The RSA Program

A fast track user-driven initiative to rapidly add value to your spatial data

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Table of Contents

1 Introduction

In a world were new technologies and data forms appear on a daily basis, the urgency to adapt to change in real-time is evident. More and more organisations and end users are now dealing with large volumes of data, from more and multiple sources, often disconnected, and being updated more frequently than ever before. This data overflow has led to the emergence of new global issues in the spatial information data management domain. In an attempt to deal with the current challenges, the international community is joining efforts to move quickly. Working collaboratively, using open source standards and cloud-based infrastructures where 'all' (data, analysis, processes, platforms) is run as a service, seem to be some of the key trends at the moment [6] [7].

The CRCSI has recognised the importance that such adaptation has in the spatial information domain, and is responding to it with a new Program aimed at tackling these challenges. The Rapid Spatial Analytics (RSA) Program is a CRCSI initiative designed to deliver high impact user-driven research to improve the ability and efficiency of government and industry to rapidly create spatial information products using mobile and cloud infrastructure.

In order to accurately respond to the current end user needs in the RSA domain, the RSA Program started with a Consultation Phase, which included an Open Call for Expression of Interest as well as a number of parallel information-gathering activities. This initiative was positively received by both internal and external Australian and New Zealand stakeholders, who replied with their current needs, ideas and research proposals. The process culminated with a one-day workshop run in Melbourne where 18 participants, representative of industry, government and the research community, exchanged their views and ideas to generate material for project proposals to be run as part of the RSA Program.

This report presents the RSA Program initiative and its characteristics, the RSA Consultation Phase process and the RSA Workshop as it happened, including the most relevant discussions and its outcomes. The report is structured as follows: Chapter 2 explains the RSA Program Vision, its timeline, requirements for projects and the themes that it encompasses. Chapter 3 presents the Consultation phase, whereas Chapter 4 focuses on the RSA Workshop and its outcomes. Finally, the results so far obtained and next steps are summarised in the Conclusions. Acknowledgments, and a number of complementary Appendices complete the document.

2 The Rapid Spatial Analytics Program vision

The Rapid Spatial Analytics (RSA) Program vision is centred on the word 'Rapid', which applies not only to the research areas and technology tackled, but also to the way this initiative is going to be run: through fast-track projects delivering value-added results over a short period of time. In this way, the RSA Program combines all the ingredients for success, and takes the unprecedented step of generating applied-research projects emerging from the real needs of partners while fostering openness and collaboration.

2.1 The timeline

The RSA program started with an *Idea Generation phase*, which was kicked-off via a Consultation process, involving CRCSI internal partners and external national and international stakeholders. A key element of this phase was the RSA Workshop that took place on 21 July 2015. This was a closed event, involved a selected group of partners, and was invaluable to identify the most relevant ideas for project proposals and partners interest.

Figure 1. Rapid Spatial Analytics Program Timeline

The projects *Initiation phase* will commence with the presentation of the Outline Project Proposals to all the stakeholders that have expressed interest in the RSA initiative, both internal and external. This will allow the RSA Program to target the right areas of research and applications, avoid duplication, and secure strong project partnership involving the most relevant organisations in the field at national and international level. Upon funding approval from the CRCSI Research Investment Committee (RIC) (November 2015), the Projects will kick-off in January 2016 with users being able to operationally benefit from the project results in a record time of no more than 18 months.

2.2 The projects

The RSA Program is fast-paced and ambitious, and only a selected number of projects (ie two to three) will be considered for initial funding. For it to be successful, a clear well-structured and flexible implementation is being put in place by selecting the right:

1. **Projects:** strong end user driven quality proposals with a clear utilisation plan, backed up by a highly qualified mix of partners (industry, government, research organisations), including a clear research component.
2. **Partners:** collaborative, open and results-oriented, clearly committed by providing contributions towards the project (in cash and/or in kind resources), linked to clients and willing to perform applied-research.
3. **Structure:** three different project structures provide flexibility and adapt to the needs of different Project Proposal. These are: Major (total project cost > AU$150k, cash requests >AU$50k), Minor (total project cost < AU$150k, cash requests < AU$50k), Exceptional Spatial Ideas (revolutionary ideas with strong impact potential in the spatial area, with the prospect of building new

partnerships, that do not fit in an RSA project, cash requests < AU$100k). In addition, the Program promotes cross-area collaboration by allowing commissioning of RSA work to existing with CRCSI initiatives whenever relevant.

2.3 The themes

The RSA Program revolves around five carefully selected themes: **Spatial Workflows, Real-Time Spatial Analytics, Big Spatial Analytics, Foundational Spatial Analytics** and **Visualisation and Decision-Making**. These are representative of the end user needs to tackle new avenues of research in the area of spatial analytics. The themes have been identified by the CRCSI through consultation with internal, external, national and international stakeholders in an iterative process that culminated with the RSA Workshop. More information on the process for Themes definition is in the Consultation phase Section.

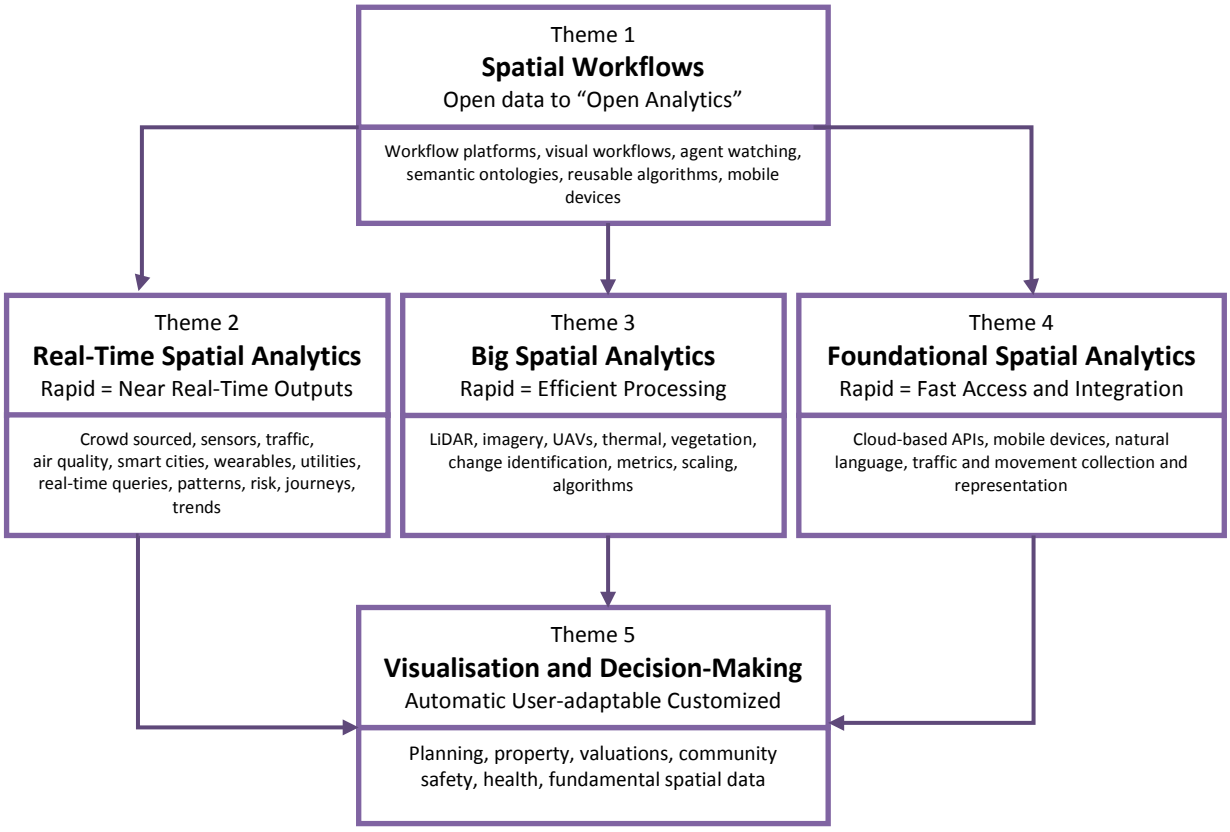


Figure 2. The Rapid Spatial Analytics Program Themes

Figure 2 depicts how 'Spatial Workflows' serves an overlay to cover and enable the remaining themes, whereas 'Visualisation and Decision-Making' is a common output for data communication and representation for all themes. The term 'Rapid' is present in each and every theme, but what does rapid mean then? Here the concept has different meanings for each area of application. Rapid can be 'near real-time provision of outputs' (Real-Time Spatial Analytics), it is also means 'efficient processing' (Big Spatial Analytics) and is 'fast access and integration of data' (Foundational Spatial Analytics).

3 The Consultation phase

Prior to launching the RSA initiative the CRCSI undertook a four-week consultation phase. The aim of the consultation was to determine the urgency and relevance such as initiative is for the CRCSI partners, and to investigate the novelty of the proposal in the research world.

3.1 The Open Call for Expressions of Interest

The process started on 29 May 2015 with an Open-Call for Expressions of Interest (EOI) sent to CRCSI partners and related stakeholders. The themes proposed at the time were only three: Big Data Analytics, Real-Time Analytics, and Spatial Analytics Workflows.

Table 1. RSA Pre-consultation Themes

Pre-Consultation RSA Themes	Description
Big Data Analytics	Efficient large volume data processing to derive useful products and visualisations.
Real-Time Analytics	Continuously streaming data that provides near real-time processing and outputs.
Spatial Analytics Work	To help spatial analysts create, execute, and share analytical models and analyses across spatial disciplines to address common needs

In order to stimulate a fast reply to the Call, the timeline for EOIs collection was set to only one week. This was followed-up by the RSA team over the following weeks, which serve to consolidate the partners' interests and to ensure all potentially interested parties were aware of the initiative. The results were extremely positive.

