellite Technology for Australia; Study of risks to Australian Critical Infrastructure; Development and Operation of a space-based Synthetic Aperture Radar capability in Australia; Spatial Information for Disaster Response in Australia Report; and the Australian Strategic Plan for GNSS.

The two day annual conference in Brisbane in May 2012 attracted 250 CRCSI delegates from partner organisations, and provided a platform to receive feedback from program and industry stakeholder workshops and for project leaders to hold face to face team meetings along with their partner base. We welcomed several visitors to the CRCSI, including Associate Professor Takeo Tadono Senior Researcher with the Japanese Aerospace Agency (March 2011 – March 2012), Professor Manfred Ehlers, Director, Institute for Geoinformatics and Remote Sensing, University of Osnabrueck, Germany (September 2011 – December 2011), and Dr Sandra Verhoeven, Senior Research Fellow from Delft University (January 2011 – December 2011).

Awards

CRCSI researchers received a number of awards during the year, including:

Commercialisation / Utilisation

The CRCSI met all of its utilisation milestones for 2011-12. There were a number of notable achievements in utilisation including implementing the Flight Assist System for use at Ergon Energy in Queensland; assisting in the trial of the Spatial Marketplace demonstrator with the Australia New Zealand Land Information Council; using the CRCSI-developed Barista feature extraction software to develop the Australian Geographic Reference Image at Geoscience Australia; further developing our Healthtracks tool for use in Department of Health WA; continued use of CRCSI IP in the development of the Unlocking the Landsat Archive project at Geoscience Australia; and rolling out initial prototypes of the Envision Urban Planning Tool in WA and Victoria. In addition the CRCSI facilitated, completed or assisted with the completion of a number of national reports, including the development of Australia's

Project	Name	Organisation	Award
Kokoda Project	Professor Tony Milne AO	Director, CRCSI Radar Research Applications Facility	Made an Officer of the Order of Australia for: "For distinguished service to science and engineering as a contributor to international research programs, particularly in the fields of radar remote sensing, assessment and wetlands mapping, and to education".
Project 4.31	Professor Rod Walker Dr Jason Ford Dr Luis Mejias Dr Felipe Gonzalez	Queensland University of Technology	Recipients of the 2011 Queensland iAward in the R&D category for their work on the Australian Research Centre for Aerospace Automation Smart Skies Project.
Project 2.02	Professor Clive Fraser Dr Mehdi Ravanbakhsh	CRCSI Program 2 Research Team	Recipients of the American Society for Photogrammetry and Remote Sensing (ASPRS) Foundation, Talbert Abrams Award, First Honorable Mention, for the PERS paper "Precise Georeferencing of Long Strips of ALSO Imagery".
Project 1.02	Professor Chris Rizos	University of New South Wales	Recipient of the Institute of Navigation (ION) 2012 Fellow Membership. Recognises the distinguished contributions of the Institute of Navigation members to the advancement of the technology, management, practice and teaching the arts and science of navigation; and/or lifetime contributions to the Institute.
Project 2.07	Professor Simon Jones	RMIT University	Winner of the Asia-Pacific Spatial Excellence Awards 2011, in the Excellence in Education and Professional Development category.
Project 4.51	Professor Peter Newman	Curtin University of Technology	Recipient of the Stephen Luker Memorial Prize for his contribution to the science and practice of urban and regional planning in Australia.

Table 1: Awards received by CRCSI Researchers in 2011-12

National Positioning Infrastructure Plan that was due for consideration by Federal Cabinet in September.

Education/training

The CRCSI made good progress towards the Commonwealth Agreement target of 'improving the skilled capability of the Australian and New Zealand workforce' working with the key stakeholders through the National Spatial Education Leadership Group. The Group comprises senior representatives of all of the lead bodies in the spatial industry from government, the private sector, the university and vocational training sectors. The CRCSI led the development of the Terms of Reference for the Group. With the full endorsement of the Group the CRCSI commenced a project to assess the skilled capacity shortage, supply and demand, using Queensland as an initial test case. A method for scaling-up a nation wide recommended suite of measures to improve the national skills shortage is under development.

The CRCSI exceeded its PhD recruitment targets for 2011-12. Thirteen post-graduate students commenced in 2011-12 (up from ten the year before) with either full or top-up Scholarships, bringing the total cohort of continuing and commencing students to twenty-seven. In addition nine students completed their studies on top of four the year before. We had forty current or completed post-graduates, significantly exceeding our target for 2011-12 of nineteen. The CRCSI is well on track to meet and exceed the Commonwealth target of having invested in (enrolled or graduated) at least fifty PhDs and Masters with university partners by 2018.

Students were involved in all major projects. Each student is required to have an external end user supervisor. Students are all invited to attend the annual CRCSI conference which has a specific session for students. We are on target to achieve planned outputs from the education program.

The coming year will see more of these exploratory workshops as well as a growing number of program and project based information sessions on technology and opportunity developments.

SME Engagement

The CRCSI has a very strong SME engagement program. The CRCSI established a unit trust in 2003 called 43pl to bring in SME's to the CRCSI with each one enjoying the status of an Essential Participant. 43pl has its own elected Board drawing Directors from across Australia and New Zealand. All of the functions of 43pl are provided by the management of the CRCSI. Directors are voluntary. The trust had 51 members companies. A further nine companies were engaged in the CRCSI as Other Participants or via letters of exchange or MOUs. 43pl, its members and the other companies are deeply embedded in the activities of the CRCSI. The membership of 43pl varies periodically as companies merge, close down or move on.

In addition the CRCSI has an MOU with the Spatial Industries Business Association of Australia (SIBA) that ensures close cooperation between the two organisations. SIBA is the peak private sector spatial industry body in Australia with about 300 members. It is working closely with the CRCSI in studies designed to systematically improve the innovation capacity of the industry. Collaborative studies are also underway in relation to quantifying the capacity and skill needs of the industry and in designing education programs to help overcome skills shortages.

The CRCSI has developed a great deal of experience in engaging companies in collaborative research and each year it builds on this knowledge.

1.2 Risks and impediments

Risks and impediments and strategies adopted to address the risks

The CRCSI maintains a comprehensive risk register which is reviewed regularly by the Audit and Compliance Committee and the Board.

There were no specific impediments experienced during the period, which is in part attributable to the very strong support from the participant base and a willingness by the new Board to embrace a collaborative approach

across the national stakeholders in the spatial information community.

However it should be noted that Program 3 (Spatial Infrastructure) is still making slower progress than anticipated. End users are driving the timetable and there has been significant consultation with hundreds of key stakeholders throughout Australia and New Zealand in the formulation of the research strategy for the program and the suite of research projects. This process is now almost complete and the detail has been agreed. In Program 3 the intense research effort is predicated on the establishment of the Australia and New Zealand Spatial Marketplace. It took six months longer than originally anticipated for industry to commence the first phase build of the Marketplace, a process over which the CRCSI had no control.

1.3 End user Environment

2011-12 was a tougher environment than previous years for end users, in particular the government partners. Several State government departments have recently faced staff cutbacks following on from the introduction of austerity measures. This is expected to have a growing impact through 2012-13 on the capacity of the government agencies to resource their in-kind commitments to projects as staff are either not replaced or assigned other duties. Company in-kind contributions are also likely to be affected as there is a sense of growing pressure to drive revenue. CRCSI expects the end user environment partner contributions to be more challenging than previous years, even where project outputs are being delivered and showing benefit. CRCSI monitors its in-kind quarterly and consults with project teams on any potential issues through its quarterly project management group meetings.

Risks in relation to end users and the strategies adopted to mitigate risks

The CRCSI prepares individual partner expectation plans with every one of the 78 Essential and Other Participants. These set out the requirements for each company,

government agency and university. They are reviewed annually. The collective knowledge from these plans makes an important contribution to the annual review of the CRCSI's strategic plan. A detailed database is kept of the nature of the engagement for every partner in every aspect of the CRCSI's activities from projects, commercialisation activities, to Boards and Committees. A customer relations management system is being implemented to track all meaningful contact with participants. Early use of red flag issues identifies potential issues ensuring prompt action.

Opportunities for the CRCSI and strategies adopted to exploit these opportunities

The Program Boards meet regularly to review the strategic development within each research and application program. The Project Management Groups meet quarterly to review progress with respect to each project. These bodies are dominated by end users. There are two primary mechanisms for ensuring opportunities are identified early and mechanisms for adoption are pursued.

How CRCSI's strategic direction aligns with its end user environment

CRCSI participants are grouped into Colleges: government; research and education; and industry. This ensures the timely flow of views, knowledge and information, aiding the accountability of management to the participants and all that flows from a management team that is in touch with its end users.

There were no major changes in the end user environment that significantly affected the CRCSI.

1.4 Impacts

Any substantial changes to the expected outputs, usages or impacts of the CRCSI

The CRCSI revised its milestones in 2011-12. Since 2009 when the milestones were first formulated the CRCSI has devoted considerable effort to operationalising the initial research program. Through the process of

establishing Program Boards, a move to provide direct end user oversight and input into the development of the planned research projects, the CRCSI had cause to re-examine the objectives, milestones and outputs of the original Programs. Together with the emphasis on project review and end user utilisation, the Boards also significantly increase the accountability for the research program objectives over the project lifecycle thereby ensuring outputs will be applied and high impact realised.

The milestone amendments did not substantially alter the utilisation and outputs that were envisaged to be delivered at the end of the CRCSI's agreement period in June 2018. There are some improvements however. For example, under Program 2 there were milestones related to the development of full motion video extraction from UAVs. This was to be a sub component of a project, however it is no longer a priority for our lead partner, the Department of Defence, and thus there is no impetus to pursue this milestone. We have instead concentrated our efforts in the vegetative landscape management area in response to partner demand. This has resulted in the addition of a new project which focuses on woody vegetation classification and seeks to develop tools and procedures to auto-generate landscape level woody vegetation features (i.e. spatial layers) from field and remotely sensed data and has the backing of all of the natural agencies in Australia.

A number of program output milestones have been delayed against initial timelines. However, the CRCSI is moving at the pace our partners expect and our re-phasing does not impact the timing of the end (2017-18) milestones.

The CRCSI has built a program that is valued by our partners, fits within the originally stated parameters for milestones and outputs as set out in the 2009 Bid and designed to result in high impact collaborative research. The PhD scholarship related milestones remain unchanged, and the utilisation milestones have only been amended where outputs have been removed or delayed. The output milestones have largely been re-phased

where projects have been slower to commence than originally anticipated, reworded to reflect the intent of the output, or revised to better meet the needs of the Program and its participants. Where partners have indicated that outputs no longer meet the needs of the Boards and our partners, changes have also been made.

Any changes in the expected non-monetary impacts and a brief overview of the changes

The CRCSI has reviewed its non-monetary impacts in light of the changes to the research output and utilisation milestones and do not expect any changes to result as a consequence. The non-monetary impacts for each program are still valid.

Where the expected monetary impacts have changed, provide the current predictions for the expected benefits associated with all programs and the expected costs associated with all programs

The CRCSI has not reviewed the monetary impacts and expected benefits with programs due to the recent amendment of output and utilisation milestones as in July 2012. It is expected that by the end of calendar year 2012 we will have revised our Economic Impact Performance Tool (EIPT) and incorporated the revised milestones for the 2013 Performance Review.

Actions the CRCSI will take to address any issues and maximise impact.

The CRCSI is now two and a half years into an eight and a half year research program in its second term and the new programs are only just beginning to yield significant impacts. A number of projects that carried over into the new CRCSI provided substantial benefits including; the National Data Grid, the automated analysis of terrestrial laser scanner in support of infrastructure asset management, and the implementation of the spatial data health pilot. These are discussed more fully in the body of this report.

A significant number of new partners have been brought

into the CRCSI and the inclusion of New Zealand as a major partner sees the creation of a strong bilateral international partnership through the government agency Land Information New Zealand, a leading university in the University of Canterbury and four New Zealand companies. The increased contribution levels for all government and 43pl members have had a significant impact on the spatial information industry itself, particularly the role that R&D can play in their future. There was high membership continuity of from CRCSI-1 to CRCSI-2:

Recapping:

- 12 of the former 14 Core participants have chosen to participate in the new CRCSI-2 as either Essential or Other Participants
- 33 of the 48 companies in 43pl have chosen to participate in CRCSI-2
- All supporting participants have chosen to participate in CRCSI-2

The overall retention proportion from CRCSI-1 to CRCSI-2 was 73% for all participants.

a charitable organisation under Subdivision 50-B of the Income Tax Assessment Act 1998 and section 123E of the Fringe Benefits Tax Assessment Act 1986. The tax exempt status means that SISR will not be liable for company taxation and will not be required to complete a tax return. SISR will still be liable for Goods & Services Tax (GST) and has reduced Fringe Benefit Tax (FBT) at a 50% rebate.

The Board of SISR is also the Board of the CRCSI UJV. Each Essential Participant may be a member of SISR and there are seven Essential Participants who have chosen to be members of SISR. They are:

- 43pl (43 Pty Ltd, version 2)
- Curtin University of Technology
- Department of Sustainability and Environment (VIC)
- Land and Property Information (NSW)
- Landgate (WA)
- Queensland University of Technology
- University of New England

There are 78 formal participants in the CRCSI from the government, private and research (university) sectors with a further 10 organisations committed through letters of agreement. They have been formed into three Colleges, one representing each of these three sectors; 43pl (with 51 SMEs), 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 their 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. They also provide a vital mechanism for two-way feedback and communication.

The CRCSI has significant membership from New Zealand including a lead government agency, Land Information New Zealand (LINZ), the University of Canterbury, and

2 Governance and Management

2.1 Structure and governance

The CRCSI is an unincorporated joint venture (UJV) 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), which is wholly owned by the UJV. SISR acts as trustee of the CRCSI Intellectual Property, employs the management staff, undertakes contract research work and otherwise manages the Centre's operations.

Following an ATO ruling in 2011 SISR is now considered

a number of companies who are members of 43pl. As a result the CRCSI is now known as the Australia and New Zealand CRC for Spatial Information.

In accordance with the Cooperative Research Centre for Spatial Information 2003-2009 (CRCSI-1) Deed of Windup and Transition, Spatial Information Systems Ltd (SISL) was wound up and ceased trading during the year. SISL acted as trustee for CRCSI-1 Intellectual Property and agent for a number of carryover research projects. Projects continuing from CRCSI-1 were completed and accordingly the company was wound up by its members. The existing CRCSI-1 assets being managed by SISL were transferred to Spatial Information Systems Research Ltd (SISR) in accordance with the Deed, and continue under the management of the SISR Board. The final audit was completed in June following the cessation of trading of the company in April 2012. The windup process was conducted successfully, as scheduled and without issue.

2.2 Board membership and key skills

The seven member skills-based Board, appointed after an extensive College led nomination and selection process, was formed in early 2010 with the non-executive directors appointed for an initial term of one year with provision for renewal. The Board met formally seven times in 2011-12 and during the year one Director, Mr Warwick Watkins AM resigned following his retirement from the NSW government. The process to fill the vacancy is set out in the Essential Participants agreement and involved the Board setting out the skill base it required, calling for nominations of candidates from the Essential Participants' College, conducting a due diligence on the suitability of the most desirable candidate, inviting the candidate to join the Board and informing the Essential Participants of its decision. The new Board member is Mr Colin MacDonald, the Secretary of the New Zealand Department of Internal Affairs and New Zealand's Chief Information Officer. Mr MacDonald is not employed by any of the CRCSI's participants and is therefore considered to be an independent. He will join his first meeting in 2012-13. The majority of Directors of the CRCSI are independent.

The Board is responsible for the governance and operations of the CRCSI and SISR. The Board has adopted formal protocols, detailing its functions and responsibilities. These are reviewed annually. While the Board has overall control of the CRCSI, it has delegated a range of its powers, duties and responsibilities to its committees and executive management team.

The Board is advised by the Research Investment Committee, the Audit & Risk Committee, the Nominations and Remuneration Committee and Program Boards for most of the CRCSI's research and applications programs. A comprehensive suite of governance protocols, policies and guidelines have been implemented. The Board and supporting Committees review these periodically to assess the performance of the CRCSI and to ensure policies remain up to date consistent with current regulatory requirements and best practice. An annual agenda of activities is maintained by the Board.

Management comprises an Executive and support staff, as well as Program Science Directors, Program Managers, and Project Leaders. Program Boards are program-wide panels tasked with the responsibility of reviewing the strategic direction of the research programs and making recommendations to the CRCSI Board with regard to the continuation, expansion, change in direction or termination of projects in their program. These Boards are chaired by a lead end user and meet several times a year. It is a requirement of the CRCSI that the Program Board signs off on each project proposal before it is considered by the Research Investment Committee and the Board. By signing off in this way the Program Board is also attesting that if the research is successful then the end users intend to take up the research outputs for use beyond the CRCSI. On a project by project basis Project Management Groups then meet quarterly to review each project's progress. Reports from these meetings are referred to the relevant Program Boards and the CRCSI's Board. The Project Management Groups have the ability to recommend continuation, variation or termination of each project.

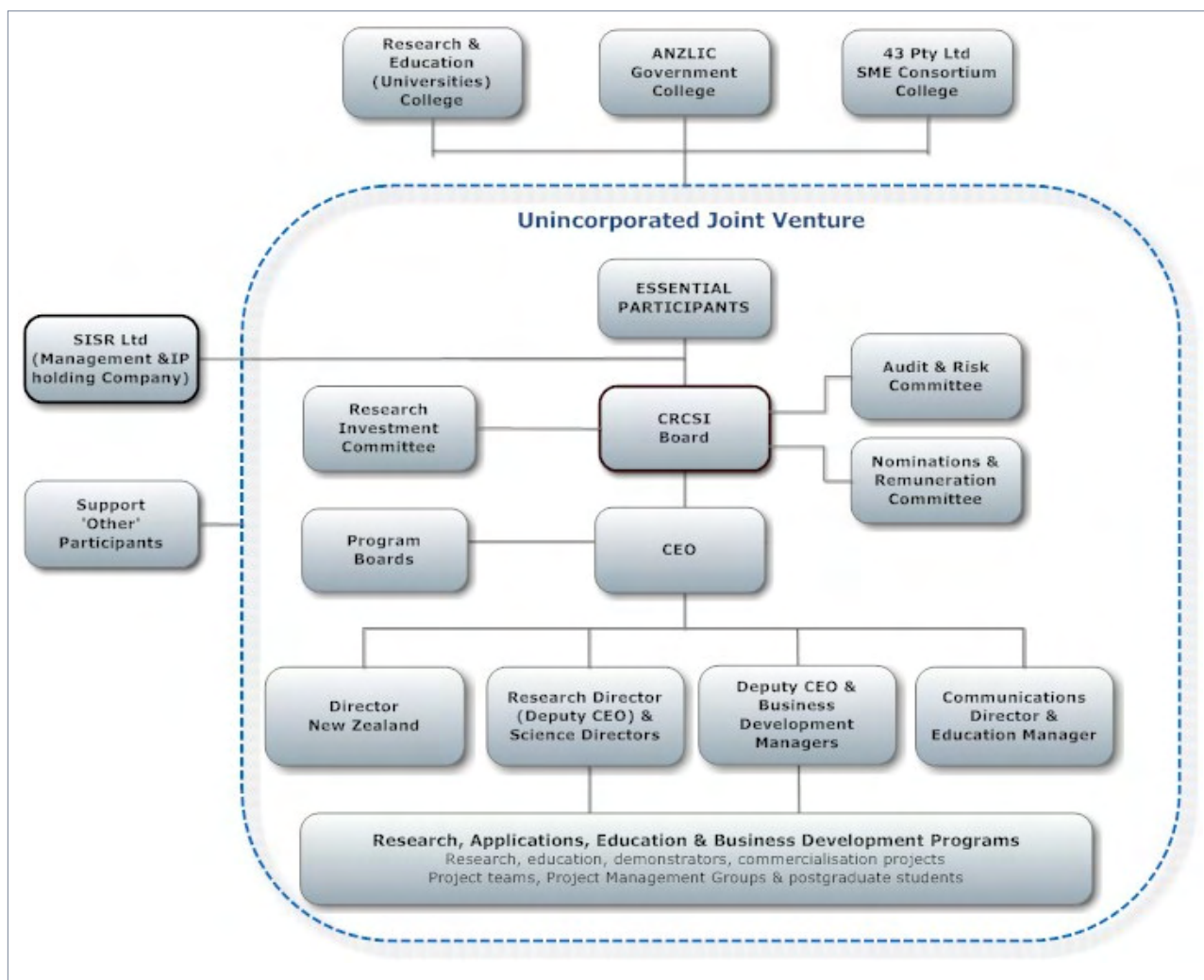


Figure 1: The governance structure of the CRC for Spatial Information (CRCSI)

Roles and Accountabilities

Board	Executive	Science Directors	Project Leaders
Strategic direction	Strategic Planning	Science and research excellence	Research leadership
Policy	Operational Management	Project input and advice (project development; work quality; technical and commercial networks)	Project stakeholder communication and relations
Budget	Business Development	Internal links	Project management (staff and budget), meeting milestones & reporting
Strategic Plan	Commercialisation	Market interface	Internal liaison
Achievement	Communications	Research utilisation	Adoption
CEO appointment	Adoption Pathways	International	
	Relationships		
	International		

Table 2: Roles and Accountabilities within the CRCSI Governance Structure

Directors



Mary O'Kane (Chair)

Mary is a consultant and company director. She is Executive Chairman of Mary O'Kane & Associates Pty Ltd, advising governments and the private sector

on innovation, research, education and development. She is also NSW Chief Scientist and Engineer and Chair of the Development Gateway Board. Mary was Vice-Chancellor and President of the University of Adelaide from 1996-2001 and Deputy Vice-Chancellor (Research) from 1994-1996. She was also Professor of Electrical and Electronic Engineering within the University and now holds the title of Professor Emeritus.

Mary has served on several boards and committees in the public and private sectors including being a Director of PSMA Ltd, ITC Ltd, National ICT Australia Ltd, Business Events Sydney Ltd, the Australian Business Foundation, the New Zealand Antarctic Research Institute, and the Capital Markets CRC. She was Chair of the Australian Centre for Renewable Energy, a Director of FH Faulding & Co Ltd and was a Member of the Australian Research Council, the Cooperative Research Centres Committee and the Board of the Commonwealth Scientific and Industrial Research Organisation. Mary is a Fellow and Vice-President of the Australian Academy of Technological Sciences and Engineering and a Fellow of Engineers Australia.



Peter Woodgate

Peter was appointed to the position of CEO of the Cooperative Research Centre for Spatial Information (CRCSI) in June 2003. Peter was previously CEO of RMIT's

Geospatial Science Initiative. During this period he was responsible for a number of developments that included helping establish Spatial Vision Innovations Pty Ltd; the Risk and Community Safety Research Centre and RMIT's Global Sustainability Institute.

Peter is currently a Member of the Executive Committee of the International Society for Digital Earth; Board Member of the Terrestrial Ecosystems Research Network; Foundation Chair of the Global Spatial Network; Board Member of the UNESCO International Centre on Space Technologies for Natural and Cultural Heritage; and Chair of VANZ Ltd.

Peter has a Doctorate in Business Administration from RMIT University, a Masters of Applied Science from the University of New South Wales and a Degree in Forest Science from the University of Melbourne.



Drew Clarke

Drew was appointed Secretary of the Commonwealth Department of Resources, Energy and Tourism in 2010. His earlier roles include Deputy Secretary for Resources,

Energy and Tourism; Head of the Energy and Environment Division; Executive General Manager of AusIndustry; and leadership of science agencies. Drew chairs national committees in the energy and resources, tourism, and spatial information sectors, that are responsible for policy advice to the Commonwealth, state and territory governments.

Drew holds a MSc from Ohio State University and is a Fellow of the Australian Academy of Technological Sciences and Engineering. Drew was awarded a Public Service Medal in 2009 for his work in energy market reform and clean energy. He began his public sector career as a surveyor working in Australia and Antarctica.