The high interest obtained from both partners and the research community corroborated the importance of the three proposed themes. A total of 21 CRCSI partners – representative of government, industry and research – expressed interest in participating in the RSA Workshop and submitted a copious amount of project ideas. However, not only the CRCSI-community was enthusiastic about it. The fact that seven other external organisations expressed interest in the RSA initiative is a clear indication of the relevance of the Program.

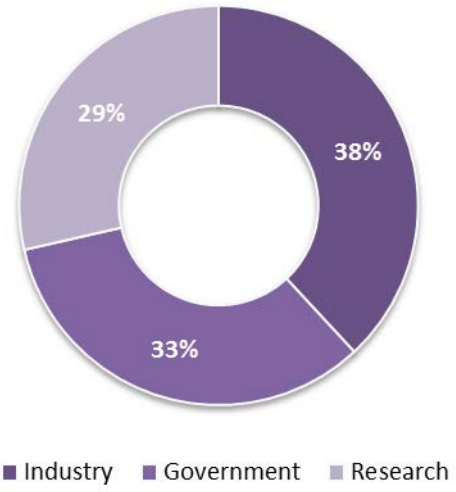


Figure 3. Distribution of type of CRCSI Participants replying to the RSA Call

The RSA Workshop originally envisaged 12 attendees. Due to the quality and relevance of the project ideas, this number was finally extended to 18. In order to select the Workshop participants, the CRCSI established a set of criteria. Priority was given to CRCSI participants first, with a strong emphasis on industrial partners and governmental organisations. Researchers and University representatives were invited according to the relevance of their proposals with respect to the first two groups interests and needs. Due to the Workshop restricted number of participants, a number of CRCSI interested partners, such as Biomedware, Amristar or the Department of Primary Industries, Parks, Water and Environment (Tasmania) could not attend. However, in order to make the process as transparent as possible, the Workshop findings will be made public and an open post-Workshop consultation will be held to welcome additional key participants.

From the analysis performed on the number of ideas, the initial three RSA themes were expanded to five, giving birth to the previously presented RSA Program Themes. The ideas submitted by the partners and selected by the RSA team as representative of potential projects were classified along the five themes, as shown in Table 2.

Table 2. Number of potential Project Proposals from Workshop participants at Consultation Phase.

Partners	Theme 1 Spatial Workflows	Theme 2 Real-Time Spatial Analytics	Theme 3 Big Spatial Analytics	Theme 4 Foundational Spatial Analytics	Theme 5 Visualisation & Decision-making
AAM	1	1	1		
GHD		3	1		2
Jacobs	1	1	1		
Land Surveys					
NGIS		2	1		1
VPAC Innovations	2	1	1		1
DEWLP	1		1	1	
DSITI			1		
GA				1	1
Landgate				2	2
LINZ		1	1	1	
LPI				1	
Canterbury		1			
Curtin		1			
QUT	4	3			1
RMIT		1			
Swinburne	1	1	1		1
UNSW			1		

Color code: Industry – Green; Government – Orange; Universities – Blue

Partners Acronyms: DELWP (Department of Environment, Land, Water and Planning, Victoria, Australia), DSITI (Department of Science, Information Technology and Innovation, Queensland, Australia), GA (Geoscience Australia), Landgate Western Australia, LINZ (Land Information New Zealand), LPI (Land and Property Information New South Wales, Australia), University of Canterbury, Curtin University, QUT (Queensland University of Technology), RMIT University, Swinburne University of Technology, UNSW (University of New South Wales).

3.2 CRCSI, National and International RSA-related initiatives

In addition to the Call for EOI process, a number of parallel activities were carried out during the Consultation Phase. These included bilateral discussions with the CRCSI Program Managers, State-of-the-Art (SoA) research on national/international RSA-related projects, and conversations with renowned RSA key-players to gather potential interest from external partners.

Table 3. CRCSI RSA-related projects

RSA Themes	CRCSI Relevant Projects
1. Spatial Workflows	2.09 – QA4LiDAR LiDAR Quality Assurance Tool, 3.02 – Integration of Search Tools / Investigating Governance Along Supply Chains / Provenance / A Trusted Model for Crowd-sourced Data, 4.17 – Big Data Solutions for Environmental Monitoring
2. Real-Time Spatial Analytics	3.02 – Crowdsourcing& Spatial Data Infrastructure
3. Big Spatial Analytics	2.01 Mobile and Terrestrial Mapping, 2.02 Urban Feature Extraction, 2.07 Woody Vegetation, 2.14 Victorian Rivers
4. Foundational Spatial Analytics	3.02 Spatial Data Supply Modelling in Australia and New Zealand, 4.55 – Greening the Greyfields
5. Visualisation and Decision-making	4.4 – Healthtracks and Epiphanee

A number of CRCSI existing projects have strong links to the RSA Themes, which indicates prospective areas of collaboration. The identified projects could find in the new Program 2 initiative the framework to investigate urgent RSA-related questions, whereas the RSA program could leverage on these CRCSI projects existing results, infrastructure and expertise.

The results of the SoA research lead to the identification of relevant national and international organisations and projects linked to RSA, as shown in Figure 4, some of which participated with inputs in the RSA Consultation phase. At national level, the RSA team established contact and had extensive conversations with National ICT Australia (NICTA), who is a key player in the areas of Big Data and Real-Time Analytics [1]. NICTA was a valuable contributor, expressed their interest in collaborating with the RSA initiative, and facilitated the link to UNSW and Swinburne who resulted in great additions to the RSA Workshop. The Terrestrial Ecosystem Research Network (TERN) at National level [2] and the Workflows for Data Science Centre of Excellence (WorDS) in the US [3], provided high-value insights into applicability of Scientific Workflows to Spatial Analytics.

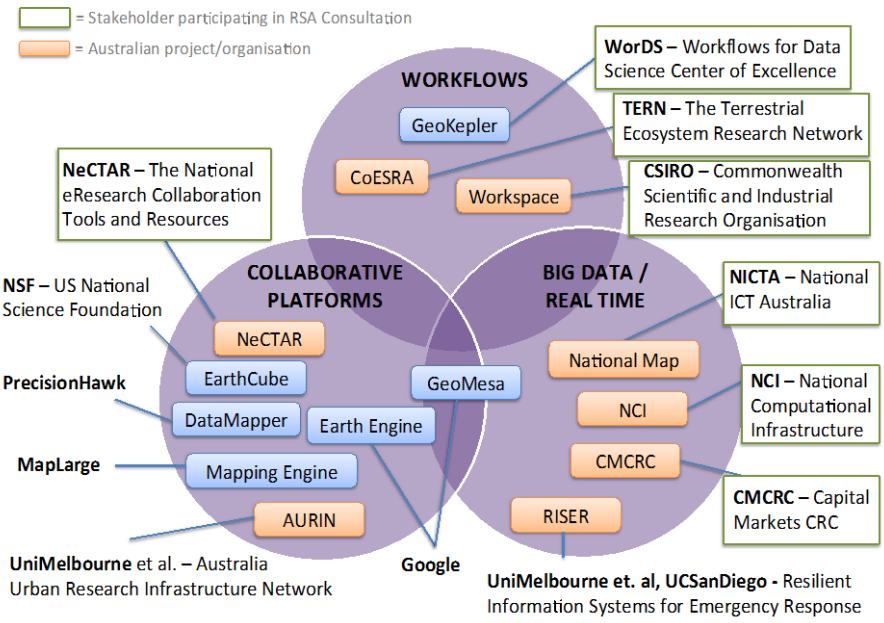


Figure 4. *Relevant National and International RSA-related organisations and projects*

Other Australian organisations expressing interest in the initiative were the National eResearch Collaboration Tools and Resources (NeCTAR) [4], the Capital Markets Collaborative Research Centre (CMCRC) [5] and the University of Notre Dame.

4 RSA Workshop: listening to partners

The CRCSI RSA Workshop was shaped as a collaborative one-day event and took place on 21 July 2015 at Graduate House (The University of Melbourne), Victoria. The event was defined and coordinated by Dr Nathan Quadros (Program 2 Manager), Prof Matt Duckham (CRCSI Program 2 Science Director), and Eva Rodriguez Rodriguez (Workshop Project Manager). Dr Peter Woodgate (CRCSI CEO) participated as key speaker opening the event, and Dr Phil Collier (CRCSI Research Director) contributed as facilitator in the Group sessions and as key speaker at the event closure.

4.1 Summary of the event

The day started with the challenging objective of defining two to four projects outline proposals with clear associated partnerships. An equally represented number of industry, government and research participants filled the room. The organisers' priority was to use the workshop as a place for discussion, where all parties could express their emerging issues and priorities in the RSA research, and to consolidate these into projects. This was achieved thanks to the use of working groups along the five CRCSI-proposed Project Themes, starting with a whole-room discussion in the morning and narrowing it down to Focus Groups in the afternoon, see RSA Workshop Agenda for details.

In numbers, the Workshop included 51 initial project ideas, 18 (selected) participants, 100% attendance, three CRCSI facilitators, five presentations and three (out of six) Group Sessions. The organisers distributed an RSA Workshop Brief, which details all the list of participants and proposals.

The outcome is also numeric: the event resulted in four specific project ideas shaped by partners, which will form the basis for the RSA Program projects, and a 100% positive feedback received from the participants.

4.2 Session 1: Setting the Scene

The session started with an introduction by the CRCSIs CEO Dr Peter Woodgate. Dr Woodgate emphasised the urgency of a Program such as the RSA focused specifically on 'doing things faster' and the great opportunity that it presented as a 'greenfield' program to be shaped and moulded by the CRCSI partners for their maximum benefit. He mentioned the need to focus on the production of value through the delivery of near-real time information products, and how Program 2 'rapid' nature fit perfectly on the CRCSIs Long Term Strategic Plan by being a clear link to other CRCSI Programs, such as Program 3 (Infrastructure) and Program 4 (Applications). Dr Woodgate also stressed the relevance of the RSA Program at National level, through its alignment with the work being conducted by the Federal Government on Critical Infrastructure risk assessment and its reliance on space and spatial assets and their supply chains.

Dr Peter Woodgate, CRCSIs CEO, opened the

"(The Workshop provided) networking opportunities, ideas about the CRCSI and its activities, some new ideas for our own project work (…) overall a well run workshop – better than many I have attended!"
– John Grundy, Swinburne University

Dr Nathan Quadros talked about Program 2 structure and highlighted the need for RSA end-user driven projects focused on utilisation, and the requirement to have a clear research component per project. He also explained the aim of the RSA Program to be a referent in terms of the quality of its projects, prospective impact and return-on-investment. He highlighted

that the current level of Program funding (AU$800k-$1M) could be increased or decreased, and that this was directly correlated to the level of excellence of the project proposals. He finished mentioning the flexibility of the RSA Program to include projects with various structures and budgets.

"AAM gained insight into the wider topics and industry drivers for RSA.I specially gained the impression that Cloud-based processing infrastructure is key to the future of RSA. – John Blackburn, AAM.

Nathan's introduction was followed by an overview of national and international RSA-related technology and research trends, given by Eva Rodriguez. On top of providing examples of relevant organisations and projects operating in the RSA domain, she highlighted the opportunistic timing of this new Program 2 initiative and its alignment with the international community collaboration efforts in areas such as Linked Data, Cloud-Computing and Open Source, as well as in the field of Real-Time and Data Visualisation. The need of moving from Big Data to Smart data, solving the lack of provenance data and enabling reusability of both data and spatial analytics processes were discussed. Ms Rodriguez also talked about the potential of the RSA program on targeting Spatial (Scientific) Workflows and Open Collaborative platforms as a promising way to provisioning Smart Spatial Vertical Solutions.

"Personally, as Service Line Leader for Spatial at GHD I need to be learning and across challenges and 'trends' in the industry. Workshops such as this give me much to think about – which is perfect". – Kate Williams, GHD

This introductory session was closed by Prof Matt Duckham, RSA Program Science Director, who provided participants with an answer to the question: 'Why should I participate in the RSA Program?' Matt provided a convincing answer by stressing the fact that the RSA program not only fills the gap in the CRCSI portfolio, but also that it is a program that looks at "sharing not just data, but sharing the underlying knowledge and expertise". He concluded his talk by talking about the benefits that could be achieved by adding intelligence to our data and applications, and how the Program is looking at connecting topics like real time analytics, big data, crowdsourcing, and cloud computing from in an applied-research environment.

4.3 Session 2: Potential Projects

Dr Nathan Quadros provided an overview of the RSA Program (Section 2) objectives and characteristics, and Peter Woodgate highlighted the flexibility of the program to accommodate fast track projects (less than 18 months) if needed. Nathan presented the five themes for project ideas: Spatial Workflows, Real-Time Spatial Analytics, Big Spatial Analytics, Foundational Spatial Analytics and Visualisation/ Decision-making; and explained the vision of having the first RSA Projects as 'foundation' projects, from which to grow and expands in terms of R&D complexity and areas of application. For each Theme, Dr Quadros presented a draft project idea, which served to start and stimulate the discussion. With the RSA program focus on open-source, some of the participants questioned the length of the process to release open source knowledge and/ or products. This was clarified by Peter Woodgate, who explained CRCSIs inclination to this approach, with some of the participants corroborating the successful results that it had provided in the past. Initial discussions started around some of the presented ideas such as the concept and definition of movement (linked to the idea 'Rapid Visualisation of Movement') or the interest in understanding how to rapidly publish information to users, specially providing information for a

Participants expressed their needs during the open discussions

"Clients are interested on regimes rather than on single events" – Milos Pelikan, Jacobs

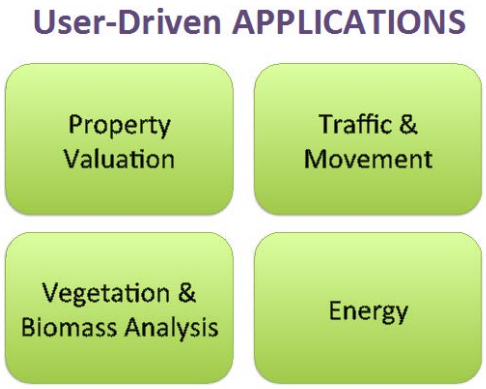
regime of time (linked to the idea of 'Continuously Streaming Data that Provides Near Real-Time Outputs'). Such discussions continued until the first break of the day.

4.4 Session 3: Group Session on Applications

The focus of the first Group Session was to establish the RSA-related needs and problems currently experienced by end-users. Through an open discussion, participants in the room actively expressed their views, with ideas mainly generated by industry and government partners as representative of the end-users. The session started with the five CRCSI-proposed Themes, and by the end of it, four areas of Application had been identified as the most recurring themes: Property and Valuation, Traffic/ Movement, Vegetation/Biomass Analysis, and Energy. A fifth category – Workflows – was identified as a key functional area.

> *"The opportunity to listen to and learn from end users in industry and government was particularly valuable (…) understanding more of the CRCSI structure (…). Canterbury was able to gain a better understanding of the end users priorities and needs."– Malcolm Campbell, University of Canterbury*

Property and valuations was the mostly supported area of interest, especially because valuation-related data sources are a link to many other areas of application such as natural hazards, air quality or health services. Several participants expressed the need to move from current heuristic methods (inefficient to manage millions of valuations per year) to improved, robust, and more automated valuation processes and light-weight user-friendly solutions. With some of the property issues arising from the cadastre management, it is important to look into how to connect this (the cadastre) to new sources of information, and to how to incorporate and deliver updates of data. Key questions that RSA could address in the area of valuation are: What gives value to a property? How to know which data sources and datasets are relevant and trustworthy? And how can we make the processes transparent? Researchers in the room talked about mobile applications for field on-spot decision making and about the need to turn changes in data into 'meaningful events'.



The discussion on Traffic and Movement orbited around the need for improved decision-making visualisation tools capable of capturing movement, with areas of application such as traffic or agriculture (cattle monitoring). Health was a clearly present topic, aligned with current government policies on promoting increased levels of mobility and activity in the population. Participants showed interest in using spatial information retrieved from wearables and sensors to extract 'real-time personalized information' which, once integrated with indicators such as air quality, could provide doctors with a holistic health record.

> *"What we need to know is: how to reduce time to market, how to save money, how to do things in a new and more efficient way. Which application can deliver that?" – Simon Costello, Geoscience Australia*

Change identification, attribution and verification were relevant requirements linked to Vegetation and Biomass Analysis. New and improved metrics and the need for integration of datasets were also pointed out. The use of spatial analytics to provide cost-benefits evidence and motivate the uptake of Renewable energies was another interesting topic. With one of the current issues being still the cumbersome process of performing building shadowing analysis (often manually on a one-by-one building basis), a new avenue could be to use the RSA program to investigate the potential of models for solar-

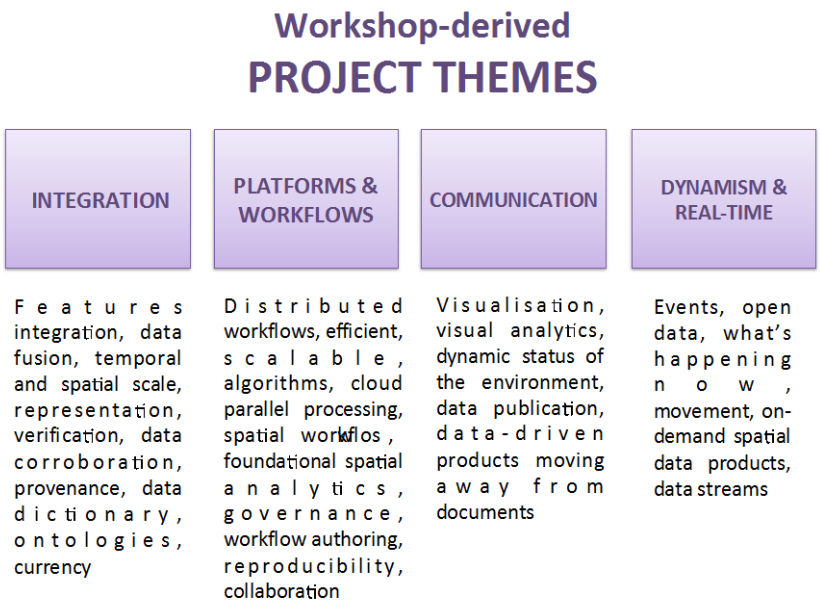
energy generation per suburbs. Other ideas in this area included the use of meteorological data for near real time building-shadow forecasting.

> *"It was good to be able to hear the perspectives and discuss the points of view and needs of other CRCSI partners. Through this discussion it was pleasing to identify some critical mass around possible valuations focused work and to understand that Landgate, LPI and and LINZ have some common challenges which could begin to be addressed through Program 2." – Brendon McAtee, Landgate*

Many other potential RSA areas of application were discussed. Some of the most relevant including: the integration of spatial world (analytics and data) into the Web and Cloud, investigating how to extract value from upcoming meteorological satellite imagery, user-dependent data presentation, real-time data packaging, data querying and accessibility provision or how to generate value-added products by connecting utility (light, water, gas) and government networks in a meaningful way.

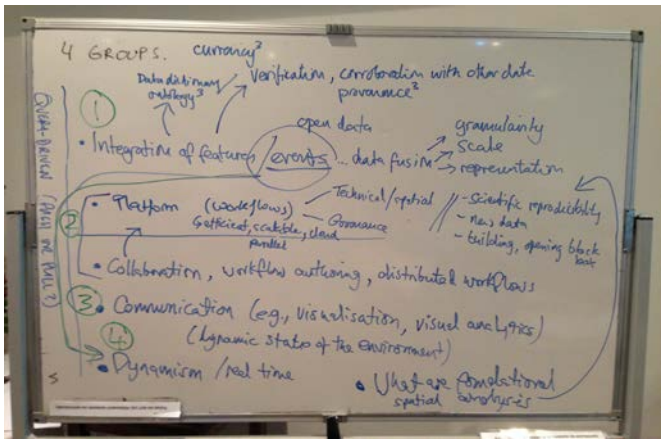
4.5 Session 4: Group Session on Research Questions

Taking as staring point the applications resulting from Session 3, the afternoon started by asking the questions: 'What do all these areas share as problems/ need for research?' and 'What is rapid?'. The room participants presented ideas, with researchers now taking the leading voice. The proposals were captured on-the-spot by Matt Duckham on a white board, and distributed around the four project themes that formed the basis for the Focus Group session:
(1) Integration
(2) Platforms/Workflows
(3) Communication
(4) Dynamism/Real-Time.