Malcolm McCoy

Malcolm has over 20 years experience as a Director of survey and spatial companies and 35 years in the industry. He has been instrumental in undertaking two

recent mergers of survey companies to form Vekta and prior to that to create Survey21. As part of this process Malcolm has been involved in lengthy due diligence

procedures, and accordingly has been appointed Managing Director of Vekta, one of a few truly national survey and spatial consultancies.

Malcolm has a profound understanding of survey and spatial disciplines and has contributed to the profession at local, national and international levels. His areas of expertise are land and engineering surveying but also strategic planning, project management, financial management, contracts administration and QA and OHS.



Graeme Wright

Graeme is the Deputy Vice-Chancellor, Research and Development at Curtin University. He has extensive knowledge and experience in education and

research, engagement with higher education policy at strategic level. He has held appointments in the vocational educational sector and across higher education at executive level, and has a profound understanding of the university research environment and its application to industry and the community. Graeme has extensive experience on Boards and Committees of research centres and CRCs, liaison with industry and negotiation of funding agreements, and broad research knowledge in spatial information sciences.

He has been closely involved with the CRC for Spatial Information since 2003 then as a member of REAC and the CRCSI Board, and until recently as Chair of the Research and Education College. Graeme also chairs the CRCSI Research and Investment Committee.



Tina McMeckan

Tina has 20 years experience as a company director and senior executive in listed and private companies, partnerships, not for profit entities and with

government businesses. Key competencies include corporate governance and risk management, enterprise development and strategic planning, investment analysis and finance and market competition and industry reform.

Tina has served as the Chair or a Member on audit, compliance, due diligence, nomination and remuneration board committees. She has extensive board expertise in public and private utility infrastructure including power production, networks and retailing businesses in the gas and electricity industries. Currently Tina is a Director of the Global Carbon Capture and Storage Institute and SP Ausnet Limited. Her other appointments as a Director have included Alinta Limited, United Energy, Snowy Hydro Trading, the Westar and Kinetik Energy Group, Victorian Power Exchange, and Solaris Power.

Tina's significant experience in technology development includes current appointments as Chairman of the Centre for Eye Research Australia and as a Director of Circadian Technologies Ltd. She is currently a Member of the Victorian EPA Hazwaste Fund Advisory Panel. She is a past Member of the Funds Management Committee of the AusIndustry Research and Development Board.



Warwick Watkins AM

At the time of his Directorship of SISR Ltd, Warwick was the Surveyor-General of NSW and Registrar General of NSW. He has studied at the Harvard Business

School in Boston, USA and holds postgraduate degrees and diplomas from the University of New England, including a Masters in Natural Resources, and a Dip Ag with Honours from Hawkesbury Agricultural College.

Warwick was also the Norfolk Island Surveyor-General; Deputy Chancellor of the University of Technology, Sydney; Chair, NSW Spatial Council; President of the NSW Board of Surveying and Spatial Information; Chair of the NSW Geographical Names Board; Chair, Australian and New Zealand Land Information Council; Chair of the Steering Committee, Australian Spatial Consortium; Deputy Chair, CSIRO Water for a Healthy Country Research Flagship Advisory Council; Fellow, Australian Academy of Technological Sciences and Engineering; Fellow, Australian Property Institute; Fellow, Royal Institution of Chartered Surveyors and Honorary Fellow of the Institution of Surveyors of NSW.

Board meeting dates and attendance

The table below sets out the number of Board and Board committee meetings held and the number of meetings attended by each Director and/or Board Committee member.

Changes to board membership

Mr Warwick Watkins resigned from the Board in July 2011. Mr Colin MacDonald, Chief Executive and Secretary for Internal Affairs and Government Chief Information and former Chief Executive of Land Information New Zealand was appointed to the CRCSI Board in July 2012.

Board committee membership, function, reporting arrangements and key skills

Audit and Risk Committee

The Audit and Risk Committee met three times in the period. Its function is to provide assistance and advice to the Board to discharge its responsibilities pertaining to financial reporting, audit and risk management. The Committee has adopted a formal Charter outlining its functions and responsibilities. This three member Board appointed Committee is comprised of two board members and one member who has considerable accounting and auditing expertise, sourced from RMIT University, a CRCSI Other Participant.

Directors/ Committee Members	Board of Directors		Audit & Risk Committee		Research Investment Committee		Nominations & Remuneration Committee	
Number of meetings held	7		3		4		4	
Directors	Eligible	Attended	Eligible	Attended	Eligible	Attended	Eligible	Attended
M. OKane	7	7					4	4
P.Woodgate	7	7			4	4		
W. Watkins	0	0						
G. Wright	7	7			4	4		
A. Clarke	7	4					4	4
T. McMeckan	7	7	3	3				
M.McCoy	7	7	3	3				
Committee Members	Eligible	Attended	Eligible	Attended	Eligible	Attended	Eligible	Attended
J. Bangay					4	2		
A. Berrill					4	2		
G. Perkins					4	2		
S. Ramage					4	1		
M Goodchild					3	2		
S Jacoby					3	1		
J Trinder					3	3		
W.Poole			3	3				

Table 3: CRCSI Board and Committee attendance in 2011-12.

Notes:

1. Board meetings were held on Aug 3rd 2011, Aug 26th 2011, Sept 23rd 2011, Dec 6th 2011, March 22nd 2012, May 8th 2012, and June 13th 2012.
2. M Goodchild ,J Trinder and S Jacoby appointed to the Research Investment Committee during 2011-12.
3. M Bradford, Bruce Thompson & T Cantoni resigned from the Research and Investment Committee at the end of 2010-11.

PKF Australia Ltd was reappointed as the external auditors and tax advisers for the CRCSI, SISR and 43pl for the reporting period. The performance of the external auditor is reviewed annually by the Audit and Risk Committee through consultation with the CRCSI Management and a recommendation provided to the Board regarding reappointment for the following year.

Research Investment Committee

The purpose of the Research Investment Committee is to advise the Board on investment decisions relating to the Research Program, including utilisation issues, market

applications of the science and technology within the activities, and any technical, research and education issues.

Appointment to the nine member Committee is by the Board who has the right to vary membership numbers as required. The Committee met four times during the period to review research project proposals and initiatives. Funding recommendations for Board approval resulted in new projects in all four CRCSI research program areas. When the Committee meets it also invites all of the Science Directors for all programs to attend each meeting. Senior Executives of the CRCSI also attend each meeting.

Committee Name - Audit & Risk Committee			
Name	Role	Key skills	CRCSI Affiliation
Tina McMeckan	Chair	Board Director - Corporate Governance, Intellectual Property Management and Capital Raising	Independent
Malcolm McCoy	Member	Board Director - Current Spatial Industry experience from SME industry perspective, Corporate Governance	Vekta Pty Ltd (43pl member)
Wayne Poole	Member	Financial Management and Audit Corporate Governance	RMIT University (Other Participant)
Committee Name - Research Investment Committee			
Name	Role	CRCSI Affiliation	
James Bangay	Member	Ergon Energy, Other Participant - Brisbane Qld	
Arthur Berrill	Member	Independent, DMTI Spatial – Toronto, Canada	
Mike Goodchild	Member	Independent, University of California, Santa Barbara	
Steve Jacoby	Member	Department of Natural Resources and Mines (QLD), Essential Participant, Brisbane Queensland	
Guy Perkins	Member	Independent, 1Spatial – Perth , WA	
Scott Ramage	Member	AAM Pty Ltd, 43pl participant – Sydney NSW	
John Trinder	Member	University of New South Wales, Other Participant, Sydney NSW	
Peter Woodgate	Member	CRCSI – CEO Ex-Officio	
Graeme Wright	Chair	Curtin University, Essential Participant – Perth, WA	
Committee Name - Nominations and Remuneration Committee			
Name	Role	Key skills	CRCSI Affiliation
Mary O’Kane	Chair	Board Director - Corporate Governance, Academic sector experience	Independent
Drew Clarke	Member	Board Director - Government and Spatial Industry Experience, Corporate Governance	Independent

Table 4: Board Committee membership 2011-12.

Names and time commitments of key staff

Key Staff	Organisation	CRC Position / Role	Time committed
Peter Woodgate	CRCSI	Chief Executive Officer	100%
Graeme Kernich	CRCSI	Deputy CEO and Business Manager	100%
Phil Collier	CRCSI	Deputy CEO and Research Director	100%
Peter Teunissen	Curtin University	Professor and Science Director (Research Program 1: Positioning)	15%
Clive Fraser	CRCSI	Professor and Science Director (Research Program 2: Automated Feature Extraction)	80%
Kylie Armstrong	Landgate	Program Director (Research Program 3: Spatial Infrastructure) (Jul '11-Jan '12)	80%
Geoff West	Curtin University	Professor and Science Director (Research Program 3: Spatial Infrastructure)	25%
TO Chan	Department of Sustainability and Environment (Vic)	Program Director (Research Program 3: Spatial Infrastructure) Environment (Vic) (Feb-June 2012)	80%
Kim Lowell	CRCSI	Professor and Science Director (Applications Program 4.1: Agriculture, Natural Resources and Climate Change)	20%
James Semmens	Curtin University	Professor and Science Director (Applications Program 4.4: Health)	13%
Peter Newman	Curtin University	Professor and Science Director (Applications Program 4.5: Urban Sustainable Development)	20%

Table 5: Time Commitments of key staff

Note: Applications Program 4.2: Defence and Program 4.3: Energy Utilities are yet to demonstrate a need for a Science Director.

Nominations and Remuneration Committee

This Committee comprises two members and is chaired by the Chair of the CRCSI, Prof Mary O'Kane. It provides advice and recommendations to the Board on issues relating to Board composition and succession, annually reviews the performance of the CEO and senior Executives, and over-see the establishment, maintenance, recruitment, retention and termination policies and practises for senior executives and independent directors. The Committee meets periodically as needed.

2.3 CRCSI Strategic Plan

The CRCSI has developed a succinct two page strategic plan. The plan is updated annually by the Board. There are a number of important activities that contribute to

the Board's annual deliberations on the plan including; a review of the Partner Engagement Plans that the CRCSI has with every partner and which set out the expectations of each partner, the Annual Conference which includes a number of stakeholder led forums, feedback from the Colleges, advice from the Committees and Program Boards and a formal report prepared by the CRCSI Executive that looks at the external environment.

The following text reflects the latest version of the Strategic Plan for 2012:

The Vision

The vision for the CRCSI is that it will spatially enable Australia and New Zealand and will be widely recognised for its high impact, collaborative research that leads to

accelerated industry growth, improved social well-being and a more sustainable environment. We will be strongly collaborative in our relationships, strive for excellence in our research, and always aim to be transformational in our impact.

Strategic collaboration will be sought where it enhances the effectiveness of the CRCSI. In addition to our Australian and New Zealand partners, the CRCSI will be an active partner in the Global Spatial Network, the alliance of spatial CRCSI-like entities from around the world. The CRCSI will continue to grow its relationship with CEODE and Wuhan University (China), GEOIDE and TECTERRA (Canada) and with other selected organisations.

What success will look like

By 2018 the CRCSI will be recognised world-wide for the high impact of our research, especially in the enabling role we played in creating a single, multi-GNSS network in Australia, and adding value to the development of the Australia-New Zealand Spatial Marketplace. A thriving spatial industry will acknowledge the central role of the CRCSI. We will be considered an essential partner for complex SI research collaborations both locally and internationally. Spatial education will be improved as a result of the CRCSI's activities, significantly enhanced by 50 or more new CRCSI PhDs. The transition of the CRCSI from the CRC Program to a permanent and sustainable entity will be implemented on or before June 2018.

Strategic Objectives

National Precise Positioning (Program 1) Objective

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

Automated Generation Of Spatial Information Products (Program 2) Objective

To develop the research capability to enable the CRC and its partners to become Australia's leading centres for automated processing of information from terrestrial,

airborne and satellite platforms and from existing data sources.

Infrastructure For An Australia New Zealand Spatial Marketplace (Program 3) Objective

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 to enable CRCSI partners to create value-added applications with new technologies.

Applications (Program 4) Objective

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 (4.1) 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 (4.2) by adapting the emerging capabilities of CRCSI's research portfolio; Energy Utilities (4.3) to enable remote monitoring of the condition of built assets in near real time; Health (4.4) by helping agencies to spatially enable their clinical databases; and Urban development (4.5) to build new tools, paradigms and theories including agglomeration economy and greyfield regeneration to support sustainable urban development.

Education (Program 5) Objective

By 2012 the CRCSI will have a plan to improve the skilled 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 50 PhDs with its university partners.

Industry Development and Sustainability (Program 6) Objective

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

Objective 7

Commissioned research; is expected to generate an additional \$10M 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.

Risks

The strategic risks are: that other research developments domestically and internationally render the CRCSI's research programs obsolete; we fail to retain and nurture a cadre of eminent researchers; fails to attract an adequate cohort of postgraduate candidates; loses its reputation as the leading spatial research institution in Australia and New Zealand; fails to generate sufficient independent funding and support to transition to a self-sustaining entity; fails to continue to meet the expectations of its partners.

Performance Indicators

1. A solution for the impediments of multi-GNSS signal processing and economic arguments for a continent-wide, ubiquitous, sparse, precise positioning network.
2. Wide recognition by its partners of the CRCSI's role in helping establish and value-add to the Australia and New Zealand Spatial Marketplace .
3. An Educational Program that is judged to be transformational by its partners.
4. Establishment of a self-sustaining entity by mid 2018.

2.4 Participants

Participant List (including Essential, Other and Third Party Participants)

CRCSI's Participants, including Essential, Other and Third Parties who have provided either cash or in-kind contributions to support the CRC's activities totalled 95 for the period. Of these, 78 Participants are equity holding partners in the CRC holding beneficial ownership rights in Centre IP based in proportional to their aggregate cash contributions to CRCSI. For a full List of Participants see Table 6.

Other Participants who formally signed during the period include Murray–Darling Basin Authority, Delft University of Technology in the Netherlands, the University of New South Wales, Wuhan University in China and Energex Limited from Queensland.

Not all partners have been able to sign off on the Essential Participant Agreements or the Other Participant agreements. Instead they are engaging in the collaboration through an exchange of letters or MOUs. The reasons for not being able to enter into a formal agreement include reluctance to enter into the legal cost of reviewing such a large agreement (applies to some companies), reluctance to enter into an Australian agreement (applies to some overseas partners), and reluctance to commit to all of the obligations in the agreements.

Key relationships have also been forged with non equity holding partners including all of Australia's leading spatial peak bodies; ANZLIC (Australia New Zealand Land Information Council) representing the government interests, SIBA (Spatial Industries Business Association) representing the private sector interests and SSSI (Surveying and Spatial Sciences Institute) representing the spatial profession. All these organisations are involved in the programs of the centre.

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Participant's Name	Participant Type	ABN or ACN	Organisation Type
43 Version 2 Pty Ltd	Essential	95 140 787 971	Industry / Private Sector
Curtin University of Technology	Essential	99 143 842 569	University
Department of Environment and Resource Management (QLD)	Essential	46 640 294 485	State Government
Ergon Energy Corporation Limited	Essential	50 087 646 062	Industry / Private Sector
Geoscience Australia	Essential	80 091 799 039	Australian Government
Land and Property Information (LPI) of the Department of Finance and Services, NSW	Essential	33 537 762 019	State Government
Landgate, WA	Essential	86 574 793 858	State Government
Queensland University of Technology	Essential	83 791 724 622	University
The University of New England	Essential	75 792 454 315	University
University of Canterbury	Essential	n/a	University
University of Melbourne	Essential	84 002 705 224	University
Department of Sustainability and Environment, VIC	Essential	90 719 052 204	State Government
Defence Imagery and Geospatial Organisation	Other	68 706 814 312	Australian Government
Department of Health, WA	Other	13 993 250 709	State Government
GEOIDE (Inc), Canada	Other	n/a	International
Land Information New Zealand	Other	n/a	International
Department of Environment Climate Change & Water, NSW	Other	30 841 387 271	State Government
Delft University of Technology	Other	n/a	University
Energex Limited	Other	40 078 849 055	Industry / Private Sector
Murray-Darling Basin Authority	Other	13 679 821 382	Australian Government
Royal Melbourne Institute of Technology University	Other	49 781 030 034	University
Spatial Information Systems Limited	Other	78 106 799 053	Industry/Private Sector
Swinburne University of Technology	Other	13 628 586 699	University
Telethon Institute for Child Health Research, WA	Other	86 009 278 755	State Government
The University of New South Wales	Other	57 195 873 179	University
Western Australian Agricultural Authority	Other	86 611 226 341	State Government
Wuhan University	Other	n/a	University
AAM Pty Ltd	43pl	63 106 160 678	Industry / Private Sector
AgLab	43pl	50 114 847 460	Industry / Private Sector
Alexander Symonds Pty Ltd	43pl	93 007 753 988	Industry / Private Sector
Amristar Solutions Pty Ltd	43pl	35 098 156 560	Industry / Private Sector
Brazier Motti	43pl	58 066 411 041	Industry / Private Sector
Brown & Pluthero Pty Ltd	43pl	55 010 117 236	Industry / Private Sector
C R Kennedy & Co Pty Ltd	43pl	50 008 458 884	Industry / Private Sector
Critchlow Limited	43pl	N/A	Industry / Private Sector
CTF Solutions Pty Ltd	43pl	82 144 513 459	Industry / Private Sector
CTG Consulting Pty Ltd	43pl	24 100 876 015	Industry / Private Sector
Eco Logical Australia	43pl	87 096 512 088	Industry / Private Sector
e-Spatial Ltd	43pl	n/a	Industry / Private Sector
ESRI Australia	43pl	16 008 852 775	Industry / Private Sector

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Participant's Name	Participant Type	ABN or ACN	Organisation Type
FBA - Fitzroy Basin Association	43pl	30 802 469 401	Industry / Private Sector
Fugro Spatial Solutions Pty Ltd	43pl	52 008 673 916	Industry / Private Sector
Geodata Australia Pty Ltd	43pl	65 128 711 482	Industry / Private Sector
GeoSmart Maps Ltd	43pl	N/A	Industry / Private Sector
Geoimage Pty Ltd	43pl	75 010 840 294	Industry / Private Sector
Geomatic Technologies Pty Ltd	43pl	41 081 782 863	Industry / Private Sector
Geometry Pty Ltd	43pl	35 094 569 507	Industry / Private Sector
GPSat Systems Australia Pty Ltd	43pl	47 056 077 902	Industry / Private Sector
iintegrate Systems	43pl	48 111 015 297	Industry / Private Sector
Insight GIS	43pl	80 059 212 798	Industry / Private Sector
Land Equity International Pty Ltd	43pl	42 097 054 165	Industry / Private Sector
Lester Franks Survey & Geographic Pty Ltd	43pl	25 098 991 210	Industry / Private Sector
LISASoft Pty Ltd	43pl	93 064 935 011	Industry / Private Sector
Mercury Project Solutions Pty Ltd	43pl	57 141 118 194	Industry / Private Sector
Milne Agricultural Group	43pl	92 008 919 579	Industry / Private Sector
Nearmap Pty Ltd	43pl	16 120 677 250	Industry / Private Sector
NGIS Australia Pty Ltd	43pl	56 061 264 793	Industry / Private Sector
Omnilink Pty Ltd	43pl	80 056 793 723	Industry / Private Sector
Fugro Satellite Positioning Pty Ltd	43pl	50 009 300 761	Industry / Private Sector
Photomapping Services	43pl	30 005 552 876	Industry / Private Sector
PSMA Australia Ltd	43pl	23 089 912 710	Industry / Private Sector
Scanalyse	43pl	63 117 523 369	Industry / Private Sector
Septentrio Satellite Navigation	43pl	n/a	Industry / Private Sector
Sinclair Knight Merz Pty Ltd	43pl	37 001 024 095	Industry / Private Sector
Spatial Information Technology Enterprises Ltd	43pl	49 085 230 173	Industry / Private Sector
SkyView Solutions	43pl	28 935 370 298	Industry / Private Sector
Spatial Vision Innovations Pty Ltd	43pl	28 092 695 951	Industry / Private Sector
Sundown Pastoral Company	43pl	86 000 334 190	Industry / Private Sector
Superair	43pl	25 990 899 338	Industry / Private Sector
Terranean Mapping Technologies Pty Ltd	43pl	52 113 485 475	Industry / Private Sector
ThinkSpatial	43pl	65 711 887 042	Industry / Private Sector
Trimble Navigation Australia Pty Ltd	43pl	23 057 599 881	Industry / Private Sector
True 3D	43pl	96 486 268 410	Industry / Private Sector
Twynam Investments	43pl	12 000 573 213	Industry / Private Sector
Vekta Pty Ltd	43pl	41 138 024 754	Industry / Private Sector
VPAC Ltd	43pl	59 093 732 426	Industry / Private Sector
we-do-IT Pty Ltd	43pl	26 071 972 891	Industry / Private Sector
Whelans (WA) Pty Ltd	43pl	68 074 363 741	Industry / Private Sector
ACIL Tasman Pty Ltd	Third Party	68 102 652 148	Industry / Private Sector
ANZLIC	Third Party	31 722 153 579	Australian Government
Manningham City Council	Third Party	61 498 471 081	State Government
Diabetes Association of Western Australia	Third Party	77 867 587 369	Industry / Private Sector

Participant's Name	Participant Type	ABN or ACN	Organisation Type
Monash University	Third Party	12 377 614 012	University
Cancer Council (QLD)	Third Party	48 321 126 727	State Government
New Zealand Petroleum and Minerals	Third Party	n/a	NZ Government
City of Canning	Third Party	80 227 965 466	State Government
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Third Party	41 687 119 230	Australian Government
Flinders University	Third Party	65 542 596 200	University
Department of Planning (WA)	Third Party	79 051 750 680	State Government
Department of Planning and Community Development (VIC)	Third Party	30 485 673 497	State Government
Department of Climate Change and Energy Efficiency	Third Party	50 182 626 845	Australian Government
Department of Sustainability, Environment, Water, Population and Communities	Third Party	34 190 894 983	Australian Government
Department of Justice (VIC)	Third Party	32 790 228 959	State Government
Department of Environment and Conservation PNG	Third Party	N/A	International
University of Sydney	Third Party	15 211 513 464	University

Table 6: CRCSI Participants² 2011-12

Changes to Participants

No changes occurred for the reporting period relating to Essential Participants listed in the Commonwealth Agreement. However University of Melbourne will change its status in the CRCSI from Essential Participant to Other Participant, commencing in July 2012.

2.5 Financial Management

Overview of the financial position and management of CRCSI in relation to the activities

The CRCSI was in a healthy financial state at the end of the 2011-12 year. CRCSI operated well within its available resources and ended the year with an operating deficit of \$1.4M against a budgeted deficit of \$5.4M. The variation from budget was largely due to under expenditure in the Research Program area and cost savings in other areas. The expenditure pattern was consistent with operations in the first centre (for the period 2003 to 2009), whereby as current projects progress and further projects commence, deferred expenditure in the current year is expected to be spent in line with budget in future years. Total cash

and inkind contributions were \$27.6M for the period, unfavourable to budget by \$0.7M, but favourable year on year by \$2.7M. CRCSI remains in a healthy cash position, with \$12.2M cash at bank at the end of the reporting period and has sufficient funding to meet its debts.

PKF were reappointed as external auditors and the related Financial Reports and Statements were prepared in accordance with the Australian Accounting Standards, International Financial Reporting Standards and Interpretations and Commonwealth guidelines where required.

Assessment of the financial performance overall, including the level of participant contributions, details of any issues experienced and the strategies implemented to address the issues

Comprehensive reporting of CRCSI financials can be found in the Commonwealth online Report and Company statutory accounts. In summary, CRCSI received total funding for 2011-12 of \$11.8M, including additional funding for commissioned research projects (\$2.39M) from the

Commonwealth Department of Climate Change for the Urban DEM Project (+\$1.45M) and the PNG Kokoda Trail project (+\$315k). Other Participant contributions (+\$339k) also contributed to the outcome with additional project funding received from DIGO (+\$100k) and UNSW (+\$100k) and an unbudgeted Participant's contribution from MDBA of \$50k. Delayed expenditure and the resultant high bank balances have also impacted on contribution levels with bank interest of \$637k received for the period.