Many of the ideas generated had direct links to the Applications session. The importance of having query-driven processes (allowing push and/or pull of data) was evident and present in all the themes proposed. Workflows are needed as an outcome, they need to be efficient, to provide portability and to be sharable – as all the room participants agreed on. In addition, management of Big Spatial Data sets still presents challenges, and real-time needs will increase in the future, expanding to areas such as illegal forest clearing or on-demand spatial data products for disaster management making use of UAVs, this poses the question: how to integrate new and existing data and to model it in real time? Researchers also expressed the need to not only look at current needs, but also to create infrastructure and platforms to move research further, since future applications cannot always be predicted

> *"What worked really really well was Matt's use of the whiteboard, and engaging attendees. This was most valuable, and timely - just after break - before we went through more discussions in smaller groups. The smaller groups was also confronting but went well, and would recommend it for the future."*
> *- Thomas Werner, Land Surveys.*



Ideas from the second Group session formed four potential Project Themes: Integration, Platforms/ Workflows, Communication and Dynamism/Real-Time

The session was very dynamic and concluded with the different stakeholders positioning themselves in one out of four Focus Groups, linked to Project Themes, according to their key priorities.

4.6 Session 5 and 6: Focus Groups and Consolidation

The Focus Group session was challenging. Participants had one hour to further discuss the initial ideas for Project Proposals in groups, with the aim to fill-in an 'RSA Project Proposal Template' identifying: problem description or case study, research questions, areas of application, targeted users and utilisation, gaps covered, novelty of the proposal and desired outputs, among others. For the Focus Group session, the CRCSI Workshop facilitators placed four flipcharts in different locations of the room, one per theme. One CRCSI facilitator was allocated per group, which helped to moderate and conduct the discussions.

At the end of the session, a representative of each group presented the group findings to the room. The session was extremely collaborative, with all participants providing ideas and feedback to the discussion.

Focus Group 1: Integration

Group 1 participants exchange views and needs around data Integration

QUT, Canterbury, Jacobs, LINZ, LPI, DELWP and Landgate composed Focus Group 1. Brendon McAtee, from Landgate, presented the group's discussion. He highlighted several **Problems** related to Integration, and focused on questions such as: How to integrate disparate datasets (data that changes temporally and spatially) to generate more value from existing data? How to distinguish real data versus virtual data (data whose original feature has been wrongly identified)? How to make the integration (process) generic? Some of the ideas for **Research questions** were related to discovering: what is the process for data integration? How to automate data integration? How to make it dynamic and query-driven? He also talked about the need to develop a process to automatically integrate datasets, which was dynamic, location aware and timely; and how this could be done in a progressive way – starting from less to more datasets. On the implementation side, the group proposed an 18 month project consisting of 12 months research and process development (first) and six months for utilisation, focusing on areas such as **valuation and verification**. Potential project outcomes could be the generation of a **new data product to be added to the Foundational Spatial Data Framework**

(FSDF), and a **dynamic data auditing process** addressed at governmental users. Landgate expressed their interest in becoming project leader.

Focus Group 2: Platform / Workflows

> *"The day was very productive, and went much better than I know some have in the past that I have been involved with. Having the butcher's paper in the room to work with for ideas, concepts and similar was really a good idea, as was having 4 teams and 4 CRC collaborators (…). Thank you for a great day! I look forward to the report so I can reiterate the above to my management." – Thomas Werner, Land Surveys.*

Swinburne University of Technology, VPAC Innovations, Land Surveys and Geoscience Australia formed Group 2. John Grundy, presented the group's discussion outcomes, focused on solving **Problems** such as: How to know which is the most useful data for my needs? How can I access this (useful) data? How can I reuse data to reduce costs? What is data? What is involved in data preparation? How do we make data application independent? As part of ideas for **Research questions**, Group 2 participants pointed at applied research to respond to: How do we put data together to increase value? How do we know where and how to perform a Push or Pull of data? How do we know how/when is it useful to combine data? The group argued that the spatial solutions so far developed in this area are neither scalable nor reusable. They proposed the **development of a framework** first, as part of feasibility study, to understand different types and alternative data sources, derive generic requirements and look at existing Workflow technologies and platforms. The actual **platform** would be developed at a later stage, it would include data pre-processing, data post-processing, and visualisation capabilities, and would be demonstrated in a relevant area of application (e.g. **valuation, traffic, transport, agriculture**). The group also talked about a data repository (linked to the FSDF) as project outcome. Several stakeholders would be project beneficiaries: standardisation organisations, the public, CRCSI partners and external stakeholders with needs to pull & push data. Swinburne and Geoscience Australia expressed their interest in leading such activity, which the group titled as "RSA framework/platform for data value maximisation".

Focus Group 3: Communication

Group 3 was focused on the communication of information. It was composed of RMIT, NGIS and AAM. Matt Duckham, on behalf of RMIT, presented the group ideas. The group focus was the question: **What's happening now?** They look at ways of solving the problem of being able to extract patterns from highly dynamic data, with a number of associated **Research questions** such as: How to make decisions on data that is changing now? How to use that knowledge to make relevant decisions? How to evaluate the impact of such changes? How to measure the usability of visualisation interfaces? Group 3 presented several relevant areas of application linked to this topic such as heat stress, urban sensor networks, epidemiology, traffic and road networks or virtual onboarding (eg for employers in remote locations in business such as oil and gas). They proposed to work on the definition of a **toolkit to allow visualisation of movement** and visualisation of change (including real-time changes). This could be developed through a Workflow, in the form of standard interfaces (eg for mobile phone) providing different (user) views, and demonstrated in a relevant area of application such as traffic.

> *"From a government perspective the Workshop was very useful, and for me it was a good day and I was happy with the results. What was discussed is extremely important for NSW Government, and the Workshop was a great opportunity to put ideas forward and comment on the potential benefits – Bradley Zawodny, LPI*

Focus Group 4: Dynamic and Real-Time Data

Group 4 shares project ideas on Dynamism and Real-Time Data

Focus Group 4, with participants from UNSW, GHD, DSITI and Curtin, discussed some of the **Problems** associated with real-time data: real-time data is not currently included in decision-making processes, most sensor network data are not used, how to understand the meaning of large real-time volumes of data? Looking at **Research Questions** the participants talked about the need to investigate: Which real time data sources are available and can be useful in query, analysis, visualisation and decision making? How to detect anomalies and patterns in real-time data? How to use online models adding prediction? Can we use machine learning to solve these problems? How to get domain experts involved in giving inputs during the initial (machine) learning phase and continuous feedback in real-time? How can we integrate real-time data into Workflows? The group proposed the development of demonstrators in several areas, such as **valuation or traffic**. Such **demonstrators** would cover: **method** for the identification and integration of new useful real-time data sources with existing (non-real-time) sources, **platform** for the assimilation of real-time information providing access to different users and linked to mobile devices, and the capability to integrate the above-mentioned method in Workflows and **decision-making visualisation tools.**

4.7 Session 7: Summary of discussions, projects and finalisation

The event was closed by Dr Phil Collier, CRCSI Science Director, who summarised it as a good starting point providing the foundations for areas of applications and associated research questions relevant to the partners and researchers in the RSA domain. In this sense, the workshop had achieved its objective.

"(The Workshop provided me with) more understanding of real world needs, problems and constraints, more awareness of collaborator capabilities. Thanks for the invite again. It was worthwhile for me even if the project does not take off. :-} " – Liming Zhu, UNSW

Phil reminded the partners that the CRCSI fills a niche by tackling spatial-related problems, and that it enables partners to do business by generating better and novel ways to do what they are currently doing. For this reason, he advised the partners to keep the project proposals emerging from the workshop focused on the specific gaps and problems that the CRCSI can help with. He also encouraged partners and researchers to get together and continue the discussion on projects, concentrating their efforts in providing answers to problems, research questions, and associated outputs.

The importance of working in close collaboration with the CRCSI during the proposal development, from the workshop onwards, was highlighted as a key component to avoid disappointed once the decisions on project funding were made at a later stage. Phil closed the event by thanking all participants and welcoming them to continue the discussion during a social wind up.

"Very well facilitated, impressed by the quality and professionalism of CRCSI staff involved"
– Malcolm Campbell, University of Canterbury

5 Conclusion

The CRCSI RSA Program stems from the need to improve the ability and efficiency of government and industry in Australia and New Zealand to rapidly create spatial information products. The RSA Program will do so by generating high impact user-driven research providing answers to the latent questions present in its five core themes: data Integration, collaborative and Workflow-based Platforms, Communication and presentation of data products, and Dynamism and Real-Time.

During its initial Consultation phase, the RSA program has gathered extensive interest from both internal and external stakeholders. The RSA Open Call for Expressions of Interest generated more than 50 ideas for project proposals, and more than 30 stakeholders, with numbers well balanced among industry, government and research organisations, expressed interest in participating in the RSA Workshop. The RSA Workshop consisted of a one-day event held in Melbourne that served to refine project ideas and to listen to the end-user needs in RSA, while giving voice to the research community to come up with relevant solutions for projects. To this end, the participants worked in different Focus Groups and discussed their most relevant requirements. The event recorded a 100% of attendance, and due to limitations in the number of participants, involved a total of 18 CRCSI partners from the three above-mentioned sectors, coming from different Australian states and from New Zealand. The Workshop resulted in 4 specific project ideas shaped by partners. Feedback gathered from participants was overall very positive, with a 100% of them finding the event useful and enjoyable and expressing their willingness to participate in a similar Workshop in the future. A recurrent remark from the participants was the “short time dedicated to Focus Groups discussions” and that they “would have liked the possibility to move between groups”; remarks of which the CRCSI RSA team takes good note of, and that once more highlight the relevance and interest of the topics discussed on the day.