Essential Participant contributions were behind budget by \$0.7M overall, at \$3.0M, with additional project funds received from Curtin University (+\$200k), DSE Vic (+\$282k), Geoscience Australia (\$+45k), Landgate (+\$50k) and Land and Property Information NSW (+\$120k) offset against deferred contribution receipts from University of Canterbury (-\$150k) and Queensland Department of Natural Resources and Mines (-\$235k). The University of Canterbury deferral relates to budget constraints as a result of the 2011 Christchurch earthquake, however the contribution invoice has since been paid in October 2012. The Queensland Department of Natural Resources and Mines payment deferral of cumulative \$685k is being addressed through the arrangement of several meetings between QDNRM and the CRCSI and several projects have been identified to reduce this gap. QDNRM has committed to covering the shortfall in future years, however with the substantial budget implications caused by the Queensland floods, has experienced some cashflow issues.

The sources of CRCSI cash funding were evenly spread between Participant contributions, Commonwealth Program funds and contract research during 2011-12.

The full year expenditure of \$9.6M was under budget by

\$3.5M. The variance was driven by the delays in research expenditure of \$2.46M, as well as savings in other cost centres including Directorate, Business Development and Communications.

Three out of every four cash dollars spent by CRCSI went into the Research Program in 2011-12, an increase from the two out of every of every three dollars in 2010-11 and a trend expected to be replicated in 2012-13. This trend reflects the continued progress toward having a full suite of projects in all Program areas in progress. The remaining expenditure was contributed to Business Development (3%), Education and Communications (3%) and Administration (16%). When inkind contributions are taken into account the cost of administration is 9% of the total investment of the CRCSI.

Participant FTE inkind contributions although higher year on year (+ FTE 6.6) also reflect slower progress than anticipated within the Research Program at 38.2 FTE against a budget of 47.6 FTE. Non staff inkind was higher than originally budgeted (\$7.0M versus \$5.5M) mainly due to higher than expected data contributions from partners for research projects, particularly in Program 4.

For the financial year ending 30 June 2012 SISR had a positive cash flow, and had sufficient funding to meet its debts. The cash balance was \$12.2M, of which 89% is tied to agreements. The Current Assets at the end of the year were \$13.1M with Current Liabilities of \$6.0M. Included in the cash balance is \$3.6M related to agreement prepayments, and advance contributions, \$3.1M to agreed research project agreements, and a further \$750k to other contracts. There was \$1.8M of accruals and provisions related to expenditure that has been incurred but not yet invoiced and \$500k of unpaid but invoiced expenditure.

Financial Statement (\$'000s)

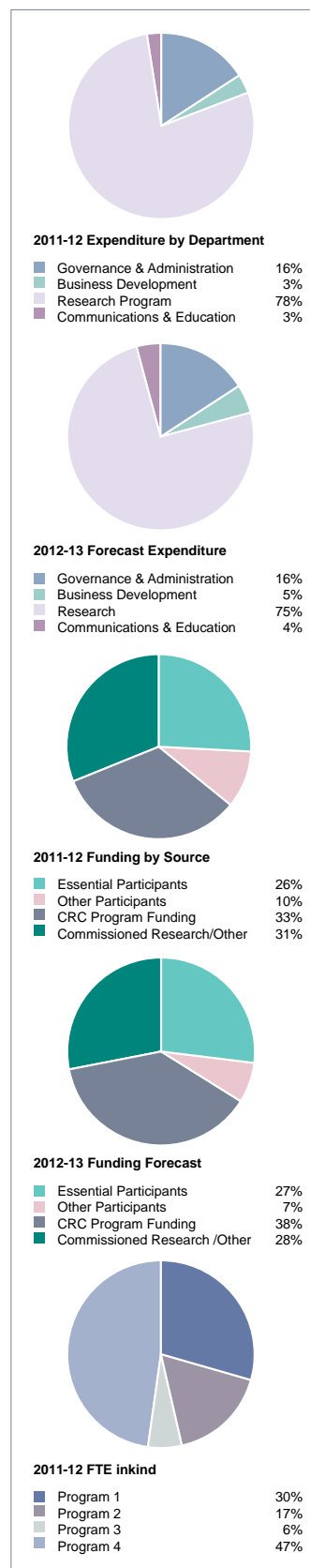
Funding (Cash)	2010-11 Actual	2011-12 Actual	2011-12 Budget	2012-13 Budget
Essential Participants	4,093	3,039	3,786	3,239
Other Participants	238	1,121	522	852
CRC Program	3674	4,002	4,002	4,452
Commissioned Research/Other	5422	3,607	3,254	3,311
Total Funds	13,427	11,769	11,564	11,854

Expenditure (Accrual)	2010-11 Actual	2011-12 Actual	2011-12 Budget	2012-13 Budget
Essential Participants	1,662	1,565	2,091	2,104
Other Participants	333	332	438	595
CRC Program	3,861	7,724	10,182	10,004
Commissioned Research/Other	0	299	423	461
Total Expenditure	5,856	9,621	13,134	13,164

Inkind Statement	Staff FTE inkind			Non-staff inkind (\$'000s)		
	Actual 2010-11	Actual 2011-12	Budget	Actual 2010-11	Actual 2011-12	Budget
Research Program 1	6.0	11.3	3.9	206	861	1,375
Research Program 2	4.6	6.4	12.5	789	1,370	1,227
Research Program 3	2.9	2.3	3.2	1,282	1,021	948
Research Program 4	18.1	18.2	28.0	1,704	3,773	1,956
Total	31.6	38.2	47.6	3,981	7,025	5,506

Contributions	2011-12 Actual	2011-12 Actual	2011-12 Budget	2012-13 Budget
CASH	13,427	11,769	11,564	11,854
FTE inkind	7,526	8,848	11,284	12,066
Non-Staff inkind	3,981	7,025	5,506	5,146
Total Contributions	24,934	27,642	28,354	29,066

Table 7: Financial Statement



2.6 Communications

Internal communications activities undertaken during the period

With 78 key stakeholders the CRCSI places a great deal of emphasis on good communications. The CRCSI has a dedicated Communications Director. It extensively utilises the network of its three Colleges each of which has a governing body; the Research and Education College has a Committee, 43pl has a formal board that operates under Corporations Law, and ANZLIC has a Council and Executive operated by the Federal Government with support from the States and Territories and the New Zealand Government.

The CRCSI produces regular communiqués to update members with reports from the Board and other governing bodies. It conducts regular road shows to foster good communication and participation in new initiatives, seek the views and engender the enthusiastic support and engagement of the participants.

The Annual Conference in 2012 was held at the Brisbane Convention Centre and attracted 250 delegates. Attendance is limited to members only as requested by members. It runs for two and half days and involves presentations on most research activities by researchers including postgraduate students, open forum sessions for members to debate and discuss critical issues, sessions for each college to discuss issues of mutual interest, presentations by selected international experts and an interactive workshop for postgraduates on a range of issues. Post conference surveys consistently report a high degree of satisfaction with the conference and the value it provides to members.

Participants attend the quarterly project meetings to review progress and discuss future plans. These are mostly conducted by teleconference. These communication activities help projects in gaining new participants and in providing materials and training courses to disseminate information and to help with the uptake of project outcomes.

CRCSI's communications allow for special attention to 43pl companies, many of which are not accustomed to research-based interactions with academic and government institutions. The Communications Director has a role in providing confidential and impartial advice to 43pl members to assist their CRCSI engagement.

Physical co-location of researchers, end users and CRCSI management is encouraged. In Melbourne the CRCSI headquarters are within the University of Melbourne. In Queensland, the Business Development Manager is located within QUT. In Canberra, another Business Development Manager is located within Geoscience Australia, and in New Zealand the New Zealand Director of Operations is located within Land Information New Zealand (LINZ). The WA office houses the Program Managers for Health, Urban Planning and Spatial Infrastructure at Curtin's Technology Park in Bentley.

External communications activities CRCSI has undertaken to communicate its successes

The website is used to regularly report on the progress of projects, with blogs available for each project to encourage debate and enquiry. Project video presentations are made available regularly through the website. Discussion groups on LinkedIn and Facebook are maintained along with blog and Twitter feeds. CRCSI also has exposure at conferences and symposia, preferring to deliver impact through project presentations rather than generalist booths, exhibits and sponsorships.

The CRCSI has been instrumental in the organisation and support of national events including the spatial@gov Conference; the Surveying Spatial Sciences Institute (SSSI) Spatial Sciences Symposium; the Geospatial Information Technology Association (GITA) Conference; the Spatial Industries Business Association of Australia (SIBA) national events; several state based conferences e.g. the Western Australia Land Information System (WALIS) Forum; as well as international events such as the International Society for Digital Earth Symposium. These are all significant events on the calendar for Australia and most of these attract between 500 and 800 delegates.

Occasional media releases are prepared around significant CRC SI and project achievements, with an emphasis on the participants involved and recognition of the collaborative nature of the event.

Workshops are held when required to transfer knowledge to end users. These occur both in the construct of a proposed research activity and to promote the outcomes of a given project. Sometimes these coincide with an Annual Conference.

Overall strategies used to ensure effective internal and external communications

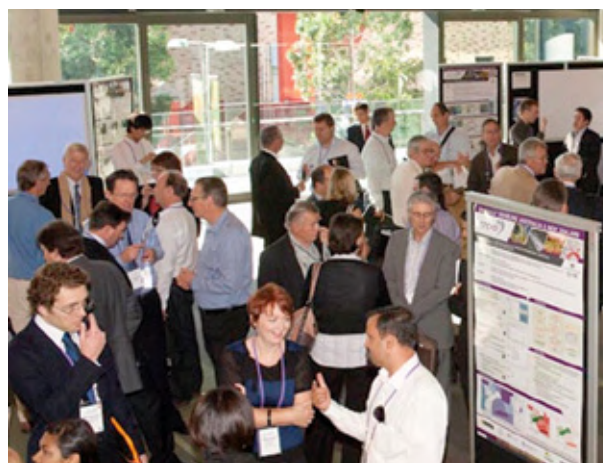
The previous sections describe a comprehensive suite of activities for internal and external communication. They are guided by Board approved policies for the media activities including social media and by a Communications Program which is maintained by the Communications Director.

2.7 Intellectual property management

IP Management arrangements

The effective management and utilisation of intellectual property (IP) is fundamental to achieving the objectives set out in the Strategic Plan. The management of IP is guided by the following practices:

- Facilitation of rapid uptake (and capability) by end user participants and stakeholders for national benefit
- Innovative use of IP including all participants having a licence to use the IP for their internal research purposes
- Endeavouring to make a priori decisions about the commercial potential of investments in IP from the research. Where an impact maximising an outcome of public good is sought or where there is no commercial uptake (and no national security or privacy issues) then the IP will be put in the public domain
- Operating an end user uptake pathway with emphasis on partnering SME's and government



Selected quotes from feedback survey from participants at the 2012 Annual CRC SI Conference:

"The CRC SI Conference is not only a great opportunity to dip into R&D across the CRC SI, and to network - it is also where I get to see where my cash contributions are being applied and to understand better how I can take advantage of all the various benefits the CRC SI provides." - **43pl company**

"I got a lot out of the conference and the opportunity to network was fantastic" - **43pl company**

"Excellent array of presentations - a great chance to catch up on what is going on across the CRC. Chance to catch up with all participants (and new ones). The layout and networking sessions were well designed to foster interactions. The Podcasts (when available) will be an added bonus for me to catch up on presentations I missed - well done!" - **Project Leader**

"I thoroughly enjoyed it and gained a lot as it was a part of my learning curve" - **Government end user**

"I thought it was a very interesting and well organized conference - Congratulations. Some of the fresh contacts I made seem to be bearing fruit already" - **International guest speaker**

"Congratulations on a brilliant conference well organised and superbly run. Well done indeed" - **Research Investment Committee member**

organisations, supported by the research providers. Appropriate consideration is also given to the needs of large corporate participants

- Use of an Expression of Interest process to seek utilisation plans from CRCSI participants for IP deemed by the Board to be ready for end user adoption
- Recognition of the substantial public benefits of the principle of open access
- Preferentially supporting end user participants who have been active in research projects and who wish to utilise research outputs
- Exercising judgement at all times to maximise the collective benefit to the CRCSI as a whole

CRCSI IP comprises any IP developed by the Participants in carrying out the activities of the CRCSI (normally via project agreements). CRCSI IP is beneficially owned by the Essential Participants as tenants-in-common in proportion to their respective participating shares in the CRCSI. The management of CRCSI IP is the highest priority of the CRCSI.

Each Essential Participant has a non-exclusive, royalty-free licence to use CRCSI IP for the purposes of CRCSI activities and a non-exclusive, royalty-free, irrevocable right to use the IP to carry out internal research and development, and training or teaching.

The legal owner of CRCSI IP is Spatial Information Systems Research Ltd (SISR), which holds the IP on trust for CRCSI Participants. SISR is responsible for protecting, registering, patenting and utilising the IP. SISR is the company that has been established as the holder and Utilisation agent of CRCSI IP, and is responsible for the utilisation of CRCSI IP, including the marketing of the IP, the seeking of potential licensees of the IP, and seeking other users of CRCSI IP for commercial purposes.

If SISR intends to utilise CRCSI IP it must advise each CRCSI Essential Participant in writing and identify the particular CRCSI IP and the terms of the proposed utilisation. Each Participant must within ten (10) working days of receipt of the notice advise SISR whether it

desires to utilise or participate in the utilisation of the IP. If no Participant desires to commercialise then SISR is free to utilise the CRCSI IP.

No CRCSI Participant can commercialise, dispose of or encumber any interests which it might hold in CRCSI IP, except where authorised.

The CRCSI adopts the principle that researchers should be encouraged to actively participate in research and utilisation/commercialisation activities of the CRCSI and be rewarded for doing so. Accordingly, all financial incentives for researchers who are employees of participating organisations will be paid in accordance with the relevant policies and employment conditions of those organisations.

Overview of current pieces of IP currently held by CRCSI

The intellectual property registers are a vital element in ensuring that information and methods generated by the CRCSI are recorded and where appropriate developed for commercial benefit. The CEO is responsible for maintaining a register of CRCSI IP.

The CRCSI IP Register serves to facilitate the use of new developments either by way of utilisation, or by contributing to other research activities within the CRCSI. It also provides a mechanism which helps to identify material which is the property of the CRCSI and should be treated as confidential, and to identify material which should be protected.

Each CRCSI researcher is obliged to disclose any invention that may have commercial potential. The onus is on the individual researcher to promptly communicate details of any IP to the relevant Project Leader, who has the responsibility to communicate the notification to the CRCSI CEO.

The CRCSI IP Management Policy provides a framework for the CRCSI participants and researchers to permit the utilisation of research outcomes of the CRCSI. The policy sets out ownership rights and the responsibilities of researchers and participants. It provides guidance on

the identification, protection and commercialisation of CRCSI IP. The policy is based upon the IP ownership and management principles outlined in the CRCSI Essential Participants Agreement and Commonwealth Agreement.

Current items being actively pursued and held on the register include:

each Essential Participant has a non-exclusive, royalty-free licence to use CRCSI IP for the purposes of CRCSI activities and a non-exclusive, royalty-free, irrevocable right to use the IP to carry out internal research and development, and training or teaching. Spatial Information Systems Research Ltd (SISR) is responsible for protecting, registering, patenting and utilising the IP. If SISR intends

Description	Pathway
Real Time Quality Control Software for Positioning	Under licence to project participants
Software and techniques for improved accuracy and range of RTK Positioning Systems	Invention disclosure under review and evaluation
Photogrammetric software for the generation of spatial information products from satellite imagery (Barista)	Continuing project and under licence to project participants
Software for the detection and measurement of ground surface movement using radar based remote sensing	Licensed to UNSW (New South Innovations) for commercialisation
Aircraft guidance and path planning software	Under licence option to CRCSI Participant
Spatial Information Exploration and Visualisation Environment (SIEVE) software	Continuing project and under licence to project participants
National Nested Grid Standard, Workflow Management System Software Platform and data model based on a grid cell (raster) approach for management of spatial information	Continuing project and under licence to CRCSI participants
Health Software Spatial Augmentation Module for increased analytical and GIS capability	Continuing project and under licence to CRCSI participants
Laser Scanning Segmentation Software (NN Clean)	Under licence to CRCSI participants
Terrestrial Laser Scanning Calibration Software	Under licence to CRCSI participants

Table 8: Overview of current IP held by CRCSI.

Mechanisms in place to ensure adherence to the National Principles of IP Management for publicly funded research

The CRCSI has an Intellectual Property (IP) Policy, and IP guidelines which adhere to the National Principles of IP Management. A research project management manual provides research project leaders with access to best practices for the identification, protection and management of IP. This strategy intends to optimise the national benefits and returns from CRCSI research.

How CRCSI's IP arrangements will ensure maximum benefits accrue to end users and Australia

As described above under the IP Management Section,

to utilise CRCSI IP it must advise each CRCSI Essential Participant in writing and identify the particular CRCSI IP and the terms of the proposed utilisation. Each Participant must within ten working days of receipt of the notice advise SISR whether it desires to utilise or participate in the utilisation of the IP. If no Participant desires to commercialise then SISR is free to utilise the CRCSI IP. No CRCSI Participant can commercialise, dispose of or encumber any interests which it might hold in CRCSI IP, except where authorised. These arrangements are in place to ensure maximum benefits accrue to end users.

Titles of patents held and /or applied for in Australia and internationally

CRCSI has no active patents.

3 Performance Against Activities

3.1 Progress against the key challenge/outcomes

The CRCSI research program is designed to meet the strategic objectives for spatially enabling Australia and New Zealand that have been developed for the Australia and New Zealand Land Information Council (ANZLIC) representing federal, state and territory government agencies, and endorsed by industry.

Objective 1: To facilitate the research to enable the creation of a coordinated national network of satellite system reference stations to permit real-time positioning to 2cm accuracy

The CRCSI, through its partners is conducting research to facilitate the creation of a coordinated national network of satellite system reference stations (to be known as the National Positioning Infrastructure) with real-time positioning of 2cm accuracy (in the 'x and y' dimensions and 6 cm accuracy in the 'z' dimension). This infrastructure and its services will provide precise information on the positions of people, vehicles, built infrastructure and natural assets across the nation. Realising such a network requires substantial research (through CRCSI Program 1 Positioning) to optimise the use of existing and new reference stations, including the 75 positioning satellites being launched by Europe, Russia, China, Japan and India over the next five years.

Program 1 projects have commenced (listed in detail under Research) under the leadership of Science Director Professor Peter Teunissen and management of the CRCSI Research Director, Dr Phil Collier. The efforts of the Program 1 Board have also ensured good progress towards achieving the Program objectives.

Objective 2: To establish a fully functioning market place for spatial information.

The development of the 'Australia New Zealand Spatial Marketplace' will enable government agencies to lift

the licensing, governance and technical restrictions on providing the vast stores of government-held spatial data to the open market and to encourage other users to trade and value-add their data as well. The National Innovation Systems Review documents the huge benefits to Australia in unlocking access to these data. Industry strongly supports this objective and CRCSI research (through CRCSI Program 3 "Spatial Infrastructures") is required for its realisation.

Progress against this objective has been slower than we anticipated due to the slower than expected development of the plan to develop the Marketplace. This plan is beyond the control of the CRCSI. The Australia New Zealand Spatial Marketplace Steering Committee, not under the control of the CRCSI, completed a pilot demonstrator in early 2012 to showcase the Marketplace (spatialmarketplace.net.au) about a year later than originally anticipated due to the understandable challenges in tackling something so large across all jurisdictions and two countries.

While the Marketplace demonstrator was being built the CRCSI created its strategy to provide research to support the development of the Marketplace through CRCSI Program 3 (Spatial Infrastructures). In early 2012 the CRCSI appointed a Program 3 Science Director (Prof Geoff West, Curtin University) and completed a study which sought to document the current state of development of spatial infrastructures throughout Australia and New Zealand largely. This study also helped identify R&D and collaboration opportunities and was largely led by member companies of 43pl.

During 2012 significant effort has been devoted to developing a detailed Program Research Strategy under the guidance of the Program's very active Program Board and supported by the industry's Marketplace Steering Committee. Meetings and workshops were held throughout Australia and New Zealand to refine the approach. Considerable attention was given to Program 3 at the 2012 CRCSI Annual Conference. This effort reflected the view of the CRCSI's Board that resolving a way forward for Program 3 in support of the industry was the CRCSI's current number one objective. By the end of

June the Program 3 research strategy had been endorsed by the key stakeholders and the Board. Detailed project briefs were under development.

3.2 Research

Summary of Research Activities by Program

The majority of CRCSI-1 carry-over projects were successfully completed during 2011-12. As shown in Table 9, only two such projects remain, both of which relate to ongoing, co-funded professorial appointments at partner universities. A total of eight new CRCSI funded projects commenced during the reporting period. Table 10 shows the complete research portfolio of 20 active CRCSI projects, with the seven new projects highlighted by an asterisk (*). A number of new project proposals are presently being developed, with a particular focus on ramping up research activity in the Spatial Infrastructures Program (Program 3). The CRCSI also undertakes a number of research projects commissioned by other organisations. These are not included here.

The research framework of CRCSI-2 is represented by the following diagram.

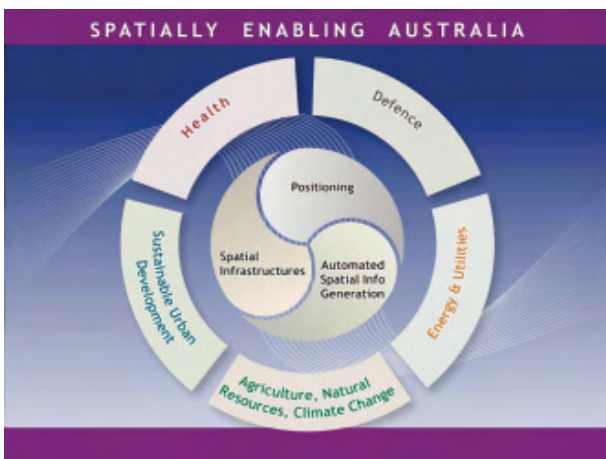
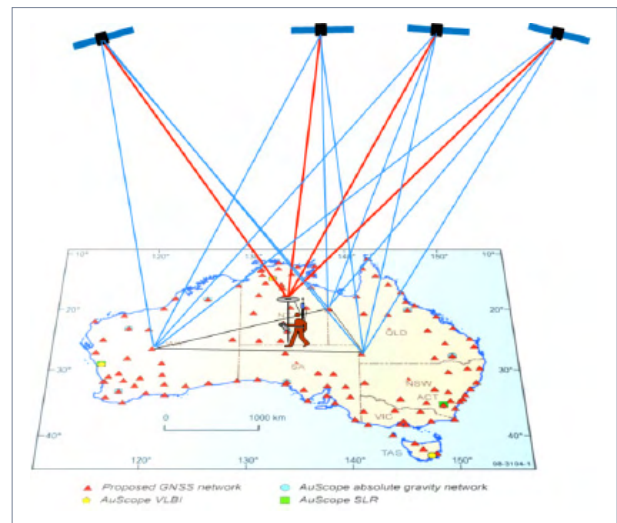


Figure 2– Structure of the CRCSI Research Program. The three core research programs are shown in the centre, and the five end user applications programs are shown around the outside.

Program-by-program review

Program 1 (Positioning) comprised four active projects with two approved projects making preparation for an imminent start (1.02 and 1.11) in 2012-13. The Program is

structured to deliver the Analysis Centre Software, which is a core milestone that facilitates the integration of research outputs and promotes utilisation by partners. The second core milestone relates to the design and implementation of a new dynamic datum for Australia and New Zealand, which is the subject of Project 1.02. This project has secured an extraordinarily high level of end user engagement. While the Program experienced a delayed start due to the need for protracted partner engagement to establish the detail of the research activities, it is now proceeding well and is on track to deliver on milestones.



Map depicting Precise Point Positioning (PPP) in Australia - Project 1.01 - map courtesy of Geoscience Australia.

From a science perspective, the Program has established a high profile both nationally and internationally with researchers actively participating in major conferences and scientific working groups as well as providing invited and keynote presentations. Visiting researchers from China and Europe have been hosted by the Program and have made notable contributions to the research activities. There is a need to constantly review research directions in light of the rapidly changing face of global positioning technologies, including the impact of new satellite systems, delays in satellite launch schedules, difficulties in accessing tracking equipment for new constellations and the emergence of competitive and complementary technologies that challenge the GNSS focus of the Program. To this end, the Science Director and the

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Status as of 30 June 2011 of CRCSI-1 carry-over projects			
Number	Title	Summary	Status
1.06	LPMA Professorial Fellow at UNSW	Funding allocated to support this position until December 2012	Continuing
3.04	Landgate Professorial Fellow at Curtin University confirmed with project participants	Ongoing funding arrangements	Continuing

Table 9: Carry-over projects from CRCSI-1.

Status as of 30 June 2012 of new CRCSI projects				
Project Number	Title	Start	Finish	Partners
1.01	New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia	1 Jul 11	30 Jun 15	12
2.01	Multimodal data acquisition and feature extraction from multi-sensor terrestrial mobile mapping systems	1 Jan 11	31 Aug 14	13
1.03*	Multi GNSS Processing Strategies and Services	3 Oct 11	30 Sep 15	11
1.04*	GNSS test track	1 Mar 12	28 Feb 15	4
1.09*	Spatial Information Applications in Rural Australia	1 Aug 11	21 Jan 12	4
2.02	Feature extraction from multi-source airborne and space-borne imaging and ranging data	1 Sep 10	30 Dec 14	14
2.07*	Australian woody vegetation landscape feature generation from multi-source airborne and space-borne imaging and ranging data	1 Jul 11	30 Jun 14	4
3.05	Unlocking the LANDSAT archive for future challenges.	1 Jan 11	31 Dec 12	5
3.06*	Alignment analysis of spatial data supply chains for SDIs	1 Jul 11	30 Sep 11	2
4.12	Biomass business	1 Jul 10	30 Jun 14	11
4.15	Towards operational monitoring of key climate parameters from synthetic aperture radar	1 Jan 11	31 Dec 13	8
4.31	Enhanced flight assist system for automated aerial survey of powerline networks	1 Apr 11	31 Mar 14	2
4.41	Geovisualisation of health information	1 Jan 11	31 Dec 13	7
4.42	Spatial-temporal modelling of cancer incidence, survival and mortality	1 Apr 11	31 Mar 14	7
4.43	Evaluation and Identification of Health Geocoding Research Priorities	1 June 12	30 Nov 12	4
4.44*	Urban Planning Geovisualisation eResearch Tools	1-Apr-12	30-Mar 13	1
4.51	Greening the Greyfields – A spatial information platform for 21st century sustainable urban planning	1 Jul 10	30 June 14	6
4.52*	Using Augmented Reality as an urban design tool	1 Apr 12	30 Sept 12	2
5.01*	Spatial Innovation & R&D - Baseline and Benchmark Study	1 Oct 11	31 Mar 14	2
9.07	Flight Assist System (FAS) Demonstrator	17 Jan 11	30 Apr 12	2

Table 10: CRCSI-2 projects. * Newly funded CRCSI projects in 2011-12

Program Board are playing a vital role in benchmarking CRCSI research activities against international trends. No major change in research direction is anticipated at this stage, though end user interest in indoor positioning

and non-GNSS technologies is growing. The Program produced fourteen refereed journal papers and thirteen refereed conference papers in 2011-12. The Science Director for the Program is Professor Peter Teunissen,

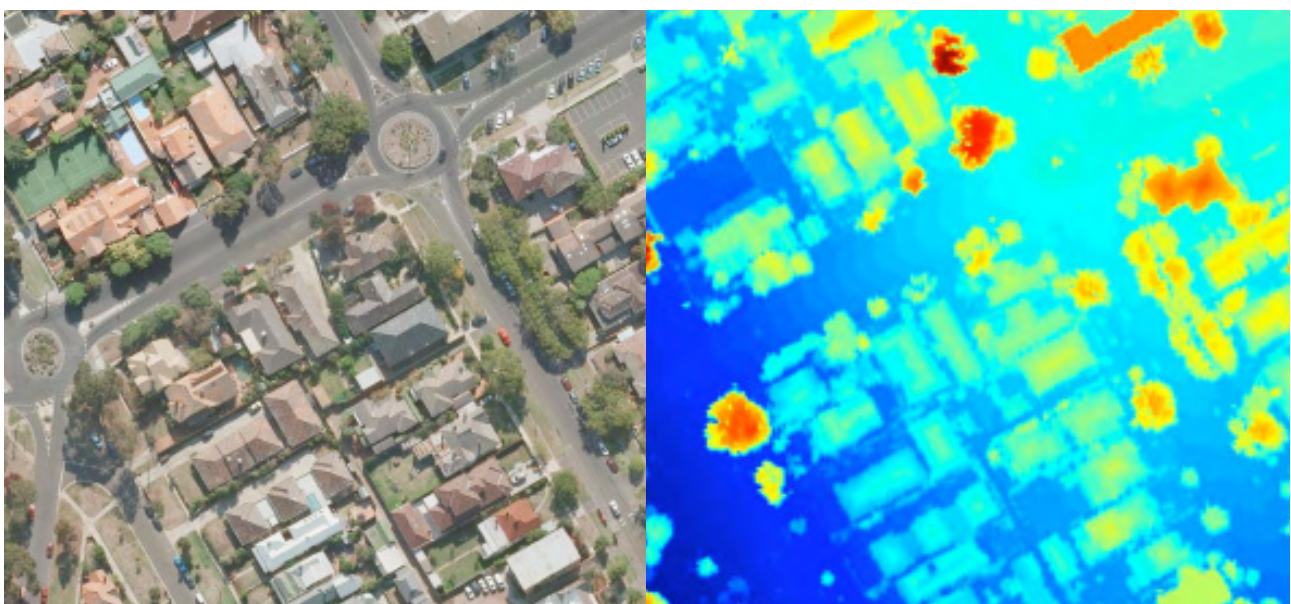
and Federation Fellow at Curtin University and one of the world's most highly regarded researchers in this area of science. The Chair of the Program Board is Dr Chris Pigram, CEO of Geoscience Australia and one of Australia's most senior science policy makers in this area.

Program 2 (Automated Spatial Information Generation) comprised three projects which focus in an integrated way on meeting the relevant milestones. The essence of the Program is the development of automated procedures for the detection, identification and measurement of natural and man-made features from terrestrial, airborne and satellite-borne remote sensing technologies. Two projects (2.01 and 2.02) concentrate on metric quality feature extraction, with one having a terrestrial sensor system focus and the other aimed at satellite and airborne imaging and ranging systems. The third project (2.07) aims at woody vegetation classification in Australian forests using advanced remote sensing technologies. At the core of the Program is the new "3D image" concept – proposed by CRC SI researchers – that aims to integrate imagery and ranging data into a single unified source and thereby enhance the reliability and efficiency of the complex and computer-intensive feature extraction process.

A key tool for Program 2 is the CRC SI-developed Barista

software which provides an operational platform for implementing and testing research outputs and allows end users to engage directly and in a timely fashion with the research activity. The technology domain in this field is more stable and predictable than in Program 1 and so emerging technologies are less disruptive. Nonetheless the Science Director, supported by the Program Board, remains vigilant for changes in the technology landscape and well apprised of international research activities. Research excellence in this Program is evidenced by the international profile of the research team and the substantial international engagement that occurs through conferences, scientific exchanges (the Program hosted a visiting scientist from JAXA, the Japanese Space Agency, for 12 months) and participation on international review panels. In addition, the Program has produced nine refereed journal papers and twelve refereed conference papers and won international awards. The Science Director for this Program is Professor Clive Fraser, a research fellow at the University of Melbourne and Australia's most senior researcher in this area of science with a highly regarded international reputation.

Program 3 (Spatial infrastructures) following a delayed start the program has made excellent progress in securing the input and support of end users through extensive consultation to establish a well-developed and thoroughly



Automated registration of airborne LiDAR Point Cloud – Project 2.02

reviewed research strategy. These achievements have been made possible through the leadership of Professor Geoff West (Curtin University, and jointly funded by the WA Government, Landgate, Curtin and the CRC SI under a special research program operated by the WA Government) who was appointed in late 2011 as the inaugural Program Science Director and Dr Tai On Chan, Program Director (a senior Manager on secondment from the Victorian Department of Sustainability and Environment). Work is currently underway to develop the one large research proposal, with a view to commencing work by the end of 2012. In the meantime, the Program has undertaken an alignment study of spatial data infrastructure activities at the government level across Australia and New Zealand. Outcomes of the alignment study provide a comprehensive picture of technology capabilities and gaps and have allowed “best of breed” criteria for a future spatial marketplace to be defined. The spatial marketplace concept continues to gain acceptance across the spatial industry and, in demonstrator form, will provide a mechanism for utilisation of research outputs by users.

Research activities in Program 3 have been delayed due to the need for an exhaustive consultation process, the complexity of the user requirements, the diversity of user views and the need for the stakeholders to make good progress on the creation of a demonstrator for the marketplace (the timing of which was not under the control of the CRC SI). Notwithstanding these delays, a start on the research activities is imminent and the CRC SI is in a position to invest substantially in the research effort to achieve accelerated outputs and thereby make up for the slow start. There is still concern that early delays will impact on meeting milestones and this will be carefully monitored and managed by the Program Board over the next 12-18 months to determine whether further intervention is required. The new research strategy has engaged not only end users and researchers in Australia and New Zealand but has been broadly exposed internationally. It has benefited from input from experts such as Professor Mike Goodchild (Vice President of Research, University of California, Santa Barbara), Mr Arthur Berrill (DMTI

Technologies, Canada), Professor Nick Chrisman (CEO GEOIDE, Canadian Network Centre of Excellence) and Associate Professor Rene Seiber (McGill University, Canada). The Program has produced one book chapter and three papers in refereed conference proceedings. Outputs from the Program will increase once the research program is underway in late 2012. The Program Board is chaired by Mr Mike Bradford, CEO of Landgate, WA, and an acknowledged leader in this area of science.

Program 4.1 (Agriculture, Natural Resources and Climate Change) had two active research projects, with a third at an early stage of development (commencement expected in 2013). Much of the Program’s research activity – through the “Biomass Business” (4.12) project – is focused on the estimation of biomass in an agricultural context using terrestrial, airborne and satellite-borne remote sensing technologies. The intention is to improve the ability of farmers to determine biomass in the landscape for forage availability for grazing stock and to assist croppers to assess plant requirements for water and nutrients. A third objective is to allow the estimation of standing carbon at farmscape level as an input to a future carbon trading scheme. The second project is a co-funded ARC Super Science project, to which the CRC SI provides a minor cash contribution. This project (4.15) tackles the problem of estimating soil moisture and vegetation status from a mix of satellite-borne and airborne radar remote sensing technologies.



Plane carrying a raptor sensor mounted underneath its belly - Biomass Business Project.

Biomass Business was the first project to secure funding in CRC SI-2. It is a very large undertaking that engages a number of researchers and partner organisations in Queensland, NSW and WA. The level of partner engagement is high and there are strong prospects for utilisation of research outputs, particularly from a number of the large farm enterprises who are partners in the CRC SI through 43pl. There is currently a push coming from end users to grow the research activities in the Program with an additional focus on the provisioning spatial information products and services in the agriculture and natural resources domain. This activity sits well with the milestones and will nurture research linkages between this Program and Program 3. Program 4.1 demonstrates high levels of national and international engagement. Collaborations with NASA are a prominent feature of the Super Science project and interest from New Zealand in the Biomass Business project has seen members of the project team attending an international conference and giving invited presentations. A total of six refereed journal papers and three papers in refereed conference proceedings have been produced by the research teams in 2011-12. Professor Kim Lowell, University of Melbourne, and internationally recognized biometrics specialist is the Program's Science Director. The Program Board is chaired by Dr Matt Adams, Manager, Satellite Remote Sensing Services, Landgate, WA.

Program 4.2 (Defence) is a different type of Program to the others within CRC SI. Suggestions coming from Defence agency partners for research activities at the time of the bid (such as the use of full motion video) were subsequently withdrawn due to changing Defence priorities. During 2011-12, Defence agencies (primarily DIGO) were content to keep a watching brief on research activities across the CRC SI without seeking direct or active engagement in any particular project. Areas of interest included Program 2 (around the problem of automated feature extraction), Program 3 (the management and provision of huge volumes of spatial information) and Program 4.3 (low level mapping and monitoring from aerial platforms). Accordingly this Program did not have any dedicated research projects, nor the usual structure of a Science

Director and Program Board. The altered priorities of the Program have given rise to revised milestones in this area.

Program 4.3 (Energy) comprised a single project (Project 4.31) focused on the spatial information priorities of electricity distribution companies, in particular Ergon Energy. The research will develop an enhanced flight assist system (eFAS) that will deliver substantial efficiency gains in the aerial acquisition of spatial information covering power line assets. eFAS has already demonstrated cost savings of approximately 15% compared to existing systems (see "Research highlights") through intelligent aircraft control when turning between flight legs. Overall, eFAS aims to ensure that the costly exercise of acquiring spatial information over hundreds of thousands of kilometres of power line assets is as efficient and as robust as possible. This includes the design and execution of 3D flight paths to ensure complete coverage from a single sortie. Thereby the need for expensive re-flying can be reduced, if not eliminated, and the completeness and resolution of the acquired data will ensure it is fit for purpose.

The End user engagement in the Program is very strong and research outputs find direct application in Ergon's



Specially modified aircraft are fitted with sensors that include photographic and LiDAR distance measurement equipment.

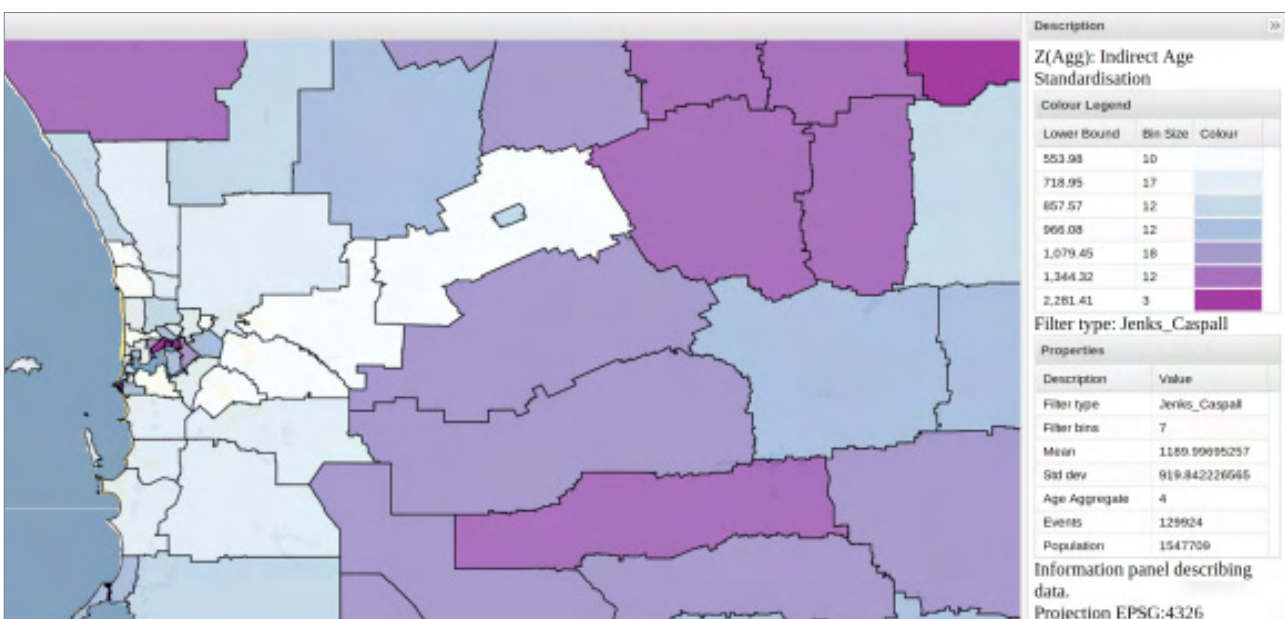
ROAMES system (<http://www.ergon.com.au/community-and-our-network/trees-and-powerlines/roames>). ROAMES is an outcome of Ergon's engagement in CRCSI-1 and is about to become fully operational. The two ROAMES planes will fly Ergon's entire network of 150,000 km of power lines once per year. Program 4.3 is strongly aligned with the Commonwealth milestones and is on track to meet the associated deadlines. The strong end user engagement ensures the continued relevance of the research activities and no need for redirecting the research activities has emerged to date. Efforts to engage other energy companies in the research are ongoing, but managing commercial sensitivities are an important consideration governing the pace of commercialisation. The Program has produced one refereed journal paper and two refereed conference papers in 2011-12. The Program does not have a Science Director. Its Program Director is Mr James Bangay, the Director of Strategy at Ergon Energy.

Program 4.4 (Health) aims in the first instance to bring the benefits of spatial enablement to the analysis, interpretation and application of public health data right across Australia and New Zealand. The rationale behind the research is that enhanced spatial awareness

by health agencies will lead ultimately to better public health outcomes through the provision of improved and more appropriately targeted health services and facilities. Strategically it will help move the two nations to a preventative health regime and yield significant health gains and cost savings.

There are three active projects within the Program, with a fourth project soon to commence at the GeoHealth Laboratory at the University of Canterbury. Areas of current activity include the geovisualisation of health data, strategies for anonymising health records in a geospatial context, and the application of spatial statistics to enhance the analysis and interpretation of health records and improve government understanding of disease risk and contributing factors. The geocoding of health data is the subject of a modest research effort presently but is destined to secure a more substantial level of support once initial findings have been analysed and partners have been identified. Health geocoding and the complexities of uncertainty in referencing relates to a prominent milestone and is a topic of substantial interest to the health research community.

Since Program inception, the efforts of the research team have focused on end user engagement, with strong



An example of Thematic Map Styling for Visual Analytics. The map shows analytical processing embedded in the workflow to reveal age standardised rate for miscellaneous injuries - Project 4.41.

participation from health agencies in WA and Queensland. The objective is to broaden the partner base by engaging with other jurisdictions and thereby to garner support for a more substantial body of research in the second half of CRCSI. International engagement has been growing with collaborative relationships strengthening with UK and US researchers. The fledgling health geocoding research and the Program's activities in geospatial statistics are attracting international attention. A growing relationship with ANU will see the research focus bolstered by activities in the primary care domain. The Science Director is Professor James Semmens, Director of Centre for Population Health Research at Curtin University with Ms. Narelle Mullan, seconded from the WA Department of Health, as Program Manager. The Program Board is chaired by Dr Tarun Weeramanthri, WA's Chief Health Officer and Executive Director, Public Health and Clinical Services.

Program 4.5 (Sustainable Urban Planning) consisted of two projects, with two additional projects in preparation and scheduled for commencement in 2013. The Program aims to facilitate enhanced access to and use of diverse spatial information resources (data and software tools) to support improved professional and community engagement, decision making and investment decisions in the re-development of the middle suburbs of Australia's major cities. The premise behind the research is that the current ad hoc and opportunistic approach to suburban re-development is sub-optimal and unsustainable in light of predicted growth in urban populations. Spatial technologies, it is argued, can be beneficially employed to identify greyfield (middle suburb) sites most suited for strategic urban re-development, both from a housing stock perspective and in terms of the need to upgrade or build new public infrastructure. The anticipated outcome will be a "greening of the greyfields" in other words a more sustainable, socially and environmentally acceptable, planned and executed process of re-development of the middle suburbs.

The research program is led by two internationally regarded researchers in Professor Peter Newman (Curtin

University, who is also a Director of Infrastructure Australia) and Professor Peter Newton (Swinburne University). The Program Board is chaired by Dr Mike Mouritz, Executive, City Futures at City of Canning, WA. Outputs to date – in the form of the new ENVISION software tool – have been widely exposed to partners and are gaining acceptance. The NCRIS initiative the Australian Urban Research Infrastructure Network (AURIN) has agreed to partner with the CRCSI in 2012-13 to collaborate in the further development of ENVISION and to make the software available to its research community working in urban planning. Program 4.5 has not only successfully engaged state government planning agencies in WA and Victoria but has been able to work closely with local government to secure needed data access and demonstrate the role and value of the research in an operational setting. International engagement is occurring through the existing collaborative relationships of the research team. A focus of the next stage of the research is to work with the Christchurch Earthquake Recovery Authority to provide a real-life laboratory for the further development of the software tools and the growth of new visualization capabilities. The research activities to date have successfully met the related milestones and the planned research is likewise aligned with unmet Commonwealth targets. In the reporting period, the research team has produced two book chapters and four refereed conference publications.

Summary of Research Program Highlights

Early efficiency gains in airborne power line inspection

In CRCSI-1 Project 6.07, the research team (based at the Australian Research Centre for Aerospace Automation at QUT) developed automated cornering procedures for fixed-wing aircraft being flown to inspect power line infrastructure. These cornering procedures were one component of a larger body of research focused on automation systems for airborne power line infrastructure inspection. Although no inspection typically occurs during cornering events, cornering is clearly an essential part of a reliable fixed-wing aircraft inspection system.

In the current CRC SI Project 4.31, the research team, led by Dr Jason Ford, has been investigating new turn strategies that are able to adapt cornering trajectories to accommodate current wind conditions. The potential operating savings are significant. A simulation study on a representative section of Ergon Energy's power line network suggests the possibility of a 15% reduction in the overall flight mission distance. This improvement approximately equates to a 15% reduction in total inspection costs relative to Project 6.07 outcomes. For example, assuming that inspection of Ergon Energy's network using current Project 6.07 technology required 1,000 flight missions per year (with 2 flight missions per day, each 4 hours long), the indicative 15% reduction realised by the outcomes of Project 4.31 would translate to a saving of 150 flight missions or approximately 2.5 flight months per year. Ergon ultimately sees these developments yielding multi-million dollar savings per year.

CRC SI's Contribution to the Australian Geographic Reference Image

The Australian Geographic Reference Image (AGRI), recently produced by Geoscience Australia (GA), is a nationwide georeferenced image mosaic comprising close to 10,000 individually orthorectified 2.5m resolution ALOS PRISM satellite images (see the 2011 report prepared by Geoscience Australia, page 4, first full paragraph, referring to the 50 fold savings in work effort: http://www.ga.gov.au/image_cache/GA20164.pdf). AGRI provides an important foundation for future mapping and environmental monitoring, as it forms a new source of ground control across Australia to which imagery from new satellites can be consistently and automatically registered. Consistency and accuracy in broad-area image orthorectification is essential to ensure that observations taken at different times, from different sources and in the field, can be compared at single-pixel resolution, thus allowing temporal monitoring.

For a country the size of Australia, scene-by-scene orthorectification of ALOS imagery constituted a time

consuming and very expensive task, with the huge number of PRISM scenes being required to cover the land area of 7.6 million km². Moreover, the number of ground control points (GCPs) needed would sum to around 30,000. GA thus turned to the CRC SI for a technical solution, which was realised as part of project 2.02 in the form of an innovative new photogrammetric processing approach centred upon orbit adjustment of very long strips of satellite imagery. This led to automated 1-pixel accuracy georeferencing of PRISM imagery, with the requirement for ground control being reduced by more than 95%. The long-strip adjustment, implemented in the CRC SI developed Barista software, rendered the AGRI project feasible in time, logistics and cost. It reduced the image registration task from almost 10,000 scenes to just 105 orbit segments. Moreover, the number of required GCPs was reduced from more than 30,000 to less than 1,000. The resulting production time savings were substantial, and the cost savings in the creation of AGRI over traditional methods exceeded several million dollars. As an added bonus, the long-strip adjustment technique broke new ground scientifically.