Taking as starting point the project ideas generated at the RSA Workshop, the RSA team is now in the process of selecting and drafting the initial RSA Project Portfolio. In order to gather formal interest in the projects and with the aim of increasing collaboration among industry, government and research organisations, this Portfolio will be publicly presented to both current CRCSI partners as well as to external organisations with specific interest in the Program.

6 Acknowledgements

The CRCSIs RSA Team would like to thank all the partners, internal and external organisations for their invaluable interest, ideas, support and contributions during this first stage of Program 2 RSA initiative.

Appendix A. Acronyms

CMCRC	Capital Markets Collaborative Research Centre
CRCSI	Cooperative Research Centre for Spatial Information
DELWP	Department of Environment, Land, Water & Planning (Victoria)
DSITI	Department of Science, Information Technology and Innovation (Queensland)
EOI	Expression of Interest
FSDF	Foundational Spatial Data Framework
GA	Geoscience Australia
ICT	Information and Communications Technologies
LINZ	Land Information New Zealand
LPI	Land and Property Information (New South Wales)
NeCTAR	National eResearch Collaboration Tools and Resources
NICTA	National ICT Australia
QUT	Queensland University of Technology
RIC	Research Investment Committee
RSA	Rapid Spatial Analytics
SoA	State of the Art
TERN	Terrestrial Ecosystem Research Network
UNSW	University of New South Wales
WorDS	Workflows for Data Science Center of Excellence

Appendix B. References

[1] National ICT Australia (NICTA) National Map Initiative
Centred on providing an improved data infrastructure and visualisation capability for Australians to government data. The project aim is to bring together dispersed information, which has been collected and produced by governments at all levels and in all functions, into an easily searchable, viewable and fully customisable map-based view. Web link: https://www.nicta.com.au/category/industry-engagement/environment/projects/national-map/

[2] Terrestrial Ecosystem Research Network (TERN) CoESRA Project
Workflow-based web-platform that allows researchers to perform complex analyses without having to set up the experiment from scratch and worry about having enough resources to run the analysis. The platform is based on the Kepler Workflow. Web link: http://www.tern.org.au/CoESRA-pg29647.html

[3] Workflows for Data Science Center of Excellence (WorDS)
Housed in the San Diego Supercomputer Center, at UC San Diego, the Workflows for Data Science (WorDS) Center of Excellence is Hub for the development, promotion, and delivery of workflow services for a wide range of applications. Web Links: http://swat.sdsc.edu/, https://kepler-project.org/

[4] National eResearch Collaboration Tools and Resources (NeCTAR)
Initiative aimed to enhance research collaboration and research outcomes by providing Information and Communication Technology (ICT) infrastructure. The organisation operates a Research Cloud. Web Link: https://www.nectar.org.au/

[5] Capital Markets Collaborative Research Centre (CMCRC)
The Collaborative Research Centre on Capital Markets has extensive knowledge and experience in areas such as data mining and real-time information management. The organisation creates and promotes technologies that increase the efficiency and integrity of health, insurance and capital markets locally and globally. Web Link: http://www.cmcrc.com/

[6] ***'Future trends in geospatial information management: the five to ten year vision'.*** United Nations Committee of Experts on Global Geospatial Information Management, July 2013.

[7] ***'Geospatial World Forum Report 2015'***. Geospatial World Forum, May 2015, Lisbon.

Appendix C. RSA Workshop Agenda

The CRCSIs Program 2 RSA Workshop took place on Tuesday 21 July 2015, at Graduate House – The University of Melbourne, Victoria, Australia.
Due to the dynamics of the event, the original Agenda was slightly modified to accommodate the emerging discussions. Here below is the Agenda, as it occurred on the day.

09:30 - 10:10	**Session 1: Setting the Scene** 1. Brief introduction to RSA from the CRCSI (Dr Peter Woodgate) 2. What does RSA mean to the CRCSI? (Dr Nathan Quadros) 3. Global trends, Projects and Emerging Concepts in RSA (Eva Rodriguez) 4. Advantages of being involved: what will you get out of this? (Prof Matt Duckham) 5. House Keeping (Eva Rodriguez)
10:10 – 11:00	**Session 2: Potential Projects** 1. Overview of how the RSA program will work and end-users (Dr Nathan Quadros) 2. CRCSI presentation and description of RSA proposed research themes and related projects (Dr Nathan Quadros)
11:00 – 11:15	Break – Morning tea
11:15 – 12:15	**Session 3: Group Session on Applications** 1. Overview of afternoon and participant expectations 2. Initial review and comment on projects, and partners' interests
12:15 – 13:15	Break – Lunch and small walk
13:15 – 14:00	**Session 4: Group Session on Research Questions** 1. Identify gaps and additional potential research projects 2. Identify projects requiring changes and those with high interest 3. Allocate workshop groups based on priority projects
14:00 – 15:00	**Session 5: Focus Groups** Break into project groups to focus project research and need.
15:00 – 15:55	**Session 6: Consolidation** Group-discussions results presentation and feedback from all participants
15:55 – 16:00	**Session 7: Summary of discussions, projects and finalisation** Conclusion and next steps
16:00 – 17:00	Drinks

Appendix D. RSA Workshop Participants

Partner	Participant	Position
RMIT University	Matt Duckham	Deputy Head of Department, School of Mathematical and Geospatial Sciences, RMIT University
Queensland University of Technology (QUT)	Shlomo Geva	Associate Professor, Science and Engineering Faculty
University of New South Wales (UNSW)	Liming Zhu[1]	Cojoint Academic, School of Computer Science and Engineering
Swinburne University of Technology	John Grundy[2]	Dean, School of Software and Electrical Engineering
University of Canterbury	Malcolm Campbell	Senior Lecturer in Health Geography
Curtin University	Geoff West	Professor of Spatial Information
Geoscience Australia	Simon Costello	Branch Head, National Location Information
Jacobs	Milos Pelikan	Technical Lead, Senior Consultant
Land Surveys	Thomas Werner	Business Development Manager
GHD	Kate Williams	Senior Spatial Consultant
NGIS	Nathan Eaton	Principal GIS Consultant
VPAC Innovations	Lachlan Hurst	Software Team Leader
AAM	John Blackburn	Business Manager
Department of Science, Information Technology and Innovation (DSITI) QLD	Peter Scarth[3]	Principal Scientist
Land Information New Zealand (LINZ)	Mike Judd	SDI Technical Leader
Land & Property Information NSW	Bradley Zawodny	Program Manager, Improvement Program Valuation Services
Department of Environment, Land, Water & Planning (DELWP) VIC	TO Chan	Project Manager Land Capability Model
Landgate Western Australia	Brendon McAtee	Manager, Innovation and Research & Development
CRC for Spatial Information	Phil Collier	Research Director
CRC for Spatial Information	Nathan Quadros	RSA Program Manager
CRC for Spatial Information	Eva Rodriguez Rodriguez	RSA Workshop Project Manager

[1] Liming Zhu other affiliations: Research Group Leader & Principal Researcher at NICTA's Software Systems Research Group (SSRG) and Honorary Associate at School of IT, University of Sydney.

[2] John Grundy's other affiliations: Director of Swinburne University Centre for Computing and Engineering Software Systems (SUCCESS) and Senior Principal Researcher with NICTA Victoria.

[3] Peter Scarth's other affiliations: Senior Research Scientist with the Joint Remote Sensing Research Program, University of Queensland and System Architect at VegCover.

Appendix E. RSA Workshop Brief

Rapid Spatial Analytics Workshop Brief

Program Leaders
CRCSI Research Director, Dr Phil Collier
RSA Science Director, Prof Matt Duckham (Acting)
RSA Program Manager, Dr Nathan Quadros
RSA Workshop Manager, Eva Rodriguez

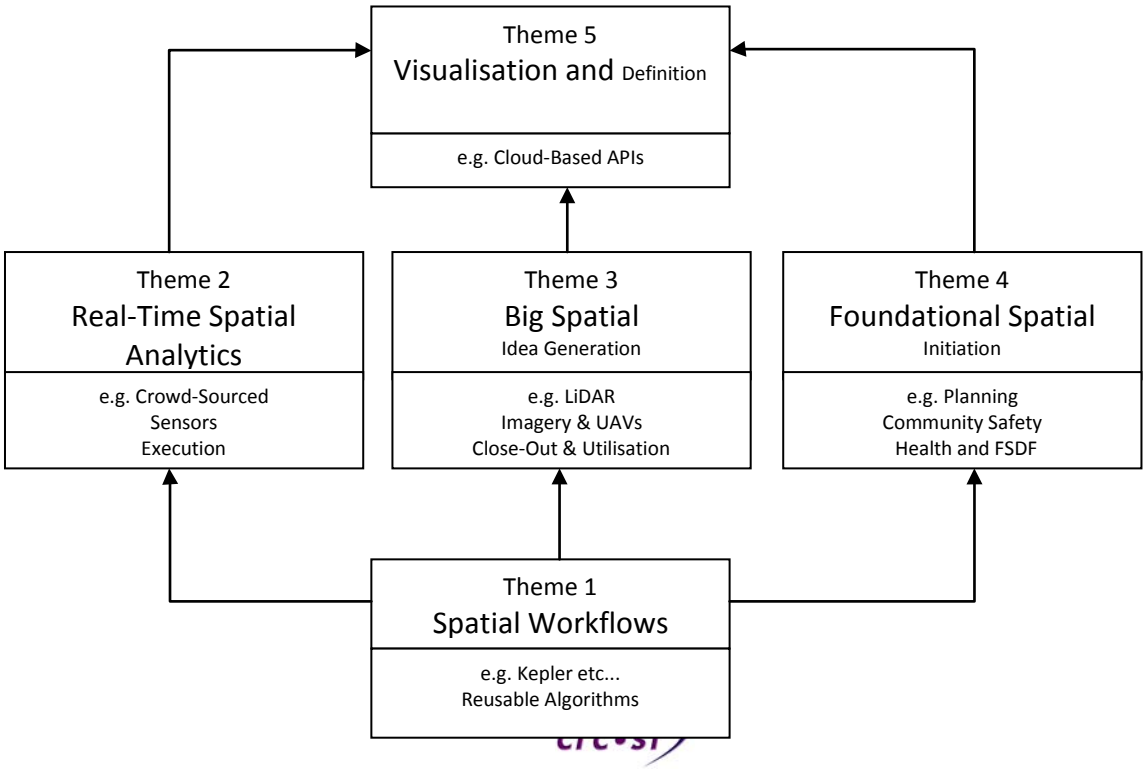
Rapid Spatial Analytics (RSA) Program Introduction