CRC SI research highlights shortcomings in global IGS orbits

The International GNSS Service (IGS) provides high accuracy orbit and clock products for real-time and post-processed GPS positioning. IGS products are generally regarded as the best in the world and are widely used by researchers and practitioners alike. A CRC SI research team based at Curtin University, working on Project 1.01 (New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia) has discovered technical problems in the IGS orbit products when related to a regional rather than a global datum (e.g. Australia's GDA94 reference frame). Discussions with IGS have confirmed the existence of the problem. A likely outcome is that the solution proposed by the CRC SI team will be adopted by IGS community becoming the new international standard for conversion of IGS products into regional frames of reference. This would represent

a significant international acknowledgement of the team's research efforts. These results will be published in the Journal of Applied Geodesy.

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

The Project 1.01 team has achieved a world first by integrating GPS and Galileo signals to demonstrate their use for real-time kinematic positioning. It is significant that Australian researchers have accomplished this ahead of colleagues in Europe – the home of the Galileo system. This research demonstrates for the first time the practical potential and a theoretical foundation for real-time, high accuracy positioning based on signals from multiple GNSS constellations. These results have been published in the Australian Journal of Spatial Science.

Overcoming privacy challenges facing health analysts

Spatial information on disease and its underlying risk factors is increasing; it should follow that knowledge on the cause of illness and how to improve health services will improve. However, gathering insight from the multiple sources and providing it to decision-makers at a resolution that is useful remains a challenge for health analysts. In Project 4.42 CRCSI researchers at Curtin University, in collaboration with WA Department of Health, Landgate and 43pl members, have demonstrated the power of spatial information disseminated via web applications with a suite of tools called HealthTracks. The past year has seen significant development in the web-GIS functionality and visualisation capabilities of HealthTracks v2, a program that visualises complex population health data for epidemiological studies. Methodologies were developed that allowed the data query, analytical processing and styling for each visualisation request to be generated on-the-fly. This dynamic web mapping method builds on existing OGC web mapping standards. Privacy algorithms have also been embedded within the system and vary in complexity from standard business rules through to allowing dynamic aggregation of data based on k-anonymity algorithms. These outcomes are

currently being tested by selected stakeholders and are expected to reduce workload by automating the workflow and removing the need to check that privacy protocols have been met when disseminating social spatial data across agencies and to the public. The methodologies will also provide analysts with enhanced spatial analysis capabilities in a web-GIS environment.

The information provided via HealthTracks is assisting those responsible for the on-ground delivery of health programs. When combined with information from epidemiology systems it is capable of identifying priority areas based for provision of health services based on sound evidence and it ensures that limited budgets are targeted to areas of greatest need. HealthTracks delivers this capability with increased clarity, time savings and efficiency increases, and results in more efficient use of time of Department of Health staff. Over 150 users within the WA Department of Health have accessed the HealthTracks reporting functionality more than 10,000 times, resulting in significant time savings for analysts. "What spatial technology will enable us to do as a Health Department is to maximise the impact of our budget spend – ensuring we put the right solutions in the right places. HealthTracks is leading the way to implement spatial awareness across the whole of the public health sector." Dr Tarun Weeramanthri, WA's Chief Health Officer and Executive Director, Public Health and Clinical Services.

The research will also be instrumental in determining how information on health risk is shared with external agencies, health researchers and the public.

A better understanding of cancer outcomes

Project 4.42 is developing novel statistical modelling tools for the better understanding of spatial and temporal variation in cancer outcomes, and related service utilisation. This research will encourage data-driven causes for further investigation and action. The use of Bayesian methodology allows the consideration of expert opinion on the nature of spatial interaction and a framework for combining information collected at different spatial and temporal scales - important research for all

health analysts as they grapple with the challenge of disparate spatial data sources. The Queensland Cancer Council is a key stakeholder in the research and intends to apply the research outcomes into their own work program as it evolves.



Mobile Breast Screen truck in QLD as used to source data for Project 4.42

One model developed examines the prediction of cancer incidence that combines information on risk factors, such as distance to health services, at regional and individual levels. The ability to consider different spatial scales provides new information to analysts, and subsequently decision makers, working in the field. The research team has also developed methodology for assessing the current state of service provision in relation to the demand for services in small areas; to assist health policy stakeholders make informed decisions regarding future service promotion and the redistribution of resources. Data has been sourced from Queensland Health and BreastScreen and the unique models allow for the complexities of changing temporal and spatial screening services. Identifying regions of unusually low service utilisation will help BreastScreen to target their marketing to women in these regions. Currently, this model is being extended to produce forecasts of future service use.

A new way to remotely measure crop/pasture biomass

Efficiently measuring and mapping green herbage mass using remote sensing devices offers substantial

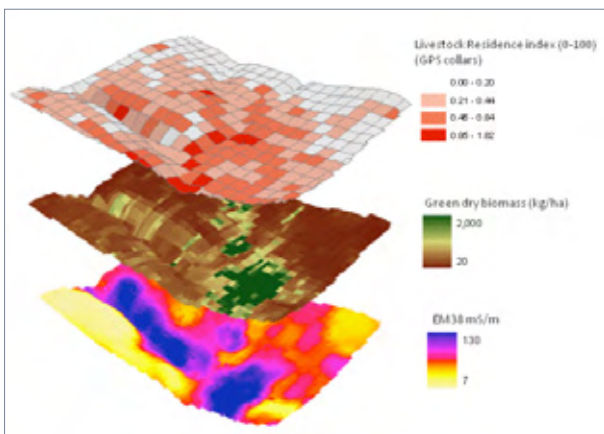
potential benefits for improved management of grazed pastures over space and time. Several techniques and instruments have been developed in CRC SI Project 4.12 for estimating herbage mass; however, they face similar limitations in terms of their ability to distinguish green and senescent material and their use over large areas. Moreover existing passive sensing techniques such as optical satellite or aerial imagery are constrained by operating on clear days and during daylight hours. CRC SI researchers have explored the use of an active, near infrared and red reflectance sensor (Crop Circle™) to quantify and map pasture herbage mass using a range of derived spectral indices.

An ultra-low-level aircraft (ULLA) carrying the sensor was successfully deployed at an altitude of 3-5 metres over a 270 hectare field of skip-row sorghum to record and subsequently map crop vigour. The results were validated using other airborne techniques and direct ground sampling. The fact that the sensor contains its own light source and can therefore be operated irrespective of ambient light conditions, is relatively cheap, lightweight, small in size and can easily be retrofitted to aircraft offers crop managers a viable alternative to conventional imaging technologies, especially when they have day-to-day access to aircraft already conducting low-level operations, for example crop dusting and reconnaissance, over their agricultural fields. On the back of the ULLA sensor work, the research team demonstrated a new, high- powered, light-emitting diode system over an 80 hectare field of wheat. This sensor proved capable of mapping the normalized difference vegetation index (NDVI) at altitudes ranging from 15 to 45 metres above the canopy. Comparisons with a detailed on-ground NDVI survey indicated the aerial sensor values indicated minimal differences which had no significant effect on prediction accuracy of monoculture pasture biomass.

Understanding the impact of cattle grazing behaviour on pasture utilization and management in high-input/high-rainfall systems

The use of Global Satellite Navigation System (GNSS) tracking as a research tool for monitoring livestock

activity is increasing. Commercial systems are now being developed for the livestock industry. CRCSI Project 4.12 researchers have developed a new low-cost, store-on-board GPS collar (UNETracker) suitable for large-scale deployment in livestock herds. A robust collar that avoids the use of external cables has been designed and tested on beef cattle and sheep. Configured for alternating wake and sleep modes to conserve battery life, the collars obtain a positional fix on 99.9% of attempts.



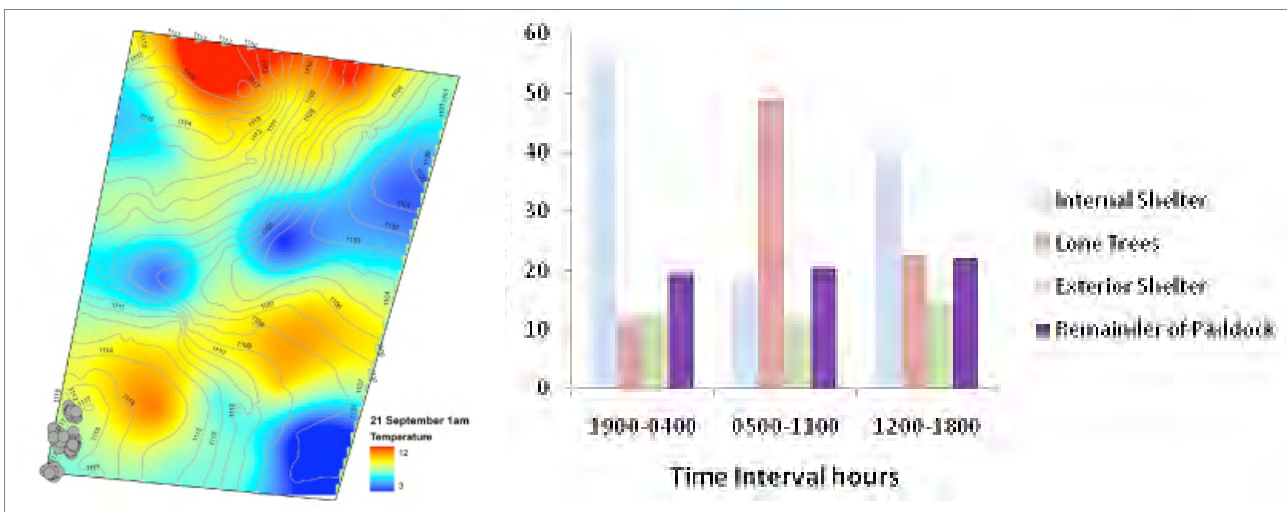
Pasture Use Efficiency in high rainfall, high-input systems (eg GPS livestock tracking for monitoring response to available pasture, Sundown Valley Farm, via Kingstown NSW) - Biomass Business Project.

Numerous ways of presenting data extracted from the collars based on average diurnal activity, mean daily velocity, Livestock Residence Index (LRI) and Dry Sheep Equivalent Maps (DSE) have been introduced. Researchers are also working on developing tools and

techniques to better understand the spatial variation found in soil nutrients across pastures and how these relate to the key landscape and plant biomass features along with the impact of the grazing animal in redistributing nutrients. A key step is the calibration of active optical sensors (AOS) to measure pasture biomass and pasture quality characteristics; the results of which are showing significant promise and garnering wide industry interest. Recent work studying the correlation of spatial grazing dynamics with pasture biomass is groundbreaking and is attracting considerable industry interest.

Industry Innovation Program

In Project 5.01, 'Innovation readiness and performance in the spatial information industry' the CRCSI is examining the degree of innovation of firms in the Spatial Information (SI) industry in Australia and what can be done to improve their innovativeness. Many of the traditional measures of innovation, like investment in R&D, patents and new products launched do not adequately measure innovation in firms in SI. Many small and medium sized SI companies employ what is now being called hidden innovation, which often entails continuous improvement and technology adoption that is not detected with traditional measures. The study aims to understand how innovation is practiced in the mainly small and medium sized firms in SI in Australia and on the basis of the results of this study to produce a revised understanding of the types of measures



GPS tracking of sheep to investigate shelter and shade use in relation to climatic conditions – Biomass Business Project

used in measuring innovation, especially in small SI firms. This research program provides new information about how SI firms create an innovation culture and practices and may help CRCSI to develop programs to assist them.

The first stage of this project, a study of 20 large and small firms engaged in surveying and spatial science information development and use, was completed and the results presented at the CRCSI Conference in May, 2012. Firms reported innovation was a key factor to their success with benefits noted in reputation, sales, survival, firm growth, attracting new customers, time efficiency, work satisfaction, staff motivation and retention. The forms of innovation reported include product and service innovation, process innovation, organisational or managerial innovation and marketing innovation. Most innovations were new to the firm or new to the industry with few considered radical or new to the world. Less than half the firms use intellectual property (IP) protection practices with more discussion of licenses and trademarks than patents. Four innovative SI firms were profiled to show how innovation is practiced in the industry.

Information from the first stage was used to develop the survey instrument to baseline innovation in the SI industry. The survey is in progress and survey respondents will receive an innovation benchmark report and other benefits. This research project is being conducted in partnership with SIBA and the leading investigators are from QUT Business School (Dr Roxanne Zolin, Dr Judy Matthews and Dr Sukanlaya Sawang).

Extent to which the CRC is on target to achieve its research outputs

The CRCSI revised and rephased output milestones with its partners in 2011-12 and confirmed the amendments in an agreement with DIISRTE. For 2011-12 the CRCSI met its 18 research output milestones, reflecting on track progress towards stated research outputs. For 2012-13 there are 24 milestones across the four programs and the CRCSI is well positioned to meet those set out in the Positioning and Feature Extraction Programs (Programs 1 and 2).

Due to the need for substantial end user engagement to define research directions and establish new research priorities, Program 3 (Spatial Infrastructures) is making slower progress than anticipated. The Program is driven by the end users. It is large, complex and challenging. The CRCSI's rate of progress is primarily determined by the rate of development of the plans to progress the Australia New Zealand Spatial Marketplace. These plans are governed by agencies who operate largely beyond the control of the CRCSI. However, planning for the Marketplace has now reached a more mature phase and we anticipate good progress towards the six Program 3 research outputs milestones in 2012-13.

Program 4 (applications) has 11 research output milestones across seven research outputs. Five of these outputs are on track, with the remaining two requiring concentrated effort over the remainder of 2012-13.

Key research achievements and evidence of the research quality

The quality of the research outputs is evidenced through the good number of referred journal articles and globally notable refereed conference publications through the year (113 in total). A list is provided separately in this report. In addition the emerging uptake of a number of research outputs (noted mainly under the Utilisation section of this report) further acts as an indicator of quality and achievement.

Any issues, including technical or scientific impediments

As mentioned previously, it has taken longer than anticipated to initiate research in Program 3 and a couple of activities in Program 4. These delays have not been due to technical and scientific difficulties. Rather the strong level of end user interest and the complexity of the fundamental issues being addressed has created the need to better understand user requirements and expectations and to build these requirements into the program design from the beginning. Specific attention in 2012-13 will be paid to facilitating projects to address the following research output milestones:

- Research Output 3.1. Development of national/international standards framework and software tools to enable effective governance and management of online digital rights, privacy and security. Output 3.1 will be used for existing and emerging spatial infrastructure environments delivering online ready resource trading and business critical information delivery to government and industry.
- Research Output 3.2. The development and implementation of a federated data model. Output 3.2 will develop generic tools to aid development of a federated data model that spatially enables data currently locked in government agencies and inconsistently managed and maintained across jurisdictional and agency borders.
- Research Output 3.3. Investigation of online processing of distributed spatial information sources and services. Output 3.3 will enable highly interoperable, large scale and high data volume processing of online distributed spatial information sources such as those emerging from advanced positioning technologies, and distributed sensor networks from public and private services.
- Research Output 4.1 Development of a web-based software system to support the use of natural resource management information across farms, landscapes and catchments. Output 4.1 will comprise a Whole of Landscape Accounting Infrastructure that will provide an analytical, monitoring and reporting capability for environmental land management.
- Research Output 4.4. Process for geocoding of health information and creation of an enabling framework for health agencies to access health-related spatial information. Output 4.4 will develop the process from new sources, while considering the sensitivities of health data and uncertainty measurements.

Level of end user involvement and evidence the research is meeting end user needs

All CRC SI projects have end user involvement either as direct project participants or via a rigorous consultative process. These participants are drawn from the academic, government and private sectors supported by the increasing uptake of research outputs amongst our partners as detailed under the Utilisation section. Our Program Board structure where each Board by mandate is chaired by a lead end user and dominated by end user members ensures that the research is designed to meet their needs.

Any changes proposed to future research directions

At present there is no evidence to suggest that substantial changes in the research directions of the CRC SI will be required. The potential for future change is acknowledged, however, either based on research results and their end user implementation or from developments from the external environment. The CRC SI will continue to be vigilant in evaluating the ongoing viability and relevance of current research directions and in the early identification of new research directions as these emerge.

Publications

As shown in Appendix 1, over 110 separate publications were produced in 2011-12, including 3 book chapters, 34 refereed journal articles and 48 papers in refereed conference proceedings.

3.3 Utilisation and commercialisation

Extent to which the CRC is on target to achieve its utilisation/commercialisation outputs

The CRC SI accomplished its utilisation milestones for 2011-12. There are a further 12 set for 2012-13. The current outlook for the 2012-13 year is that two will be completed by late calendar 2012, with a further eight milestones on track for completion by June 2013. Four

milestones require further focus (see below). Beyond 2013 the CRCSI is increasingly confident that further milestones will be met.

Key risks, issues and strategies in place to address the risks and any unmet milestones

The CRCSI has four milestones that require concentrated effort in 2012-13:

- Utilisation 3.2.2: Usage of Output 3.1 (standards and Web 2.0 enabled online tools for national framework for spatial infrastructure access rights and governance) will have three users – (1) spatial infrastructure owners and operators, (2) government and industry resource suppliers and (3) users of spatial data and online service resources. The full software toolset accompanying the framework will be implemented by existing government spatial infrastructure operators. For 2012-13 the interim milestone is for implementation of infrastructure governance guidelines developed under Output 3.1 (Utilisation 3.2.2). The CRCSI is currently scoping a project which will deliver this milestone during 2012-13, although the uptake by government users is expected to take longer.
- Utilisation 4.3: Usage for Outputs 4.4 and 4.5 are expected to build over the 8.5 year timeframe starting with the Department of Health WA, Telethon Institute for Child Health Research and Queensland Cancer Council. A gradual build up to all State Health Department, Commonwealth Department of Health & Aging (DoHA) and other Cancer Councils and Research Institutes will follow. After the establishment of spatial health privacy protocols (Year 3) the front-line of health care - GP Divisions, Community Health Providers and Local Government Areas will benefit. The CRCSI anticipated the three utilisation milestones of u4.3.4: Roll-out to two further Health agencies, u4.3.5 Health researchers and GP Divisions trial involving above three major agencies completed; and u4.3.6 Health researchers from Universities use results of geocoding positional error sensitivity

research. The research outputs are progressing well and the major capacity of the government health agencies to absorb and roll out the software is providing some impediment. The follow-on consequence is that subsequent rollout to other agencies may be slightly delayed.

The strategies for ensuring uptake by end users of the research outputs and the current levels of uptake

The technology transfer and utilisation strategy are built into CRCSI proposals before the Board will approve CRCSI funding and enter into a project agreement. Criteria for project funding approval include a requirement that prospective utilisers and/or end users have significant involvement in the project. There must be a clear and credible route to industry application. Moreover the work plan has to reflect an appropriate degree of commercialisation capability and awareness.

Every project is governed by a project agreement which details intellectual property ownership, the proposed route to application, and the role to be played by the entities involved. All parties committing resources to the project sign the agreement. The agenda for the quarterly meetings of the Project Management Groups includes consideration of any potential commercialisation.

Projects are structured to include end users and market channel partners early within the project proposal process. Utilisation cases are developed for consideration by the Board with input from the project management group and CRCSI Executive. If approved, the utilisation case is progressed through the CRCSI commercial agent, SISR, with an expression of interest to develop the commercial proposition sought from CRCSI participants.

Utilisation/commercialisation arrangements with industry, including SMEs and other end users

Spatial Information Systems Limited (SISR) is the legal owner of CRCSI Intellectual Property (CIP), with the beneficial rights of the property belonging to the

Essential Participants of the Centre in proportion to the annual cash contributions. SISR is responsible for the commercialisation of CIP including marketing, seeking potential licensees and other commercial applications.

If SISR intends to utilise any CIP, it must advise each CRCSI participant in writing and each participant has a set period in which to express a desire to utilise or participate in the utilisation of CIP. Through the structure of 43pl, all of the SMEs involved can bid for commercialisation rights, as can any other participant in the CRCSI. If no participant desires to utilise the IP then SISR is free to utilise the CIP in the manner it sees fit.

The CRCSI Board is guided by two principles when selecting organisations to lead the utilisation of CRCSI research outputs. Firstly preference is given to those participants who have played a lead role in the research and development phase. Secondly the flow of benefits from the outcomes of the utilisation must be in the overall best interests of all CRCSI partners. The strength of the business case presented following an expression of interest process for utilisation, is a key factor in helping the Board with its final decision. Examples of uptake follow below, in each case the use is ongoing:

Project: Quality Control Issues for Real-Time Positioning:

Continued use by project partners including the Victorian Department of Sustainability and Environment (DSE), Landgate (Western Australia), the Land and Property Information (New South Wales), and the Department of Environment and Resource Management (Queensland). Note this research output also acts as an input to the GNSS test track project which addresses Research Output 1.2.1 and 1.2.2.

Project: Enabling Real-Time Information Access in Both Urban and Regional Areas:

This project has raised significant awareness about Creative Commons licensing and has directly influenced government agencies in Australia and New Zealand to collectively adopt this approach to licensing spatial and other government information. A central focus was the further development and implementation of the Government Information

Licensing Framework (GILF) which provides a simplified licensing scheme for access to and reuse of spatial (and other government) information. The AusGOAL project is based on GILF, taking it beyond Queensland with the intention of implementing it Australia-wide. Like GILF, it uses the Creative Commons licences and the Restrictive Licence template that was developed as part of the GILF project. Note this is a successful implementation of Research Output 3.5.

Project 4.41: Spatial Health Pilot Project (HealthTracks):

HealthTracks is a software tool that disseminates analysed and useable spatio-temporal health information to health professionals, regardless of their spatial information background. It can be used to identify populations at disease risk and gaps in health service delivery. Furthermore, the resulting visualised information helps communicate these gaps and risks to local program leaders and decision makers so they can make decisions quickly and accurately.

The Western Australian Department of Health (DoH) has an active GIS Section in the Epidemiology Branch which spends a large proportion of its time preparing maps that depict health related data from internally held epidemiology systems. DoH wished to broaden the accessibility of such data by providing a web mapping application that could satisfy the major mapping requirements of public health staff and professionals. HealthTracks delivers this capability with increased clarity, time savings and efficiency increases, and results in more efficient use of time of DoH staff. It was built following a comprehensive user needs analysis and aims to assist those responsible for the on-ground delivery of health programs. When combined with information from epidemiology systems, it is capable of identifying priority areas and ensures that limited budgets are targeted to areas of greatest need.

“HealthTracks allows the user to spatially enable, model and visualise health information together with spatial data from external agencies. It optimises resource allocation through better identification of high risk populations, placement of treatment services and improved strategic

planning and policy formulation". (Dr Tarun Weeramanthri, Chief Health Officer and Executive Director, WA Department of Health).

Subsequent roll out of HealthTracks is planned for mental health, child health, environmental health, policy, country health service areas, and state-wide health planning. This tool addresses research outputs 4.4 and 4.5 and utilisation output 4.3.

Details of any new or improved products, services or processes, and specific benefits to end users (including SMEs), their nature and scale

The utilisation activities for the period were restricted to those which built on development from CRCSI-1. These activities were active throughout 2011-12:

Project National Data Grid Project - Enhanced Platform for Environmental Modelling has been adopted by both Geoscience Australia and Victorian Department of Sustainability and Environment. In addition CRCSI is a consortium member to the project titled 'Unlocking the LANDSAT archive for future challenges' (ULA) led by Lockheed Martin Australia. The project is funded by the Australian Space Research Program and the \$3.4M initiative aims to build earth observation infrastructure to enable ongoing processing of the national LANDSAT imagery archive currently housed at Geoscience Australia.