This is a new CRCSI program designed to develop and harness the latest developments in rapid cloud-based processing. The Program does not yet have an agreed structure or any approved projects. In-depth consultation with partners will now take place to flesh out the program so that it meets the needs of partners and end users in high priority areas. What is known from our early consultation is that there is a high demand for R&D in this area. Preliminary investigations have identified five candidate themes for the new RSA Program. It is envisaged that projects can operate across one or more of these themes. The themes are:

Theme #1. Tools for Spatial Workflows
The ability to reuse existing spatial data, models, algorithms, structures and/or any other software component in a modular form. This theme provides the foundation for the other themes.
Theme #2. Real-Time Spatial Analytics
Streaming data sources, including sensor networks and crowd sourced data present similar challenges to users.
Theme #3. Big Spatial Analytics
Combining large data sources and composing efficient analytic techniques demands the ability to 'put it all together'.
Theme #4. Foundational Spatial Analytics
Common cross-jurisdictional analytics on foundation data sources to ensure governments are producing comparable products and information. Similarly, to foundation spatial data this theme seeks to provide foundation spatial analytics.
Theme #5. Decision making and Visual Analytics
New online decision-making and visualisation tools are required by end users of spatial workflows.

Work across the projects can be aligned to the well- known four Vs of Big Data. These are:

1. Managing large *volumes* of data
2. that are streaming from data sources at high *velocity*
3. from a *variety* of different sources
4. and with varying levels of *veracity* (eg accuracy, trustworthiness)
5. Adding our own 'v' for *value*, the information products achieve maximum value when they are delivered quickly to the end user.



Workshop Participants

The following people and organisations have been invited to the RSA workshop on 21 July 2015. The workshop will be from 9.30am – 4.00pm at Graduate House, The University of Melbourne.

Partner	Participant	Position	Contact Email
RMIT University	Matt Duckham	Deputy Head of Department, School of Mathematical and Geospatial Sciences, RMIT University	matt@duckham.org
Queensland University of Technology (QUT)	Shlomo Geva	Associate Professor, Science and Engineering Faculty	s.geva@qut.edu.au
University of New South Wales (UNSW)	Liming Zhu[4]	Cojoint Academic, School of Computer Science and Engineering	Liming.Zhu@nicta.com.au
Swinburne University of Technology	John Grundy[5]	Dean, School of Software and Electrical Engineering	jgrundy@swin.edu.au
University of Canterbury	Malcolm Campbell	Senior Lecturer in Health Geography	malcolm.campbell@ canterbury.ac.nz
Curtin University	Geoff West	Professor of Spatial Information	G.West@curtin.edu.au
Geoscience Australia	Simon Costello	Branch Head, National Location Information	Simon.Costello@ga.gov.au
Jacobs	Milos Pelikan	Technical Lead, Senior Consultant	Milos.Pelikan@jacobs.com
Land Surveys	Thomas Werner	Business Development Manager	TWerner@landsurveys.net.au
GHD	Kate Williams	Senior Spatial Consultant	Katherine.Williams3@ghd.com
NGIS	Nathan Eaton	Principal GIS Consultant	nathan.eaton@ngis.com.au
VPAC Innovations	Lachlan Hurst	Software Team Leader	lachlan.hurst@vpac-innovations.com.au
AAM	John Blackburn	Business Manager	J.Blackburn@aamgroup.com
Department of Science, Information Technology and Innovation (DSITI) QLD	Peter Scarth	Principal Scientist	peter.scarth@dsitia.qld.gov.au
Land Information New Zealand (LINZ)	Mike Judd	SDI Technical Leader	mjudd@linz.govt.nz
Land & Property Information NSW	Bradley Zawodny	Program Manager, Improvement Program Valuation Services	Bradley.Zawodny@lpi.nsw.gov.au
Department of Environment, Land, Water & Planning (DELWP) VIC	TO Chan	Project Manager Land Capability Model	Tai.Chan@delwp.vic.gov.au
Landgate Western Australia	Brendon McAtee	Manager, Innovation and Research & Development	Brendon.McAtee@landgate.wa.gov.au
CRC for Spatial Information	Phil Collier	Research Director	pcollier@crcsi.com.au
CRC for Spatial Information	Nathan Quadros	RSA Program Manager	nquadros@crcsi.com.au
CRC for Spatial Information	Eva Rodriguez Rodriguez	RSA Workshop Project Manager	erodriguez@crcsi.com.au

[4] Liming Zhu other affiliations: Research Group Leader & Principal Researcher at NICTA's Software Systems Research Group (SSRG) and Honorary Associate at School of IT, University of Sydney.

[5] John Grundy's other affiliations: Director of Swinburne University Centre for Computing and Engineering Software Systems (SUCCESS) and Senior Principal Researcher with NICTA Victoria.

Input Project Proposals and Ideas

CRCSI partners have submitted a range of ideas and proposals in response to the EOI in rapid spatial analytics. These ideas have helped to identify the main CRCSI RSA themes. The topics provided from university partners demonstrate the CRCSI research capabilities, and where knowledge can be leveraged.

Although most ideas have been submitted from universities, partners will be key to identifying and driving the upcoming projects.

The titles of the potential projects have been provided, along with the RSA themes that they most closely align. (1) Spatial Workflows (2) Real-Time (3) Big Spatial (4) Foundational Spatial (5) Visualisation

Partner	Proposal Title	Themes
QUT	Data Science: Data mining and machine learning algorithms	1
QUT	A spatial analytic workflow to support real-time event monitoring in streams	1, 2
QUT	Adaptive design for spatio-temporal modelling of fine scale image classification	1, 3
QUT	Spatiotemporal quantification of riparian zones using hand-held image collection and automated processing	1, 2
Swinburne	Rapid Data Analytics Infrastructure for Subject Matter Experts	1
Jacobs	Open source visual workflow software that enables algorithm development and deployment (exe).	1
VPAC	Pre-processing of spatial data to get data in a format suitable for ingestion into business systems (e.g. re-projection, cutting raster with vector).	1
VPAC	Agent watching source datasets, and if updated, complete the pre-processing and import process	1, 4
AAM	Online contextual indexing for semantic ontologies – what is being collected and archived - complex concurrent geospatial queries on that indexed data.	1, 2
QUT	Rapid spatially localised data from unmanned aerial vehicles.	2, 3
QUT	Real-Time Crowd-Sourced Spatial Data for Multi-Scale Urban Decision Support, Sentient Visualisation Analytics, and Municipal Management	2, 5
QUT	Vision-based sensing and real-time estimation of stream flow rates for assimilation into predictive models	2
RMIT	Real Time Monitoring of Traffic Flows	2
University of Canterbury	Real time processing and interpolation of the air quality data to visualise a surface of air quality for a whole city	2
LINZ	Sensing Cities to create new information products from emerging opportunities in sensor data	2
Curtin University	Vision and plan for fire management and biodiversity protection in the Shire of Augusta Margaret River and Southwest WA: A GeoDesign Approach	2
Biomedware	Rapid Spatial Analysis for Wearable Technologies	2
Jacobs	Classification of sewer pipe video to provide meaningful information	2
VPAC	Supporting real-time queries e.g. How many people are currently within 5km of this bushfire.	2

AAM	On-the-fly processing from streamed data to identify a pattern of interest, much like in-line transaction fraud detection, to provide immediately actionable intelligence.	2
Swinburne	Next-generation wearable devices to capture diverse data, integrate, compute and visualise.	2, 5
NGIS	Near real-time risk and exposure analysis with a focus on quantifying risk and exposure	2
NGIS	Leveraging sensors and data archives for trend analysis and prediction	2
GHD	Journey to Work - Smart ways to extract and visualise journey data.	2, 5
GHD	Modelling, visualising and reporting on groundwater data, and analysing this info with pumping, rainfall etc..	2, 5
GHD	Councils are looking for ways of charging people who don't sort their rubbish. Rubbish sorting and audits are increasingly of interest as tip prices increase.	2, 3
DELWP	River metrics extraction models / toolbox	3, 1
DSITI	An open platform for direct and repeatable measurements of vegetation structure and above-ground biomass using LiDAR remote sensing	3
Landgate	Information extraction and change identification and attribution through spatial analytics methods from high resolution imagery of the urban and natural environment.	3
UNSW	A Rapid Spatial Analytics platform for climate-sensitive urban design, planning and policy to improve the heat resilience in Australian settlements	3, 5
Jacobs	Development of trends and trigger algorithms and metrics (numbers not classifications) for: urban change, water regimes, land use regimes and multi-res extraction of information from LiDAR for regional flood models	3, 5
VPAC	Further Utilisation of the 4.17 Data Cube Outcomes	3
AAM	Feature identification/classification and extraction using iterative pattern recognition and semantic segmentation.	3
Swinburne	"Brute force" parallelisation and scaling enabling use of existing algorithms, code, script without complete re-engineering for cloud and grid platforms.	3
NGIS	Large scale change detection and feature detection	3
GHD	Measuring foot traffic before and after greening to build business cases for funding. Developing tools to measure pedestrian from wearables.	3, 2
Landgate	Big data analytics for identifying trends and new knowledge in long term archives of property and valuation of land registration information.	4
DELWP	Next generation Vicmap (NGV)	4
Landgate	Efficient cross-government derivation and sharing of information from spatial analytics of planning and property information.	4, 5

Landgate	Provision of Spatial Analytics information in form that are readily digestible by business, and not in the form of spatial data requiring further interpretation.	4, 5
Geoscience Australia	RSA to support FSDF project	4
LPI	To develop enhanced valuation models which capture the relationship between land values and property spatial attributes	4
University of Notre Dame[6]	Dynamic maps to improve health outcomes for diabetics in disease 'hotspots'	4, 5
University of Notre Dame	Real time optimisation of flu vaccination according to geospatial need	4, 2
LINZ	Better Property Services - LINZ has programme level interests in building and property data and data integration	4
VPAC	Visualisation, and being able to 'do more' with statistical data extracted from raster datasets. Thinking along the lines of being able to respond to natural language queries.	5, 1
Geoscience Australia	How end data products from analytics can/should be visualised	5
Swinburne	Real-time traffic data visualisation toolsets, along with historic data traffic analysis and visualisation toolsets	5, 2
NGIS	Effective communication of RSA answers and outcomes	5
GHD	Integrating and visualising groundwater, rainfall, volumes, air quality, run-off etc information across a mine, and understanding the broader impacts	5, 3
GHD	Assessing rain gardens, stormwater treatment wetlands and so on for reduced pollutant load to our streams and bays	5, 3

[6] Although not a partner of the CRCSI, Prof Moyez Jiwa, who has recently transferred from Curtin to Notre Dame, is keen to grow a new relationship on the back of a successful research project be initiated whilst at Curtin

Workshop Objective

The workshop will focus on developing an outline and collaborators for two to four project proposals to go to the CRCSI Research Investment Committee (RIC) in November, for projects to start in January with an 18 month duration.

The aim of this workshop is to review, refine, prioritise and focus the project proposals (described in following sections) in this document based on the five themes, on the premise that only two to four projects will be funded. The current project listing is general in nature and new proposals will be considered. The workshop will also provide recommendations on where two or more existing proposals could be combined in to a larger project to achieve more of the RSA goals.

The projects need to identify a clear research element, and be specific to an end-user need with future development leading to utilisation in the short (less than a year), medium (one to two years) and long term (greater than two years). The workshop will identify the partner interests in spatial analytics and potential collaborations. It will also identify an initial level of interest and engagement from partners for each of the proposed projects. Those partners with potential CRCSI external cash co-contributions will ideally be identified.

Worksop Agenda

The workshop encourages discussion. The CRCSI wants to hear from its partners about emerging issues and priorities in RSA research. The floor should be equally shared between all participants. Discussions will be encouraged around all aspects of RSA, and should not be directed towards the interests of a minority. The format of the workshop on 21 July 2015 at Graduate House, The University of Melbourne will be as follows:

9:30-10:10am Setting the Scene

1. Brief introduction to RSA from the CRCSI [Dr Peter Woodgate]
2. What does RSA mean to the CRCSI? [Dr Nathan Quadros]
3. Global trends, Projects and Emerging Concepts in RSA [Eva Rodriguez]
4. Advantages of being involved: what will you get out of this? [Prof Matt Duckham]
5. House Keeping [Eva Rodriguez]

10:10-10:40am Potential Projects (Break for 15min around 10:40am)

6. Overview of how the RSA program will work and end-users
7. CRCSI presentation and description of RSA proposed research themes and related projects

10:55am-12:15pm Partner Interest (Break for 45min around 12:15pm for provided lunch)
[Session facilitated by: Dr Nathan Quadros / Prof Matt Duckham]

8. Overview of afternoon and participant expectations
9. Initial review and comment on projects, and partners' interests
10. Identify gaps and additional potential research projects
11. Identify projects requiring changes and those with high interest
12. Allocate workshop groups based on priority projects

1:00-2:30pm Focus Groups

13. Overview of session: objectives and dynamics [Dr Nathan Quadros]
14. Break into project groups to focus project research and need.

2:30-3:50pm Consolidation

15. Group-discussions results presentation and feedback from all participants

Has a decision been made or a design agreed? If the answer is no not yet (which is very common) the next stage is to identify what outcome has been. What needs to be done to progress it? Actions should be articulated and taken, including approaching non-workshop stakeholders.

3:50-4:00pm Summary of discussions/projects and finalisation

16. Conclusions and next steps [Dr Phil Collier]

Key Homework Questions

Due to limited time at the workshop it's important to get some thinking done before hand. To hit the ground running it would be useful if all workshop participants can note some thoughts answering the following questions:

- What are the current and emerging industry/government problems which RSA research can help solve?
- How can RSA research resolve emerging issues? Which are the main themes for CRCSI investment to resolve these issues?
- What are the research versus development components of potential projects?
- What applications should be the focus of the project proposals? Who will be the end users of these research application outcomes?
- What level of engagement can the CRCSI expect with each of the project proposals to assist in the development and utilisation components of the research?
- Do you wish to lead project any of the projects? Who is best suited to perform the leadership?

Please feel free to email Nathan Quadros (nquadros@crcsi.com.au) the answers to some of these questions before the workshop if you think they will impact the workshop program, otherwise please feed these thoughts into the discussions on the day of the workshop.

Theme #1: Spatial Workflows

Potential Project Title

Facilitating CRCSI Research into Cloud-Based Workflows

Project Description

Cloud-based (scientific and business) workflows call in data, programs, and other inputs and produce outputs that might include visualizations and analytical results. These workflows have the potential to provide an underlying framework for unifying research in the area of RSA:

- Cloud-based workflows can be easily shared, reused and adapted
- Workflows provide a nexus for researchers and businesses to collaborate across different domains and areas of expertise.

Spatial workflows are all about sharing not just data, but the procedures and models for processing and using data. As such, they could provide a mechanism for researchers from the different RSA projects to share their results, and collaborate more easily (using and adapting each others' individual actors and complete workflows).

A project within this theme will provide the foundation from which other projects can develop and share algorithms and processes. It will seek to engage with existing workflow infrastructure, enabling researchers to engage with spatial objects within scientific workflows. The cloud-based nature of the research should facilitate easy demonstration and adoption of parallel research.

Although scientific and business workflows are beginning to be commonplace within research and industry, the spatial elements within these workflows requires considerable development. Some initial work has begun internationally, such as the Grass GIS Kepler extension.

The integration of workflow analysis methods based on data-flow and control-flow is a promising new area of research, with cross-fertilization between communities yielding new insights for both scientific and business workflows. Provenance[7] within these workflows has become a key area of research in this space.

This project will aim to solve foundational issues in regards to sharing and reusing spatial objects within scientific workflows. Issues with regard to spatial provenance will also need to be explored. The use of scientific workflows for spatial data has only been lightly explored, with most research confined to non-spatial applications. This research will also link to CRCSI Program 3 in addressing issues in spatial data provenance, and with parallel research in Program 2 and 4 with a view to assisting researchers to migrate algorithms into a cloud-based workflow infrastructure.

[7] The provenance (also referred to as the audit trail, lineage, and pedigree) of a data product contains information about the process and data used to derive the data product. It provides important documentation that is key to preserving the data, to determining the data's quality and authorship, and to reproduce as well as validate the results.

Potential Applications	Dependent upon the other projects. Will need to engage with the other Program 2 and 4 projects. Would be the underlying project which will enable the sharing and reusability of algorithms, lowering the threshold for industry and government to utilise and adopt outcomes from projects.
Possible Outputs	Recommended workflow infrastructure, template data sources, spatial data consistency checks, data quality management procedures, spatial provenance standards and spatial data sources encoded as actors within workflows.
Benefits	Provide a suite of basic tools for businesses to access and integrate data sources into their workflows along with metadata and standards.
Targeted User	Depends on applications and partners. Workshop to determine.
Related CRCSI Projects	CRCSI Project 2.09 – QA4LiDAR (LiDAR Quality Assurance Tool) CRCSI Project 3.02 – Chet Bing Tan (Integration of Search Tools), Muhammed Sadiq (Investigating governance along supply chains and concentrating on provenance) and Paul Goodhue (A Trusted Model for Crowd-Sourced Data) CRCSI Project 4.17 – Big Data Solutions for Environmental Monitoring
Related Project Proposals and Ideas	QUT – Data Science: Data mining and machine learning algorithms QUT – A spatial analytic workflow to support real-time event monitoring in streams QUT – Adaptive design for spatio-temporal modelling of fine scale image classification QUT – Spatiotemporal quantification of riparian zones using hand-held image collection and automated processing Swinburne – Rapid Data Analytics Infrastructure for Subject Matter Experts DELWP – River metrics extraction models / toolbox Jacobs – Open source visual workflow software that enables algorithm development and deployment (exe). VPAC – Pre-processing of spatial data to get data in a format suitable for ingestion into business systems (eg re-projection, cutting raster with vector). VPAC – Agent watching source datasets, and if updated, complete the pre-processing and import process AAM – Online contextual indexing for semantic ontologies – what is being collected and archived – complex concurrent geospatial queries on that indexed data.