The Landsat archive is the most significant satellite archive in Australia. It has over 680,000 satellite scenes routinely collected since 1979 and used by many agencies and individuals every day. It is considered to be an invaluable resource, charting the history of land use across Australia and for developing trends and predictive models. These images are currently largely inaccessible to the user, stored in remote databases. It is costly for Geoscience Australia to provision each request for use.

The ULA project represents a fundamental shift away from on-demand processing of raw scene-based Landsat data to produce bespoke data products to the automated

generation and use of standardised, well calibrated, products at the national scale. These products include Surface Reflectance, Pixel Quality Assessment and ISO endorsed Fractional Cover products. This data will be populated in the National Nested Grid (NNG) and will be made available online free of charge under a Creative Commons licence. The NNG will enable advanced analysis of the processed archive at the pixel level utilising the computing power of the NCI. The NNG is being developed as a fundamental framework of eResearch and has the potential to change the face of Earth Observation science. This will be a massive efficiency gain for Australia and will stimulate new innovation, research and applications.

The infrastructure outcome from this initiative is continuing to be developed by the consortium partners and it will be operationalised by Geoscience Australia. This initiative will utilise CRCSI-1 Centre Intellectual Property created under the National Data Grid project. Both of these CRCSI-1 projects have resulted in successful prototype installations in government partners and implementation of further instances of NDG is the next phase of development. Note this is a successful implementation of Research Output 3.6.

Project: 'Business Process Improvement' at Ergon Energy. This project was conducted in Queensland from 2007-2010 and in the final year, a specific piece of research was undertaken to investigate proof of concept techniques intended to improve the efficiency and effectiveness of powerline data capture from manned fixed wing aircraft. Proof of concept flight planning software has been developed which actively assists a pilot to fly an optimised flight path and maintain the aircraft orientation such that fixed assets remain within the field of view of the aircraft data capture hardware. Results obtained at project completion were encouraging and following the successful outcome to a CRCSI Expression of Interest and awarding of option to Ergon Energy, an industry funded Special Project was established to progress the proof of concept activity through to commercialisation of the technology. The project aimed to refine the CRCSI Intellectual Property into 'commercial ready' code; secure

CASA approval with for implementation of the flight assistance package onto commercial aircraft; conduct large scale trials across Ergon's powerline network; quantify the repeatability, efficiency and performance improvements of the commercial ready package to further validate the business case. It is now being used as background IP in operations to develop optimised route planning and actively control the aircraft. Ergon is now rolling out this system to multiple aircraft to enable timely, effective capture over their entire distribution network. The main business driver for Ergon are the cost savings in the management of vegetation near its powerlines however, information captured in this project will have much broader application. Note this is a successful implementation of Research Output 2.2 and Utilisation milestone 2.2.

Project 2.02 Topographic Mapping Feature Extraction

(Barista) The Australian Geographic Reference Image (AGRI) is a national mosaic from Geoscience Australia which provides a spatially correct reference image at a 2.5 metre resolution across Australia. AGRI was developed using a combination of new data from Japan's Advanced Land Observing Satellite, new rectification technologies developed by the CRCSI, high accuracy differential Global Positioning System capabilities, and the capabilities of the Australian spatial information industry. AGRI is intended for use by government, researchers, students, industry, international satellite operators and others. Consistency and accuracy of image is essential to ensure that observations taken at different times, from different sources and in the field, can be compared. The new photogrammetric data processing approach was implemented within the CRCSI Barista software system and used as the computational engine for the production of AGRI. This technique rendered the project feasible in time, logistics and cost. It reduced the image registration problem from correction of almost 10,000 scenes to correction of just 105 orbit segments. Moreover, the number of required ground control points was reduced from more than 30,000 to less than 1,000. Note this outcome assisted the meeting of Utilisation Milestone 2.3.1.

Project 4.51 Housing Redevelopment Planning

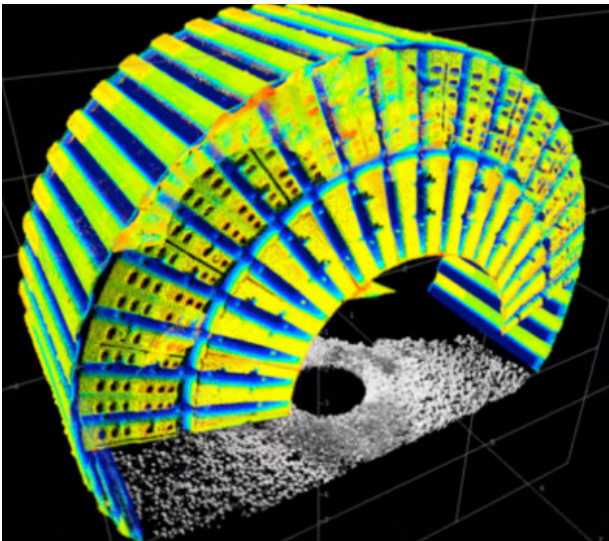
Platform CRCSI researchers have developed a decision-making tool called ENVISION to predict where housing redevelopments are likely to occur. This tool assists planners with housing redevelopment decisions and has been used by two councils in their decision making. It is planned to be further developed for rollout to state governments for wider use. Note this outcome successfully addresses Research Outputs 4.4 and Utilisation Milestone 4.6.

Status/current performance of existing spin off companies

The CRCSI maintains an equity position in two companies through the transfer of previous research efforts. Australian company iintegrate Systems Pty Ltd (www.iintegratesys.com) is commercialising IndjiWatch™ (www.indji.com), a product based on "HazWatch" which was an outcome of one of the first round CRCSI projects. The Project Leader was from the end user organisation Landgate, and subsequently moved to the start-up company.

IndjiWatch is a product for fully automated monitoring and analysis of natural hazard information and enterprise spatial information dissemination. The company provides software and online services that enable its customers to transform massive amounts of real-time, location-based data into valuable, targeted information. The IndjiWatch online service currently watches hundreds of thousands of kilometres of the interconnected electricity network through most of eastern Australia from Queensland to Tasmania. It also operates in the USA and Canada. IndjiWatch assesses the impact of over twenty million natural phenomenon events, such as lightning strikes, per month on this network. The company expanded into the US in late 2009 to target sales into the energy sector, however following a significant contraction of power generation revenues the US operation is now run from Australia. Iintegrate Systems continues to maintain its product with Australian and US energy customers.

Scanalyse Pty Ltd (www.scanalyse.com.au), a spin out company of CRC SI-funded research now employs over 20 people. Scanalyse Pty Ltd specialises in products and services providing mineral processing operations with sophisticated wear and performance management tools. The company has targeted applications where overall site productivity and efficiency are directly impacted by the extent and quality of condition monitoring information.



Example of the use of MillMapper™ technology to scan the inside of a mill. Image courtesy of Scanalyse.

MillMapper™, Scanalyse's first commercial product release was a world first and has international patent protection. MillMapper™ is a three-dimensional laser scanning and modelling technology and service for monitoring rates of wear in milling and other mining operations. It reduces maintenance costs, increases productivity, improves safety and offers greenhouse savings in the energy-intensive operations. It represents a quantum leap in the in-situ measurement, modelling and management of grinding mill liners and grinding media previously based on visual inspection or manual measurement inside dangerous grinding mills. Now established and operating on mine sites around the world, this technology has become standard operating practice in all progressive mine site milling applications. Operators are now able to make decisions based on solid measurement data and robust analyses.

Based in Perth, Western Australia, Scanalyse has operations in Australia, and North and South America and has worked in over sixty different mine sites around the world.

3.4 Education and Training

The CRC SI made good progress towards the Commonwealth Agreement target of 'improving the skilled capability of the Australian and New Zealand workforce' working with the key stakeholders through the National Spatial Education Leadership Group. The Group comprises senior representatives of all of the lead bodies in the spatial industry from government, the private sector and the university and vocational training sectors. The CRC SI led the development of the Terms of Reference for the Group. With the full endorsement of the Group the CRC SI funded a project to assess the skilled capacity shortage, supply and demand, using Queensland as an initial test case, and developing a method for scaling-up nation wide and prepare a recommended suite of measures to improve the national skills shortage.

Thirteen postgraduate students commenced in 2011-12 (up from ten the year before) with either full or top-up Scholarships, bringing the total cohort of continuing and commencing students to twenty-seven. In addition nine students completed their studies on top of four the year before. We have forty current or completed post-graduates, significantly exceeding our target for 2011-12 of nineteen. The CRC SI is well on track to meet and exceed the Commonwealth target of having invested in (enrolled or graduated) at least fifty PhDs and Masters with university partners by 2018. A full list of CRC SI PhD completions for 2010-12 is included in Appendix 2.

Students are involved in all major projects. Each student is required to have an external end user supervisor. Students are all invited to attend the annual CRC SI Conference which has a specific session for students. The CRC SI is on target to achieve planned outputs from the education program.

The coming year will see more of these exploratory

workshops as well as a growing number of program and project based information sessions on technology and opportunity developments.

Extent to which the CRC is on target to achieve its education/training outputs

The CRCSI is well on target to meet and exceed its education and training targets.

Key risks, issues and strategies in place to address the risks and any unmet milestones

There are no unmet milestones for 2011-12. One milestone is continuing from 2010-11 and will be met in 2012-13. It relates to the recruitment of students, although it should be noted that overall, CRCSI is ahead of schedule in its recruitment of students.

Details of the education / training activities conducted during the reporting period, including postgraduate, undergraduate, vocational education and training (VET) and professional development

Postgraduate: CRCSI-supported students are all invited to the Annual Conference which includes a workshop specifically for students with the workshop program set by the students in consultation with senior management.

Undergraduate and VET: While the CRCSI is not active in this field, we do support overall skills provision to the industry through participation in national fora and planning eg the National Spatial Education Leadership Group.

Professional Development: CRCSI's professional development initiatives are focused around the Annual Conference and regional workshops. These workshops are tailored to the needs of the partners, and provide opportunities for partners (and occasionally their clients) to more actively engage with CRCSI at a direct level. Examples during the year include the WA Agriculture workshop and the Victorian Positioning seminar. The CRCSI also convened an Industry Development workshop and informal get-togethers during the year for information sharing and networking throughout the regions.

Evidence of the level of student involvement in the CRC's activities

Students are involved in all major projects. Each student is required to have an external end user supervisor. All students are invited to attend the annual CRCSI conference which has a specific session for students. Twenty-two students attended the Student Workshop at the Annual Conference in May, with specific highlights from the feedback including networking, cultural learning, meeting other PhD students, getting to know the roadmap of CRCSI, and improved interactivity and collaboration.

Evidence of the level of involvement of end users in developing and conducting education / training activities, including the supervision of postgraduate students

The CRCSI held four workshops throughout the year to inform the planning of programs, and explore and promote collaboration. These were held across each of the CRCSI nodes:

- Industry development workshop – Brisbane
- Groundwater seminar – Christchurch
- Agriculture workshop – Perth
- Feature extraction program seminar - Melbourne

The coming year will see more of these exploratory workshops as well as a growing number of program and project based information sessions on technology and opportunity developments.

Each student is required to have an external end user supervisor. End user supervisors are present at student events and at the annual conference and workshops. Guest lectures are sometimes given by 43pl members in CRCSI university courses.

Support structures for postgraduate students, including the opportunities for interaction between students working in different parts of the CRCSI

As outlined above, all CRCSI students are invited to attend the Annual Conference and the Student workshop.

They are also invited to seminars, workshops, and the quarterly project meetings. The Student Workshop is explicitly designed to increase the engagement of students in CRCSI. Because they are all brought to the same location, they can form stronger bonds, and get to know students in different locations and/or projects. The CRCSI's current student population is drawn from 13 different nations representing a diverse range of cultures and prior experiences. There is substantial benefit to be had for the students by interacting with each. It clearly produces a much richer experience for the students.

Graduate destinations

All graduates are tracked following completion. A database records their employment or further training. A summary of the employment destinations follows:

- 5 are working for a 43pl member
- 4 are in other companies
- 9 are in academia
- 3 are Research Fellows in CRCSI projects
- 6 are working in government departments

Evidence that the education / training activities are meeting the needs of end users.

The survey responses following the CRCSI's Annual Conference in May 2012 showed that 100% of respondents either agreed or strongly agreed that the conference was useful. Of all respondents, not just students, 96% agreed or strongly agreed that the conference 'met or exceeded expectations', and 73% 'identified potential applications of new technology or innovation'.

3.5 SME Engagement

CRCSI strategy for engaging with SMEs

SMEs are deeply integrated into CRCSI's activities. CRCSI has a unique structure for its SME consortium: members purchase units in a unit trust (43pl) through which each can participate in CRCSI with appropriate flexibility. Importantly this firewalls the risk to the unit trust, which assumes the indemnity for each SME without

obligating each SME to take out the costly levels of public liability and professional indemnity insurance required of each Essential Participant. It also permits each SME to enjoy "Essential Participant" status through 43pl so they can access the Centre Intellectual Property and participate in all the activities of the CRCSI. A resourced set of strategies to engage with these companies is implemented through the Communications Director. The Company Secretary function and administrative support for 43pl is provided by CRCSI. The cost of administering 43pl is very modest.

These strategies are based on individual "Expectations and Engagement Plans", which are reviewed annually with each company in confidence. Key themes and strategies arising from these plans are collated and presented through the 43pl Board into the CRCSI strategic planning process.

Examples of these strategies include:

- The Annual Conference, which is a confirmed highlight for many companies
- Allied CRCSI Roadshows around the regions, which bring the CRCSI culture to the regions and spread the benefits across Australia and New Zealand
- Building clusters or ecosystems of activity, which create an environment where SMEs can more easily engage with customers and researchers
- Matching company expertise and technology aspirations with current and developing projects, which brings companies, when ready, to engage with relevant innovation activities

43pl is an Essential Participant in CRCSI as are its members. A company from each jurisdictional area provides a Director for the Board of 43pl following a process of nominations. These directors aid communication with members. As at 30 June 2012 the 43pl Directors were Tony Wheeler (Independent Chair), Jack de Lange (Queensland), Jim Curnow (SA and NT), Chris Earls (WA), Ed Garvin (NSW & ACT), Rob Rowell (Tasmania and Victoria) and Simon Jellie (New Zealand & International).

The current membership of 43pl is 53 companies. The number fluctuates as companies merge, leave the industry, spin-off new companies or choose to leave the CRCSI. An additional number of companies are partners by exchange of letters but are not members. New applications for membership of 43pl are encouraged.

The CRCSI also has an MOU with the peak private sector body, the Spatial Industries Business Association (SIBA). This body represents around 300 companies. SIBA and the CRCSI work closely together, particularly with respect to the development of new programs for encouraging innovation in the industry and in improving its skilled capacity.

Demonstration of how the CRC is assisting SMEs to build their innovation capacity and utilise research and development outputs of the CRC.

The 43pl value proposition includes the provision of:

- A cluster or ecosystem of spatial companies, clients and researchers that provides an open model of innovation, reducing the barriers to collaboration and R&D ; as well as a neutral ground to meet clients and suppliers
- Project engagement and learning through 43pl participation being sought in every project
- Access to R&D initiatives and IP for commercialisation, eg Scanalyse: a spin off company based on CRCSI research and development
- Skills development and capacity building, including the recruitment of CRCSI postgraduate students
- Meaningful networking into government & academia to bring the end user close to the researcher, so the 43pl company can participate where their niche expertise can be best applied. During the year two CRCSI partners, Landate and Geomatic Technologies, collaborated in the development of a new company, Earthmine Australia. At the launch of the new company

the Chief Executive of Landgate publically acknowledged the role of the CRCSI in facilitating the formation of this company through the demonstration of the power of the technology by CRCSI researchers to be used by Earthmine (mobile laser scanning imaging of built assets) and the networking provided by CRCSI forums.

- Assisting companies develop submissions for grant funds for innovation and business development
- Assisting with technical advice on the development of intellectual property

All research outputs are available for companies to use internally, under certain conditions. Opportunities to commercialise specific project outputs are presented to companies through expressions of interest in taking on the innovation, with the Board selecting the most appropriate business case.



IndjiWatch a web based emergency management system for integrating tactical emergency management activities through a single web portal. The system has been commercialised by iintegrate Systems Pty Ltd with significant sales in the large energy utility and mining markets.

In addition the CRCSI has an Industry Development Program which targets not only 43pl companies but also SIBA members to provide training and mentoring and advice with regard to commercialisation and company growth through innovation.

3.6 Collaboration

The CRCSI has a detailed database of all participants and key stakeholders. It monitors about 130 organisations in this way. The database records details of all activities, each person, each project, each committee role and much more. It records management's view of the level of expectation that each participant has of the CRCSI, and Management's view of how well the CRCSI is performing in relation to meeting those expectations. This analysis is quantified and reviewed regularly.

CRCSI has many participants across Australia and in New Zealand. Most 43pl companies and some external companies had formal collaborative arrangements with CRCSI activities in the period, along with over a dozen government departments and a similar number of universities.

Respective organisational cultures differ between the various government agencies, small service provider companies and manufacturers, R&D based enterprises, and universities. These differences are well managed by CRCSI when judged by the number of organisations prepared to participate. Fostering a CRCSI culture of excellence in cooperation is important to the Board and Management. The CRCSI is a collaborative enterprise and this is practiced in various ways.

Collaborations between researcher participants, researcher participants and end user participants, and between the end users themselves.

The CRCSI has a matrix structure so that leading edge customers are engaged with technology and service providers along the value chain and across parallel lines of business drawing valuable new knowledge from the interdisciplinary experience. Indeed the CRCSI's three primary research programs (1 to 3) operate as platforms for all five applications programs encouraging innovative synergies that would not be possible with a silo approach.

In addition many of the customers are also suppliers of the data and infrastructure used by the market in devising new products.

Cooperation amongst geographically spread activities and entities is assisted through regular electronic and face to face symposia.

The level of collaboration varies across the CRCSI. For instance in Program 1 Positioning, there is close integration of the efforts from four universities across Australia as the recognised leaders in the field, orchestrated through the CRCSI's Program 1 Science Director. Another example is the Health Program, which has close ties across Curtin University, Queensland University as well as the Telethon Institute for Child Health Research WA and the Queensland Cancer Council.

End users are involved in all aspects of CRCSI. Meaningful SME engagement is a particular strength of CRCSI and is reflected in all aspects of CRCSI's operations.

It is a prerequisite for Research Investment Committee consideration of a proposal that all activities to be funded have meaningful input from academia, government and private sectors. Without the presence of these three a persuasive argument is required as to why the CRCSI should be operating in the area.

The internal interactions in the CRCSI are very strong at the government and industry sectors. The collaboration and communications strategies of the CRCSI support and encourage this. Within 43pl there have been a number of corporate mergers brought about – in part – by the closeness of collaboration CRCSI engenders. A prime motivation for many 43pl companies in participating in CRCSI is the collaborative experience to both government and academia.

Commonly some agencies have released work packages to the CRCSI which then oversees the conduct of the research therein and brings into play the private sector in certain operational circumstances. The UDEM project is one example where twenty organisations were collaborating on behalf of the client, the Department of Climate Change and Energy Efficiency.

CRCSI welcomes potential new partners to the Annual Conference, allowing them to investigate the benefits of its research and discuss membership options. Further,

research and end user partners are invited to regional roadshows and project-specific workshops. This ensures that; CRCSI's program of research is widely understood by our partners, the research is up to date and relevant to end users, and that collaboration is increased as partners are involved from the outset.

In general there is a very high degree of collaboration between the researchers, and between researchers and end users irrespective of their physical location or organisational affiliation. The CRCSI College structure ensures strong collaboration within the end users themselves, particularly in the development of common strategies designed to benefit all through the creation of the largest possible national benefit. The wonderful degree of collaboration between all participants is one of the hallmarks of the CRC Program overall.

External linkages and how they contribute to the CRC overall

Cooperation with Other CRCs.

CRCSI selectively collaborates with other CRCs including NintiOne (Remote Economic Participation CRC) and the Bushfires CRC. The CRCSI also assisted several CRC bids.

National

Strong links have been established with key stakeholder groups, notably the peak industry body the Spatial Industries Business Association (SIBA); the peak professional body the Surveying and Spatial Sciences Institute (SSSI) and the peak government body ANZLIC – the Spatial Information Council. Mechanisms include invitations to Board meetings, joint Board meetings, membership, committee representation, and invited presentations, shared web links, and collaborations on important initiatives such as the National Spatial Education Leadership Group of which the CEO and Communications Director are members; leadership roles within the NCRIS AuScope; AURIN and TERN, and related activities; and the commissioning of joint projects. These relationships are important to give strategic advice and context to the

CRCSI on the one hand and on the other to effectively convey the work of the CRCSI to the broader spatial end user communities.

International

International collaborative alliances were maintained during the period with strategic advantage sought for specific projects. The following international links are well developed:

- New Zealand – the CRCSI established a partnership with New Zealand through Land Information New Zealand (LINZ), the University of Canterbury and four 43pl members. The CRCSI is actively pursuing collaboration with new agencies and organisations in the region and has funded several projects involving NZ enterprises. The CRCSI proposed to the New Zealand Government that New Zealand develop a Geospatial Research Strategy to guide its priorities with the CRCSI. The New Zealand Government agreed and is now developing the strategy with help from the CRCSI.
- Tecterra – of Canada which “ creates economic value for Canada through investment in geomatics technology solutions for various resource sectors and geospatial information management applications.” Tecterra and the CRCSI collaborate through the exchange of ideas to stimulate industry innovation.
- GEOIDE Network - based at the University of Laval in Quebec, Canada (analogous to the CRCSI), funded as a Canadian 'Network of Centres of Excellence' (<http://www.geoide.ulaval.ca>)
- Chinese Academy of Sciences (CAS) - A collaborative research agreement underpins joint activities that are being developed, in particular through CAS's Centre for Earth Observation and Digital Earth (CEODE).
- Global Spatial Network (GSN) of which the CRCSI is a founding member. The GSN is a global body made up of organisations with same composition and objectives as the CRCSI. The CRCSI CEO

is the Chair. This new organisation has five founding members together with the CRCSI: Canada (GEOIDE), South Korea (Korean Land Spatialization Group), Mexico (Centro-Geo), Sweden (Future Position X) and two affiliate partners; European Union (AGILE) and the US (UCGIS). Iran and Ireland are also expressing interest in joining.

3.7 Other activities

This section covers the more significant activities that have occurred complimentary to the research activities specified and funded under the Commonwealth Agreement.

The Urban Digital Elevation Model Project and Development of a National Elevation Data Framework

Industry and government agencies at all levels are increasingly requiring high quality spatial data to understand and mitigate risks, and support effective responses to climate change adaptation, water and natural resource management, emergency management, and health and safety concerns. Digital elevation data and models that describe the land surface are a fundamental dataset to meet these demands.

In 2007, the Council of Australian Governments (COAG) identified as a national priority the need for a fit-for-purpose coastal digital elevation model (DEM) to assess the potential impacts of rising sea levels. COAG also noted that a national DEM would have important benefits for catchment managers and natural resource managers, and that there were likely to be considerable cost savings through developing a national DEM.

In recent years there has also been growing recognition of the benefits of national frameworks for fundamental data types like DEMs to: reduce duplication; increase data quality, consistency and access; deliver greater economic efficiencies from coordinated investment; enable opportunities from emerging applications to be realised; improve Australia's international competitiveness and

support decision making by governments, industry and the community.

The National Elevation Data Framework (NEDF) is one such framework. The NEDF was progressed through a partnership between the Australia and New Zealand Land Information Council (ANZLIC), the Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), Geoscience Australia (GA), and the CRCSI. A success of this partnership was the connection between operational and research capacities, a policy driver and a forum for national collaboration. Key initial steps in developing the NEDF included a national user needs survey, a business plan, and a science case using the COAG-required DEM as the main impetus.

The Coastal Urban Digital Elevation Modelling in High Priority Regions (CUDEM) project has implemented many of the foundation elements of the NEDF. DCCEE acting on behalf of COAG asked the CRCSI to lead the CUDEM project. DCCEE allocated \$8M to the project over four years.