Theme #2: Real-Time Spatial Analytics

Potential Project Title	**Continuously Streaming Data that Provides Near Real-Time Outputs**
Project Description	The explosion of new data sources, whether from automated sensors or 'humans as sensors', requires a concomitant explosion of new techniques for capturing, classifying, and pre-processing this data. However, several key challenges are common across many such data sources, including dealing with streaming and real-time data; managing data quality, continuity and redundancy; and rapidly publishing updates to users around the world. This project will focus on an application to develop the fundamental analytics for managing real-time or rapidly updated spatial data emanating from a wide range of non-traditional data sources, such as sensor networks, traffic and crowd-sourced data. The focus will be on general purpose and application specific tools for data processing and resolving issues in regards to data continuity and redundancy. In order to achieve this focus, the project will address a partner driven real-time data source and/or application. The project will focus on cloud-based processing and analytics, and is expected to work with the workflow project to provide input into resolving issues within real-time spatial workflows. In situ processing on mobile platforms will also be considered.
Potential Applications	UAVs, crowd-source urban visualisation, river and stream flow, traffic flow, air quality monitoring, urban sensors and wearable devices.
Possible Outputs	Managing real-time and rapidly updated spatial data sources, and encoding these as actors within workflows.
Benefits	Provide a suite of basic tools for automatically managing real-time and rapidly updated new data sources, reducing the costs of adopting new technology, and making it easier for businesses to integrate data feeds into their workflows.
Targeted User	Depends upon application and partners. Workshop to determine.
Related Projects	CRCSI Project 3.02 – Levi Mutambo (Crowdsourcing a Spatial Data Infrastructure)

Related Project Proposals and Ideas

QUT – Rapid spatially localised data from unmanned aerial vehicles.

QUT – Real-time Crowd-Sourced Spatial Data for Multi-Scale Urban Decision Support, Sentient Visualisation Analytics, and Municipal Management

QUT – Vision-based sensing and real-time estimation of stream flow rates for assimilation into predictive models

RMIT – Real-time Monitoring of Traffic Flows

University of Canterbury – Real-time processing and interpolation of the air quality data to visualise a surface of air quality for a whole city

LINZ – Sensing Cities to create new information products from emerging opportunities in sensor data

Biomedware – Rapid Spatial Analysis for Wearable Technologies

Curtin – Vision and plan for fire management and biodiversity protection in the Shire of Augusta Margaret River and Southwest WA: A GeoDesign Approach

Jacobs – Classification of sewer pipe video to provide meaningful information

VPAC – Supporting real-time queries e.g. How many people are currently within 5km of this bushfire.

AAM – On-the-fly processing from streamed data to identify a pattern of interest, much like in-line transaction fraud detection, to provide immediately actionable intelligence.

Swinburne – Next-generation wearable devices to capture diverse data, integrate, compute and visualise.

NGIS – Near real-time risk and exposure analysis with a focus on quantifying risk and exposure

NGIS – Leveraging sensors and data archives for trend analysis and prediction.

GHD – Journey to Work - Smart ways to extract and visualise journey data.

GHD – Modelling, visualising and reporting on groundwater data, and analysing this info with pumping, rainfall etc.

GHD – Councils are looking for ways of charging people who don't sort their rubbish. Rubbish sorting and audits are increasingly of interest as tip prices increase.

Theme #3: Big Spatial Integration

Potential Project Title	**Efficient Processing of Big Spatial Data to Derive Useful Products and Visualisations**
Project Description	Processing large LiDAR and imagery datasets within cloud-based infrastructure is in its infancy. The ability to efficiently process this data online and to share algorithms to generate metrics has the potential to benefit a range of users across the community. Using the case study of vegetation metrics and/or stream flows this project will develop efficient processing algorithms for imagery and point clouds datasets using online workflows. Constructing linkages between these different areas could involve linking different workflows at the same level, but more frequently at different levels of granularity. The results will validate the capability to share workflows, and showcase the enhanced collaboration between different expertise and industries that derive benefits from online processing.
Potential Applications	Vegetation structure and stream metrics, or heat resilience in urban centres
Possible Outputs	Vegetation and stream metric algorithms encoded on a cloud-based platform.
Benefits	Will provide a blueprint for integration of large datasets connected within a single workflow.
Targeted User	Depends upon application and partners. Workshop to determine.
Related CRCSI Projects	CRCSI Project 2.01 – Mobile and Terrestrial Mapping CRCSI Project 2.02 – Urban Feature Extraction CRCSI Project 2.07 – Woody Vegetation CRCSI Project 2.14 – Victorian Rivers

Related Project Proposals and Ideas	DELWP – River and vegetation metrics extraction models / toolbox
	DSITI – An open platform for direct and repeatable measurements of vegetation structure and above-ground biomass using LiDAR remote sensing
	Landgate – Information extraction and change identification and attribution through spatial analytics methods from high resolution imagery of the urban and natural environment.
	UNSW – A Rapid Spatial Analytics platform for climate-sensitive urban design, planning and policy to improve the heat resilience in Australian settlements
	Jacobs – Development of trends and trigger algorithms and metrics (numbers not classifications) for: urban change, water regimes, land use regimes and multi-res extraction of information from LiDAR for regional flood models
	VPAC – Further Utilisation of the 4.17 Data Cube Outcomes
	AAM – Feature identification/classification and extraction using iterative pattern recognition and semantic segmentation.
	Swinburne – 'Brute force' parallelisation and scaling enabling use of existing algorithms, code, script without complete re-engineering for cloud and grid platforms.
	NGIS – Large scale change detection and feature detection
	GHD – Measuring foot traffic before and after greening to build business cases for funding. Developing tools to measure pedestrian from wearables.

Theme #4: Foundational Spatial Analytics

Potential Project Title	Value Added Rapid Spatial Analytics for Foundation Spatial Datasets
Project Description	Authoritative spatial datasets (such as those for which Geoscience Australia, Landgate in WA, and DELWP in Victoria are custodians) are the foundation of innumerable activities in businesses and organisations across Australia. Many of these activities will involve, at least in part, similar data processing steps (eg importing data, summarising patterns, identifying trends). Today, each individual business and organisation must 'reinvent the wheel', expending significant time and effort on constructing similar processes. This project will investigate the system architecture and structures needed to allow sharing of the foundational analytics most frequently used with foundational data. By defining and sharing documented and composable workflows for the most frequently used and fundamental spatial analytics operations, the project will significantly reduce the time spent by users of the most important datasets in the country. The project will focus on key case studies for building and sharing spatial analytic workflows, including in the domains of planning and property information, community safety, and land cover change detection.
Potential Applications	Planning and property, community safety, geocoded addressing, health analytics
Outputs	New foundational workflow analytics and data
Benefits	Enable free sharing and adaptation of the most frequently used foundational spatial analytics by businesses. In turn, providing a mechanism for data custodians to “value add” to their foundational spatial data sets and significantly reduce the time spent by users of these data sets performing and customizing basic spatial analytics.
Targeted User	Depends upon application and partners. Workshop to determine.
Related CRCSI Projects	CRCSI Project 3.02 – Premalatha Varadharajulu (Spatial Data Supply Chain Modelling in Australia and New Zealand) CRCSI Project 4.55 – Greening the Greyfields

Related Project Proposals and Ideas	DELWP – Next generation Vicmap (NGV)
	Landgate – Efficient cross-government derivation and sharing of information from spatial analytics of planning and property information
	Landgate – Provision of Spatial Analytics information in form that are readily digestible by business, and not in the form of spatial data requiring further interpretation.
	GA – RSA to support FSDF project
	LPI – To develop enhanced valuation models which capture the relationship between land values and property spatial attributes
	University of Notre Dame – Dynamic maps to improve health outcomes for diabetics in disease 'hotspots'
	University of Notre Dame – Real time optimisation of flu vaccination according to geospatial need
	LINZ – Better Property Services – LINZ has programme level interests in building and property data and data integration

Theme #5: Decision-making and Visual Analytics

Potential Project Title	Rapid visualisation of movement
Project Description	Making sense of the wealth of new and emerging data sources is made all the harder by the rapidity with which many such data sources are being updated. Traffic data, for example, is derived from numerous different sources, including imagery and crowdsourced data, frequently updated in real-time. Interpreting the patterns embedded in such rapidly updated and diverse data requires not only sophisticated tools for data mining and visualization, but also human intelligence. Providing standardized and interactive representations of such highly dynamic data can assist human users in better understanding the changes occurring, and ultimately making better decisions. This project will define and develop a standardized set of visual analytics tools for assisting human users in exploring and identifying patterns in dynamic data. Specifically, the focus will be on data about human movement, as well as the dynamic environment in which movement takes place. The data may be fine grained and frequently updated, but may also involve coarser-grained or static data sets (such as transportation networks). The results will focus on case studies across key applications, including traffic management, emergency response, and human health monitoring. The project is expected to work with the other program 2 projects, and may even be integrated with the spatial workflows project.
Potential Applications	Is expected to combine with the other themes to provide visualisation and decision-making products.
Outputs	New visual analytics toolkits integrated with workflow systems for enabling decision-making based on real-time data.
Benefits	Enable better decisions based on complex and highly dynamic movement data sources, in application areas such as traffic management, evacuations, emergency response, location-based health monitoring and environmental health hazards.
Targeted User	Depends upon application and partners. Workshop to determine.
Related Projects	CRCSI Project 4.4 – Healthtracks and Epiphanee

Related Project Proposals and Ideas	Highly related to other themes. Could be a project integrated into either any of these themes. QUT – Real-Time Crowd-Sourced Spatial Data for Multi-Scale Urban Decision Support, Sentient Visualisation Analytics, and Municipal Management Landgate – Efficient cross-government derivation and sharing of information from spatial analytics of planning and property information. Landgate – Provision of Spatial Analytics information in form that are readily digestible by business, and not in the form of spatial data requiring further interpretation. University of Notre Dame – Dynamic maps to improve health outcomes for diabetics in disease 'hotspots' VPAC – Visualisation, and being able to 'do more' with statistical data extracted from raster datasets. Thinking along the lines of being able to respond to natural language queries. Geoscience Australia – How end data products from analytics can/should be visualised Swinburne – Real-time traffic data visualisation toolsets, along with historic data traffic analysis and visualisation toolsets NGIS – Effective communication of RSA answers and outcomes GHD – Integrating and visualising groundwater, rainfall, volumes, air quality, run-off etc information across a mine, and understanding the broader impacts GHD – Assessing rain gardens, stormwater treatment wetlands and so on for reduced pollutant load to our streams and bays