CUDEM has involved the CRCSI in developing a nationally agreed science case for the DEM generation using the Australian Academy of Science as facilitator (and culminating in a national workshop at the Shine Dome in Canberra). The CRCSI brought together a number of lead organisations including Geoscience Australia, state agencies, local governments and leading companies. With their involvement the CRCSI arranged for the acquisition, processing and provisioning of Whole-of-government access to high resolution elevation data for priority coastal areas of Australia; closing the gap between existing land and sea datasets. The CUDEM project has also developed information products to assist decision-makers (government, business and industry, and communities) to plan for the impacts of climate change.

Investment through the CUDEM project has implemented a model of improved management and governance of a fundamental, national elevation dataset. Key outcomes from the investment include:

- Over 60,000 km² of high resolution elevation data covering major urbanised coastal areas of

Australia available for Whole-of-government use through streamlined licensing arrangements

- Coordination of a comprehensive, national approach for the ongoing acquisition, enhancement, and distribution of elevation data to address open access (beyond Whole-of-Government) issues and associated funding and licensing arrangements
- Improved discoverability and access to elevation data via a national portal (nedf.ga.gov.au)
- Consistent national guidelines for the collection and processing of high resolution elevation data implemented as industry standards
- Sea level rise communication products that have been widely accessed by governments, community and the private sector. The tool has 350 registered user organisations, accessing up to 40,000 web hits per month and to date there have been over 300,000 map downloads
- Demonstration of the benefits of developing the right partnerships that can support delivery of a robust technical approach that is responsive to the policy needs of government
- Cost-effective delivery of models and communication products
- Demonstrated robust capacity to support international coastal inundation risk mapping through the Pacific Australia Climate Change Science and Adaptation Planning program.

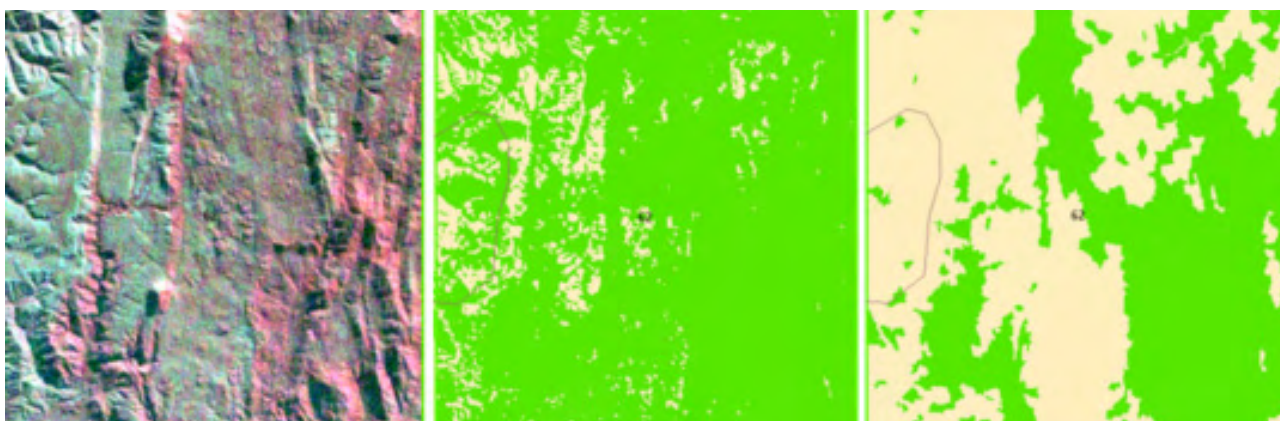
- Substantial research to improve the quality and accuracy and DEMs

The CUDEM project demonstrated world best practice in elevation modelling, particularly at a continental scale. No other nation of comparable size has delivered coastal elevation modelling for all highly vulnerable areas in less than five years using the latest technology, with the highest possible resolution, and with a very modest budget. The scale with its focus on innovation and efficiency, enabled the final cost of modelling in 2012 to be around one-quarter of that first estimated when the project started. The project also helped create an industry that is more robust and competitive; that delivers quality assured product to meet national standards.

The benefits of the NEDF and the CUDEM will be long lasting, particularly in positioning Australia to understand and manage the risks of coastal inundation from climate change, in disaster mitigation, infrastructure and local planning and better management of insurance.

Carbon Monitoring to Support the International Forest Carbon Initiative (IFCI)

An initiative of the Department of Climate Change and Energy Efficiency (DCCEE), the IFCI forms a key part of Australia's leadership in reducing emissions from deforestation and forest degradation in developing countries (REDD). A critical component of the IFCI is the development of a global carbon monitoring system (GCMS) that has the capability to use advanced satellite imaging using radar and optical sensors to measure rates



Comparison of landcover change maps: raw image (left), NCAS/Thematic Mapper (middle) and radar (right) - IFCI Project.

of deforestation and forest degradation by monitoring, reporting and verifying (MRV) emissions of greenhouse gases. The GCMS will form a global network of compatible national forest monitoring and reporting systems that meet national reporting requirements, and can potentially be linked to support domestic and international carbon trading initiatives. Through the IFCI, the Australian Government is providing expert advice and assistance to developing countries on MRV issues.

The role of the CRCSI within IFCI was to assist in pooling and coordinating the body of expertise in Australia to support these training, advice and assistance roles. To progress this objective it is necessary to complete the following:

- Secure unencumbered access to adequate and cost-effective satellite data
- Ensure interoperability of earth observation satellite sensor technologies
- Produce accepted accuracy assessments of remote sensing and ground monitoring products
- Link remote sensing and ground forest data and models to provide emissions estimating tools

To cost-effectively achieve these objectives at an international level, the Department of Climate Change and Energy Efficiency on behalf of Australia is working through the intergovernmental Group on Earth Observations (GEO) and the Committee on Earth Observation Satellites (CEOS). Under GEO, Australia, Norway and Japan are co-leads on a Forest Mapping and Tracking Program that aims to demonstrate a robust forest observations capability. As part of Australia's contributions to this effort, Australia nominated Tasmania as one of the global reference and demonstration sites. The demonstration site will show through practical demonstration that the above four objectives can be met, thereby influencing post 2012 climate change negotiations by demonstrating ongoing technical improvement to a globally applicable.

The IFCI-supported CRCSI Carbon Monitoring project was commissioned by DCCEE in 2009 at a cost of \$2 million. It was a joint venture with CSIRO.

The CRCSI Carbon Monitoring project has:

- Evaluated the feasibility of using optical and radar imagery interchangeably in the same carbon monitoring system.
- Established concepts and demonstrated results of different accuracy assessment procedures for single data Forest/Non-forest maps and multi-temporal maps showing deforestation and regeneration.
- Authored a GEO Forest Carbon Tracking guide on accuracy assessment of remote sensing products.
- Provided training in image processing for carbon accounting.
- Maintained a strong international presence by contributing to the GEO Forest Carbon Tracking task in the areas of image processing and accuracy assessment.
- Contributed research into the ongoing use of emerging remote sensing-derived biophysical parameters for improved forest characterization (forest type, structure, biomass, function), and identification of forest disturbance and degradation events.

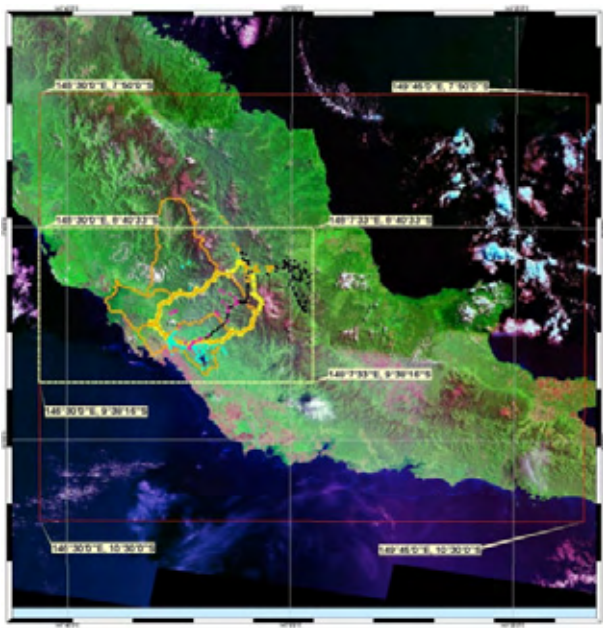
Kokoda Project

In 2008, Australia and Papua and New Guinea committed to cooperate and work together for the protection and sustainable use of the natural and cultural resources of the 40,000 square kilometers that make up the Owen Stanley Ranges region including the Kokoda Track.

The Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) is assisting PNG to undertake a number of land use and protection projects. This is a Whole-of-government initiative and the PNG Department of Environment and Conservation (DEC), with DEWHA's assistance, is currently developing spatial systems and databases to support the land use planning requirements of the Kokoda Initiative and development of a Sustainable Development Masterplan for the Brown River Catchment, Kokoda Track and Owen Stanley Ranges region.

The Australian Kokoda Taskforce and PNG National Taskforce identified three critical datasets as requirements for the land use planning work for the Kokoda Initiative:

- High Resolution Digital Elevation Model (DEM) for use in deriving key terrain attributes such as slope, aspect, drainage and susceptibility to erosion.
- Current land use maps for delineating the Kokoda Track and broader heritage values and Interim Protection Zone.
- Forest cover change and biomass assessment.



Map of the Kokoda Track region developed utilising DEM techniques for deriving key terrain attributes – the Kokoda Project

CRCSI assisted to develop these key datasets through the provision of high spatial resolution, digital elevation data for slope analysis, drainage delineation and flood modelling using Earthdata aerial GeoSAR and Japanese satellite PALSAR data. These datasets were required to assess the suitability of the Owen-Stanley Ranges and adjacent high-relief hills and foothills for logging, susceptibility of the cleared landscape to erosion, line of site visualisation and to assess the suitability of these areas for different land uses.

Land cover mapping was also carried out using the combined GeoSAR data set, which included P-band and X-band radar imagery, and in which land cover types, such

as forest, plantations and crops, mangroves, clearings and disturbed areas could be readily distinguished.

2011-12 Short term Commissioned CRCSI Research projects

A number of short term projects were undertaken at the request of partners.

Priorities for Investment in Remote Sensing Satellite Technology for Australia:

There is a growing national consensus that Australia has a strong dependency and reliance on foreign Earth Observation (EO) satellites. This gives rise to questions regarding investment priorities for the nation in EO satellite infrastructure and technologies. This paper looked at the background to Australia's present complete dependence upon overseas owned and operated EO satellites, and then briefly summarizes relevant strategic objectives in EO. Three priority areas of investment were considered. (Paper available at: www.crcsi.com.au/getattachment/b2035ae1-4cb8-42b1-9c8e-2a0768b0b877/).

Study of risks to Australian Critical Infrastructure

This project provided a sectoral analysis of Australia's significant dependency on the use of Global Navigation Satellite Systems, known as GNSS vulnerabilities, and an analysis of potential threats and their impact on critical infrastructure from a disruption or failure of GNSS. The project was commissioned by the Department of Broadband and Digital Communications.

Development and operation of a space-based Synthetic Aperture Radar (SAR) capability in Australia

Commissioned by the Department of Innovation, Industry, Science, Research, Education and Training, this project examined the potential for greater use of SAR satellites in Australia. SAR is one of the fastest growing and most powerful sources imagery.

Spatial Information for Disaster Response in Australia Report (November 2011)

This report was commissioned by the Australian Space Policy Unit (SPU), Geoscience Australia (GA), the

University of New South Wales, the then Department of Environment and Natural Resources, Queensland, and the former Land and Property Management Authority, New South Wales. Its purpose was to review the lessons learnt during the Queensland floods of 2011 and Victorian bushfires of 2009 to enable the spatial information community to better support Australia's ability to manage natural disasters. The study involved consultation with disaster management agencies. (Report available at: www.crcsi.com.au/getattachment/61ef1eba-1b53-43f8-9aa1-e63ccb7d17d4/.aspx).

Australian Strategic Plan for GNSS

The CRCSI conceived and managed the development of the Strategic Plan on behalf of the Australian Spatial Consortium, a committee made up of the heads of all the lead spatial organisations across all sectors in Australia. The objective of the Plan is to make recommendations to prepare Australia for the challenges of, and capitalise on, the opportunities that will flow from, imminent and far reaching changes in the Global Navigation Satellite System (GNSS) domain. The plan was subsequently used to assist the Federal Government to develop a new Satellite Utilisation Policy and the National Positioning Strategy. (The plan is available at: www.spatialbusiness.org/site/DefaultSite/filesystem/documents/Miscellaneous/Australian%20Strategic%20Plan%20for%20GNSS.pdf).

Assistance in Development of the National Positioning Infrastructure Plan

The Government recently undertook the development of the National Positioning Infrastructure Plan. The CRCSI assisted Geoscience Australia in its development. The plan will facilitate coordinated access to critical space-based positioning infrastructure; enable a nationwide positioning capability through informed public and private investment and international cooperation; and enhance the nation's capacity to develop and deliver integrated, reliable and sustainable PNT applications and services. Is the subject of a cabinet submission.

ROAMES Research Consultancy – Technical Due Diligence & Market Analysis of Gimbal Sensor Systems

This specialized consulting activity related to a technical and scientific due-diligence and analytical simulation study of electro optical and infra red gimbal systems. The outcomes were intended for use by Essential Participant, Ergon Energy for research planning and strategic capability development purposes.

Management assistance

CRCSI has provided services to the Commonwealth in relation to management of airborne LiDAR surveys, capacity building and coastal modelling in the Pacific.

Verification update for the National Carbon Accounting System

This project provided an updated verification of forest extent and change for Australia's National Inventory System. The national inventory forms the foundation for Australia's efforts to address climate change. By identifying and reporting emissions sources and sinks, and changes in these over time, the inventory provides information fundamental to the development of domestic mitigation policies and programs, while also tracking Australia's progress towards meeting international obligations.

3.8 Compliance with legal and regulatory requirements

The CRCSI executed 81 new agreements (up from 73 the year before) comprising; 12 business development agreements (5 NDAs, 1 MOU, 3 SISL agreements and 3 43pl agreements), 37 CRCSI project agreements (up from 31 the previous year), 9 employment agreements, 9 partnering agreements, 14 scholarship agreements (up from 4 the previous year). The CRCSI is now administering 153 live agreements across 513 organisations (up from 130 agreements across 425 organisations the previous year). CRCSI's Compliance Manager reports that there are no known breaches of compliance.

4 Glossary and Acronyms

43pl	43 Pty Ltd, a company representing the CRCSI's SME consortium
ACC	Audit & Compliance Committee
AGRI	Australian Geographic Reference Image
ALOS	Advanced Land Observation Satellite
ANZLIC	ANZLIC - the Spatial Information Council formerly known as the Australia and New Zealand Land Information Council
ANU	Australian National University
AOS	Active Optical Sensors
ARC	Australian Research Council
ARGN	Australian Regional GPS Network
ASC	Australian Spatial Consortium
ASIERA	Australasian Spatial Information Education and Research Association
AURIN	Australian Urban Research Infrastructure Network
ASPRS	The American Society for Photogrammetry & Remote Sensing
ATO	Australian Taxation Office
CAS	Chinese Academy of Sciences
CASA	Civil Aviation Safety Authority
CEO	Chief Executive Officer
CEODE	Centre for Earth Observation and Digital Earth, Chinese Academy of Science
CEOS	Committee on Earth Observation Satellites
CIP	CRCSI Intellectual Property
COAG	Council of Australian Governments
CORS	Continuously Operating Reference Station
CRC	Cooperative Research Centre
CRC Program	Secretariat of the DIISRTE CRC Program
CRCSI	Cooperative Research Centre for Spatial Information, Australia and New Zealand
CRCSI-1	Name given to the 1st funding round of the CRCSI 2003-2009
CRCSI-2	Name given to the 2nd funding round of the CRCSI 2010-2018
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CUDEM	Coastal Urban Digital Elevation Modelling
EIPT	Economic Impact Performance Tool
DCCEE	Australian Department of Climate Change and Energy Efficiency
DEC	PNG Department of Environment and Conservation
DEM	Digital Elevation Model
DEWHA	Australian Government Department of Sustainability, Environment, Water, Population and Communities.
DIGO	Defence Imagery & Geospatial Organisation Australia
DInSAR	Differential Interferometric Synthetic Aperture Radar
DIISRTE	Commonwealth Department of Innovation, Industry, Science, Research, Training and Education
DoHA	Department of Health Australia
DSE	Dry Sheep Equivalent

DSE VIC	Department of Sustainability & Environment Victoria
eFAS	Enhanced Flight Assist System
EO	Earth Observations
EPA	Environmental Protection Authority
FAS	Flight Assist System
FBT	Fringe Benefits Tax
FTE	Full Time Equivalent
GA	Geoscience Australia
GCMS	Global Carbon Monitoring System
GDA	Geocentric Datum of Australia
GEO	Intergovernmental Group on Earth Observations
GEOIDE	GEOmatics for Informed Decisions (Canada)
GeoSAR	Geographic Synthetic Aperture Radar
GFI	Global Forests Initiative
GILF	Government Information Licensing Framework
GIS	Geographical Information Systems
GITA	Geospatial Information & Technology Association
G-NAF	Geocoded National Address File
GNSS	Global Navigation Satellite Systems
GPCs	Ground Control Points
GPS	Global Positioning System
GSN	Global Spatial Network
GST	Goods and Services Tax
IACC	Industry Advisory & Commercialisation Committee of the CRCSI-1
IFCI	International Forest Carbon Initiative
IGS	International GNSS Service
INS	Inertial Navigation Systems
InSar	Interferometric Synthetic Aperture Radar
ION	Institute of Navigation
IP	Intellectual Property
ISO	International Standards Organisation
JAXA	Japanese Aerospace Exploration Agency
LINZ	Land Information New Zealand
LPI	Land & Property Information NSW
LRI	Livestock Resistance Index
MDBA	Murray-Darling Basin Authority
MOU	Memorandum of Understanding
MRV	Monitoring, Reporting & Verifying
NASA	National Aeronautics & Space Administration (USA)
NCI	National Computation Infrastructure
NCRIS	National Collaborative Research Infrastructure Strategy
NDVI	Normalised Difference Vegetation Index
NEDF	National Elevation Data Framework

NNG	National Nested Grid
OHS	Occupational Health & Safety
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PERS	Photogrammetric Engineering & Remote Sensing
PNG	Papua New Guinea
PNT	Position, Navigation and Timing
PRISM	Panchromatic Remote Sensing Instrument for Stereo Mapping
PSInSAR	Permanent Scatter Interferometric Synthetic Aperture Radar
PSM	Public Service Medal
QA	Quality Assurance
QDNRM	Queensland Department of Natural Resources & Mines
REAC	Research & Education Advisory Committee of the CRCSI-1
REDD	Reducing Emissions from Deforestation and Degradation in developing countries
RNNS	Reverse Nearest Neighbour Search
ROAMES	Remote Observation Automated Modelling Economic Simulation (Ergon)
Round 11	The 2009 CRC Program Funding Round
SPU	Australian Space Policy Unit
RTK	Real-Time Kinematic
SAR	Synthetic Aperture Radar
SDI	Spatial Data Infrastructure
SEAC	Spatial Education Advisory Committee of Australia
SI	Spatial Information
SIBA	Spatial Industries Business Association
SISL	Spatial Information Systems Ltd
SISR	Spatial Information Systems Research Ltd
SME	Small to Medium [sized] Enterprises
SSSI	Surveying & Spatial Sciences Institute
TERN	Terrestrial Ecosystem Research Network
UAV	Unmanned Aerial Vehicle
UCGIS	University Consortium for Geographic Information Science (USA)
UDEM	Urban Digital Elevation Management
UJV	Unincorporated Joint Venture
UK	United Kingdom
ULA	Unlocking the Landsat Archive
ULLA	Ultra Low Level Aircraft
UNESCO	United Nations Educational, Scientific and Cultural Organisation
US	United States of America
VANZ	Virtual Australia and New Zealand
VET	Vocational Education & Training
WALIS	Western Australia Land Information System

5 Appendix 1 - Publications

Program/ Project	Authors	Title	Bibliographic detail
1	Al-Shaery, A., Lim, S., Rizos, C.	Investigation of different interpolation models using in Network-RTK for the Virtual Reference Station technique.	Journal of GPS, 10(2), 136-148
1	Al-Shaery, A., Lim, S., Rizos, C.	Assessment of network-based positioning performance using GPS alone versus GPS and GLONASS combined.	24th Int. Tech. Meeting of the Satellite Division of the U.S. Inst. of Navigation, Portland, Oregon, USA, 20-23 September, 2341-2349.
1	Glennon, E.P.	QZSS research at UNSW.	IGNSS Symp., Sydney, Australia, 15-17 November
1	Grinter, T., & Roberts, C.A.	Precise Point Positioning – Where are we now?	IGNSS Symp., Sydney, Australia, 15-17 November
1	Janssen, V., Grinter, T., & Roberts, C.A.	Can RTK GPS be used to improve cadastral infrastructure?	Engineering Journal, 15(1), ISSN 0125-8281, 43-54.
1	Li, B., Zhang, S., Dempster, A.G., & Rizos, C.	RNSSs positioning in the Asia-Oceania region.	Journal of GPS, 10(2), 114-124
1	Li, T., & Wang, J.	Comparing the mathematical models for GPS & GLONASS integration.	IGNSS Symp., Sydney, Australia, 15-17 November
1	Li, Y. & Rizos, C.	Evaluation of positioning accuracy with QZSS enhanced global navigation satellite systems.	IEEE/ION PLANS, Myrtle Beach, South Carolina, USA, 24-26 April.
1	Li, Y. & Rizos, C.	Evaluation of positioning accuracy of GNSS with QZSS augmentation.	IGNSS Symp., Sydney, Australia, 15-17 November
1	QUT traffic report		
1	Rizos, C., & Nix, M.	Mining: Geospatial technology & skills.	Position, 54, 22-25. Engineering
1	Rizos, C., & Satirapod, C.	Contribution of GNSS CORS infrastructure to the mission of modern geodesy and status of GNSS CORS in Thailand.	Journal, 15(1), 25-42.
1	Rizos, C., Janssen, V., Roberts, C.A., & Grinter, T.	Precise Point Positioning: Is the era of differential GNSS positioning drawing to an end?	FIG Working Week, Rome, Italy, 6-11 May.
1	Stanaway, R., & Roberts, C.A..	ITRF transformations in deforming zones to support CORS-NRTK applications.	IGNSS Symp., Sydney, Australia, 15-17 November
1	Stanaway, R., Roberts, C.A., Blick, G., & Crook, C.	Four dimensional deformation modelling, the link between international, regional and local reference frames.	FIG Working Week, Rome, Italy, 6-11 May.
1	Xu, C., Wang, J., & Gao, J.	Outlier detection performance in Precise Point Positioning.	IGNSS Symp., Sydney, Australia, 15-17 November
1	Yang, L., & Wang, J.	Reliability analysis of robust estimation for GNSS positioning.	IGNSS Symp., Sydney, Australia, 15-17 November
1	Zhang, S.C., Wu, S., Zhang, K., & Li, B.	Network-based RTK positioning using integrated GPS and GLONASS observations.	IGNSS Symp., Sydney, Australia, 15-17 November

Program/ Project	Authors	Title	Bibliographic detail
1.01	Hauschild, Andre, Montenbruck, Oliver, Sleewaegen, Jean-Marie, Huisman, Lennard & Teunissen, Peter J.G.	Characterization of Compass M-1 signals	GPS Solutions, 16, 117 - 126
1.01	Huisman, L., Teunissen, P.J.G., Hu, C.	Single Frequency PPP using real-time regional broadcast corrections via NTRIP for the Australian GDA94 datum	The XXV IUGG General Assembly, Earth of the Edge: Science for a Sustainable Planet, 28 June - 7 July 2011, Melbourne, Australia. IAG Symposia, Springer Berlin Heidelberg.
1.01	Huisman, Lennard / Teunissen, Peter / Hu, Congwei	GNSS precise point positioning in regional reference frames using real-time broadcast corrections	Journal of Applied Geodesy. Volume 6, Issue 1, Pages 15–23, March 2012
1.01	Li B. & Teunissen, P.J.G	High Dimensional Integer Ambiguity Resolution: A First Comparison between LAMBDA and Bernese	Journal of Navigation, 2011, 64, S192-S210
1.01	LI Xing-Xing, ZHANG Xiao-Hong, LI Pan	Rapid integer ambiguity-fixing in precise point positioning	Chinese Journal of Geophysics - Chinese Edition, ISSN: 00010-5733
1.01	Odijk, D., Teunissen, P. J. G. & Huisman, L.	First Results of Mixed GPS + GIVE Single-TRK Frequency in Australia	Journal of Spatial Science Volume: 57 Pages: 3-18 DOI: 10.1080/14498596.2012.679247
1.01	Odijk, D., Teunissen, P.J.G., Huisman, L.	First results of mixed GPS+GIOVE single-frequency RTK in Australia	Journal of Spatial Science DOI:10.1080/14498596.2012. 679247 June 2012
1.01	Odijk, D., Teunissen, P.J.G., Khodabandeh	Single Frequency PPP-RTK: Theory and Experimental Results.	The XXV IUGG General Assembly, Earth of the Edge: Science for a Sustainable Planet, 28 June - 7 July 2011, Melbourne, Australia. IAG Symposia, Springer Berlin Heidelberg.
1.01	Odijk, D., Teunissen, P.J.G., Zhang B.	PPP-RTK platform performance based on single-frequency data	Proc. 32nd Asian Conference on Remote Sensing, 3-7 October 2011, Taipei, Taiwan
1.01	Odijk, D., Teunissen, P.J.G., Zhang B.	Single-frequency integer ambiguity resolution enabled precise point positioning	Journal of Surveying Engineering. DOI: 10.2061/(ASCE)SU.1943-5428.0000085. March 2012
1.01	Odijk, D., Teunissen, P.J.G., Zhang, B.	An Accuracy Analysis of PPP-RTK Network Corrections.	The XXV IUGG General Assembly, Earth of the Edge: Science for a Sustainable Planet, 28 June - 7 July 2011, Melbourne.
1.01	Teunissen	Report on 'PPP-RTK & Open Standards' Symposium	CRCSI website
1.01	Teunissen, P.J.G., Huisman, L., Hu, C.	Real-Time Precise Point Positioning in NAD83: Global and Regional Broadcast Corrections Compared.	Journal of Surveying Engineering. DOI: 10.2061/(ASCE)SU.1943-5428.0000089.
1.03	Jun Wang, Yanming Feng	Reliability of partial ambiguity fixing with multiple GNSS constellations.	Journal of Geodesy, 2012 DOI:10.1007/s00190-012-0573-4. Published online first.

Program/ Authors Project	Title	Bibliographic detail
1.03	Jun Wang, Yanming Feng	Orthogonality Defect and Reduced Search-Space Size for Solving Interger Least-Squares Problems. GPS Solutions 2012 DOI:10.1007/s10291-012-0276-6. Published online first
2	Alex Hay-Man Ng, Linlin Ge, Xiaojing Li & Kui Zhang	Monitoring ground deformation in Beijing, China with persistent scatterer SAR interferometry
2	Cholathat, R., Ge, L., Li, X., & Rizos, C.	Monitoring geologic sequestration with radar remote sensing. Proc. published 2011 in Australian Space Science Conference Series, ed. W. Short & I. Cairns, 10th Australian Space Science Conf., Brisbane, Australia, 27-30 September 2010, 187-198.
2	Cholathat, R., Li, X., X., & Ge, L.	Monitoring natural analog of geologic carbon sequestration using multi-temporal Landsat TM images in Mammoth Mountain, Long Valley Caldera, California.
2	NG, A.H.-M., GE, L., ZHANG, K., & LI, X.	Subsidence revealed by PSI technique in the Jakarta city, Indonesia.
2	Ng, A.H.M., Chang, H.C., Zhang, K., Ge, L., Rizos, C., & Omura, M.	Deformation mapping in three dimensions for underground mining using InSAR – Southern Highland coal field in New South Wales, Australia.
2	Ng, A.H.M., Ge, L., Zhang, K., & LI, X.	Monitoring ground deformation in Beijing, China with Persistent Scatterer SAR Interferometry.
2	Thulin S., Hill M.J., Held A., Jones S., Woodgate P.	Hyperspectral determination of feed quality constituents in temperate pastures: effect of processing methods on predictive relationships from partial least squares regression.
2	Ting, J., Tan, T., West, G., Squelch, A. & Foster, J	Quantitative assessment of 2D versus 3D visualisation.
2	YU, J.H., GE, L., & RIZOS, C.	Digital elevation model generation using multibaseline advanced land observing satellite/phased array type L-band synthetic aperture radar imagery.
2	Zhang, K., Ge, L., Hu, Z., Ng, A.H.-M., Li, X., & Rizos, C.	Phase unwrapping for very large interferometric datasets
2.01	Belton, D., Gibson, A., Stansby, B., Tingay, S., Bae, K-H.	Modeling of an inexpensive 9m satellite dish from 3D point clouds by Terrestrial Laser Scanners
2.01	Belton, D., Mooney, B., Bae, K-H, Snow, A. J.	Automated matching of segmented terrestrial laser scanning to as-built plans

Program/ Project	Authors	Title	Bibliographic detail
2.01	Belton, D., West, G., Bae, K-H.	Low level feature extraction from Mobile Mapping Laser Point Clouds	IEEE DICTA conference, Queensland Australia
2.01	D. Belton, B. Mooney, K.H. Bae & T. Snow	Automated matching of segmented point clouds to As-built plans	SSSC 2011, Wellington NZ, December
2.01	Lim, K., Bae, K-H., Belton, D	Semi-automated colour registration and evaluation of digital Photogrammetry and Terrestrial Laser Scanning	Proceedings of SSC2011, Wellington, NZ
2.02	Awrangjeb, M, Zhang, C., Fraser, C.S.	Improved Building Detection using Texture Information.	International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science, Volume 38, Part 3. Munich, Germany, Oct 5-7, 2011. 6 pages on CD-ROM
2.02	Awrangjeb, M., Zhang, C., Fraser, C.S.	Building detection in complex scenes through effective separation of buildings form trees.	Photogrammetric Engineering and Remote Sensing July 2012
2.02	Fraser, C.S. and Ravanbakhsh, M.	Performance of DEM Generation Technologies in Coastal Environments.	Proceedings of 7th International Symposium on Digital Earth, Perth, 23 - 25 August, 10 pages.
2.02	M. Awrangjeb, C. Zhang & C.S. Fraser	An Improved Building Detection Technique for Complex Scenes.	IEEE International Conference on Multimedia & Expo
2.02	Panciera, R., Walker, J.P., Kalma, J., Kim, E.	A Proposed Extension to the SMOS Level 2 Algorithm for Mixed Forest and Moderate Vegetation Pixels	Remote Sensing of Environment, doi: 10.1016/j. rse.2011.07.017, 2011.
2.02	Zhang, C., Awrangjeb, m., Fraser, C.S.	Effective Separation of Trees and Buildings for Automated Building Detection.	32nd Asian Conference on Remote Sensing, Taipei, 3-7 Oct., 6 pages on CD-ROM
2.07	Farmer, E., Reinke, K.J., Jones, S.	A current perspective on Australian woody vegetation maps and implications for small remnant patches.	Journal of Spatial Science: Vol 56/No.2/Dec 2011
3	Veenendaal, B. & West, G.	Transforming location intelligence through geospatial web-based technologies.	Proc. 2nd ISPRS Workshop on Pervasive Web Mapping, Geoprocessing and Services: Our Complex World: Representation, Analysis and Modeling, Vancouver, August, 2011.
3	Wu, X., Xia, C., Arnold, J., West, G. & Veenendaal, B.	Managing Schema Evolution in a Federated Spatial Database System	In Discovery of Geospatial Resources: Methodologies, Technologies and, Emergent Applications, Eds Laura Díaz, Carlos Granell, Joaquín Huerta, 2012.
3	Wu, X., Xia, C., West, G., Arnold, L. & Veenendaal, B.	Managing Schema Evolution in a Federated Spatial Database System	Proc. ISDE7: 7th Int. Symp. on Digital Earth, Perth, WA, August 2011.
3	Wu, X., Xia, C., West, G., Arnold, L. & Veenendaal, B.	Scheme element dependencies in a federated spatial database system.	Proc. SSSC 2011: Surveying and Spatial Sciences Conference, Wellington, NZ, November 2011
4.1	Lowell, K., &ews, J., Hudson, D., & Woodgate, P	Spatial Information for Disaster Responses in Australia: National Consultation Final Report	Published by the CRC for Spatial Information, November 2011.

Program/ Project	Authors	Title	Bibliographic detail
4.12	Anderson, S., Trotter, M., Haling, R., Edwards, C., Guppy, C., Lamb, D.	Exploring the potential for site specific nitrogen management in grazing systems	In: Betteridge, K. (Ed.), 3rd Australian and New Zealand Spatially Enabled Livestock Management Symposium. AgResearch, Lincoln, New Zealand, p. 25.
4.12	Barnes, P., Wilson, B.R., Reid, N., Koen, T.B., Lockwood, P., Lamb, D.W.	Litterfall and associated nutrient pools extend beyond the canopy of scattered eucalypt trees in temperate pastures	Plant and Soil 345:339–352 (DOI 10.1007/s11104-011-0786-y)
4.12	Barnes, P., Wilson, B.R., Trotter, M.G., Lamb, D.W., Reid, N. & Koen, T.	The patterns of grazed pasture associated with scattered trees across an Australian temperate landscape: an investigation of pasture quantity and quality	Rangeland Journal 33:121-130.
4.12	Barron, J., Trotter, M., Guppy, C., Haling, R., Lamb, D.	Using common PA tools and GPS livestock tracking to examine the variability in soil nutrients across grazing landscapes	In: Betteridge, K. (Ed.), 3rd Australian and New Zealand Spatially Enabled Livestock Management Symposium. AgResearch, Lincoln, New Zealand, p. 27.
4.12	Donald, G., Trotter, M. & Lamb D.W.	The impact of the availability and rate of growth of pasture on livestock productivity at a regional scale	2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12	Donald, G.E., Trotter, M., Lamb, D.	The impact of the availability and rate of growth of pasture on livestock productivity at a regional scale.	In: Gonzalez, L., Trotter, M. (Eds.), 2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12	Falzon, G., Lamb, D.W. & Schneider, D.	The Dynamic Aerial Survey algorithm architecture and its use in airborne fertilizer applications.	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. January 2012
4.12	Falzon, G., Lamb, D.W. & Schneider, D.	On-the-go forecasting of crop reflectance indices for controlling aerial prescription applications.	2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.

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4.12 Falzon, G., Trotter, M., Lamb D.W. & Schneider, D.	Functional data analysis tools for the livestock science researcher	2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12 Garraway, E., Lamb, D.W.	Delineating spatial variations in soil carbon using remotely sensed data: A New England case study	Proceedings of the 2011 Regional Convention, Newcastle Division, Engineers Australia (R. Patterson Ed.), (Newcastle Division Engineers Australia: Newcastle West, Australia), University of New England, Armidale. NSW 16th-18th September 2011. ISBN 978-0-85825-870-9, 45-52
4.12 Holl, K.H., Lamb, D.W. & Schepers, J.S.	Radiometry of Proximal Active Optical Sensors (AOS) for Agricultural Sensing	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 5 (6), 10.1109/JSTARS.2012.2198049.
4.12 Lamb D.W., Donald, G.E., Stovold, R.G. . & Trotter, M.G	Towards a landscape systems-based forage assessment tool for the Kimberly region of Western Australia	2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12 Lamb, D.W.	Active reflectance sensors for crops and pastures. Is the sky the limit?	2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12 Schaefer, M.T., Lamb, D.W. & Bradbury, R.	A comparison of two ranging approaches to an integrated active, optical, reflectance and ranging sensor	Proceedings of the Biennial Conference of the Australian Society for Engineering in Agriculture (SEAg), published by SEAg ISBN 978 085825 982 9, (Editors: T. Banhazi, C. Saunders & R.Hegarty)- 29-30 of September 2011, Surfers Paradise, Queensland, Australia, 298-306.

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4.12	Schaefer, M.T., Lamb, D.W. & Bradbury, R.	ORRS- an integrated, active, optical reflectance and ranging sensor for crop canopies.	2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12	Schneider, D., Trotter, M., Schneider, R. & Lamb D.W.	Comparing spatial landscape utilisation estimates for livestock land managers and GPS collars	2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 Sept 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12	Taylor, D.B., Schneider, D.A., Brown, W.Y., Price, I.R., Trotter, M.G., Lamb, D.W. & Hinch, G.N.	GPS observation of shelter utilization by merino ewes.	Animal Production Science 51:724-737.
4.12	Trotter, M.	Applications of autonomous spatial livestock monitoring in commercial grazing systems.	In: Gonzalez, L., Trotter, M. (Eds.), 2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.
4.12	Trotter, M.	Establishing and testing a Taggle® real-time autonomous spatial livestock monitoring system	In: Betteridge, K. (Ed.), 3rd Australian and New Zealand Spatially Enabled Livestock Management Symposium. Agresearch Grasslands, Lincoln, New Zealand, p. 23.
4.12	Trotter, M., Falzon, G., Dobos, R., Hinch G., Roberts, J. & Lamb D.W.	Progress in developing grazing behaviour models from spatio-temporal data	2nd Australian and New Zealand Spatially-enabled Livestock Management Symposium, 2011 CIGR International Conference of the Australian Society for Engineering in Agriculture 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 Sept 'Engineering in Agriculture - Diverse Challenges Innovative Solutions'. 28-30 September, Surfers Paradise.

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4.12	Yerbrury, M., Walkden-Brown, S., Trotter, M.	Spatial landscape utilisation by sheep and its relationship to individual productivity and health	In: Betteridge, K. (Ed.), 3rd Australian and New Zealand Spatially Enabled Livestock Management Symposium. AgResearch, Lincoln, New Zealand, p. 11.
4.15	Lowell, K., Christy, B., Benke, K., Day, G.	Modelling fundamentals and the quantification and spatial presentation of uncertainty.	Journal of Spatial Science: Vol 56/No.2/ Dec 2011
4.15	M. Tanase, R. Panciera	PLIS polarimetric and radiometric calibration	Project report/Internal document distributed via the web
4.15	Panciera, R., Walker, J.P., Kalma, J., Kim, E.	A Proposed Extension to the SMOS Level 2 Algorithm for Mixed Forest and Moderate Vegetation Pixels	Remote Sensing of Environment, doi: 10.1016/j.rse.2011.07.017, 2011.
4.31	Simon Grose (CIO)	Ergon Energy to switch on spatial data collection project	http://www.cio.com.au/article/407286/ergon_energy_switch_spatial_data_collection_project/
4.31	Troy Bruggemann	Compensation of Unmodeled Aircraft Dynamics in Airborne Inspection of Linear Infrastructure Assets	Australian Control Conference (AUCC), Melbourne, Nov 2011
4.31	Troy Bruggemann & Jason J. Ford	Guidance of Aircraft in Periodic Inspection Tasks	Australian Control Conference (AUCC), Melbourne, Nov 2011
4.31	Zhengrong Li, Troy S. Bruggemann, Jason J. Ford, Luis Mejias, Yuee Liu.	Toward automated power line corridor monitoring using advanced aircraft control and multisource feature fusion	Journal of Field Robotics, DOI: 10.1002/rob.20424
4.44	Mullan, N., Boyd, J., Koning, P., Butler, D., Veenendaal, B., West, G. & Semmens, J.	The impact of Australian spatial data infrastructures on geocoded health data.	Proc. International Geocoding Conference, December 2011
4.51	Bachels, M. & Newman, P.	Technologies for Climate Change Mitigations - Transport	Chapter 3, Section E. TNA Guidebook Series, UNEP Riso Centre for Energy, Climate and Sustainable Development, pp: 71-84
4.51	Beattie, C., Newman P.	The density trade-off: Does High Rise Construction Contribute more than Single Dwellings to Greenhouse Gas Emissions?	State of Australian Cities Conference, Melbourne, 29 November - 1st December 2011
4.51	Newman, P.	Sustaining our future: resolving the conflict over population models	International Congress on Modelling and Simulation (MODISM) Conference, Perth 12-16 December 2011
4.51	Newman, P., & Kenworthy, J.	Evaluating the Transport Sector's Contribution to Greenhouse Gas Emissions and Energy Consumption.	Chapter 2 in Salter, R., Dhar, S. And Newman P. (eds) Technologies for Climate Change Mitigation - Transport, TNA Guidebook series, UNEP Riso Centre for Energy, Climate and Sustainable Development, pp: 71-84
4.51	Newman, P., Beatley, T.	Resilience Planning: Forging a New Planning Paradigm.	Proceedings World Planning Schools Conference, Perth WA, 4 - 8 July, 2011
4.51	Newman, P., Kenworthy	The Density Multiplier: A response to Mees	World Transport Policy and Practice 17 (3):32-44

Program/ Project	Authors	Title	Bibliographic detail
4.51	Newman, P., Rauland, V . & Holden, D	Creating resilient cities	Newman, P, Holden, D, and Rauland, V. 2011. Creating Resilient Cities. State of Australian Cities 2011, 29/11/2011. Melbourne, Australia: State of Australian Cities National Conference 2011 SOAC Conference, Melbourne 29 November - 1st December 2011
4.51	Peter Newman	Wide Open Road: how did Australia plan pedestrians, cyclists and transit out of its cities.	The Conversation (expert news and views) 24/10/2011
IFCI	Lehmann, E., Caccetta, P., Zhou, Z-S., McNeill, S.J., Wu, X. & Mitchell, A.L.	Joint processing of Landsat and ALOS PALSAR data for forest mapping and monitoring.	IEEE Transactions on Geoscience and Remote Sensing (TGRS), Vol 50, 1: 55-67.
IFCI	Lehmann, E., Zhou, Z.-S., Caccetta, P., Mitchell, A., Milne, T., Lowell, K., McNeill, S.	Combined analysis of SAR and optical remote sensing data for forest mapping and monitoring.	Proceedings: 7th International Symposium on Digital Earth. August, Perth, Australia.
IFCI	Lowell, K., Held, A., Milne, T., Mitchell, A., Tapley, I., Caccetta, P.,	Areal sample units for accuracy evaluation of single-date and multi-temporal image classifications.	Proceedings: Accuracy 2012 (in prep.). Lehmann, E., Zhou, Z. Florianopolis, Brazil.
IFCI	Mitchell, A., Milne, T., Tapley, I., Lowell, K., . Caccetta, P., Lehmann, E., Zhou, Z.-S	Interoperability of radar and optical data for forest information assessment.	Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS) 2011. July, Vancouver, Canada.
IFCI	Mitchell, A.L., Tapley, I., Milne, A.K. & Williams, M.	GEO Forest Carbon Tracking Tasmania National Demonstrator: Radar processing methodologies for generation of forest information products.	Technical document, Vol II, 93 pp.
IFCI	Mitchell, A.L., Tapley, I., Milne, A.K. & Williams, M.	GEO Forest Carbon Tracking Tasmania National Demonstrator: Radar processing methodologies for generation of wall-to-wall mosaics.	Technical document, Vol I, 71 pp.
IFCI	Mitchell, A.L., Williams, M.L. & Milne, A.K.	Forest and forest changemapping using SAR data and a robust classification methodology.	Proceedings: 32nd Asian Conference on Remote Sensing, October, Taiwan.
IFCI	Zhou, Z-S., Lehmann, E., Wu, X., Cacetta, P., Mitchell, A., Tapley, I., Lowell, K., Milne, T.	Practices of Terrain Slope Correction and Precise Registration of SAR Data for Forest Mapping and Carbon Tracking in Tasmania.	Proceedings: 34th International Symposium on Remote Sensing of the Environment, April, Sydney, Australia.
IFCI	Zhou, Z.-S., Cacetta, P., Lehmann, E., McNeill, S., Mitchell, A., Milne, T., Tapley, I., Lowell, K.	Dual polarised entropy/alpha decomposition and coherence optimisation for improved forest biomass mapping.	Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS) 2011. July, Vancouver, Canada.
Misc	Albrecht, T., Tan, T., West, G. & Li, T.	Vision-based attention in maritime environments.	Proc. 8th Int. Conf. on Information, Communications and Signal Processing, Singapore, December 2011.
Misc	Albrecht, T., West, G., Tan, T. & Ly, T.	Visual maritime attention using multiple low-level features and naive Bayes classification.	Proc. DICTA 2011: Digital Imaging, Computing, Techniques and Applications, Noosa, Queensland, December 2011

Program/ Project	Authors	Title	Bibliographic detail
Misc	Michael F. Goodchild, Guo Huadong, Alessandro Annoni, Ling Bian, Kees de Bie, Fred Campbell, Max Craglia, Manfred Ehlers, John van Genderen, Davina Jackson, Anthony J. Lewis, Martino Pesaresi, Gabor Remetey-Fülöpp, Richard Simpson, Andrew Skidmore, Changlin Wang, and Peter Woodgate	Next Generation Digital Earth.	Proceedings of the U.S. National Academy of Science, June 21, 2012,doi:10.1073/pnas.1202383109
Misc	West, G.& Jones, T.	Dynamic visualisation of tourism impact in the Ningaloo region.	Proc. ISDE7: 7th Int. Symp. on Digital Earth, Perth, WA, August 2011.
Misc	Max Craglia, Kees de Bie, Davina Jackson, Martino Pesaresi, Gabor Remetey-Fülöpp, Changlin Wang, Aless&ro Annoni, Ling Bian, Fred Campbell, Manfred Ehlers, John van Genderen, Michael F. Goodchild, Huadong Guo, Anthony J. Lewis, Richard Simpson, Drew Skidmore, & Peter Woodgate	Digital Earth 2020: Towards the vision for the next decade	International Journal of Digital Earth, Vol. 5,Issue1, June 2012.

6 Appendix 2 – Phd Completions 2010-12

Name	Title of Thesis	Graduating University	CRCSI Program
Anna Donets	Using Single Receiver GPS Observations to Analyze the Dynamic Motion of Large Engineering Structures.	Melbourne	1
Jun Wang	RTK Integrity.	QUT	1
Michael Filmer	An Examination of the Australian Height Datum.	Curtin	1
Kui Zhang	Advanced InSAR Technologies.	UNSW	2
Eric Zhengrong Li	Aerial Image Analysis Using Spiking Neural Networks with Application to Power Line Corridor Monitoring.	QUT	2
Alex Ng	PsinSAR Radar Interferometry.	UNSW	2
Adam Roff	Hyperspectral Imagery for Vegetation Management.	UNSW	2
Michael Day	Hyperspectral Remote Sensing for Land Management Applications.	UNSW	2
Matthew Hutchison	Developing an Agent-Based Framework for Intelligent Geocoding.	Curtin	3
Marco Marinelli	Assessing Error Effects in Critical Application Areas.	Curtin	3
Jiang Li	Intelligent Object Placement and Scaling in Virtual Decision Environments.	Melbourne	4
Marcos Nino-Ruiz	Application of Rural Landscape Visualisation for Decision Making and Policy Development.	Melbourne	4
Roman Trubka	Agglomeration Economies in Australian Cities: Productivity benefits of increasing density and accessibility by way of urban transport infrastructure planning.	Curtin	4
Pan Peter Wang	Real-Time Data Visualisation in Collaborative Virtual Environments for Emergency Management.	Melbourne	4
Tao Chen	Augmented Reality Integration and Live Communication between GIS and SIEVE.	Melbourne	4
Haohui Chen	Collaborative Virtual Environment for Knowledge Management - A New Paradigm for Distributed Communications.	Melbourne	4

