

VIRTUAL AUSTRALIA - THE NEXT GENERATION OF RESEARCH INVESTMENTS TO HELP SHAPE A NATION

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Commission II,SS-2

KEY WORDS: Virtual; Spatial information; Innovation; National; Australia

ABSTRACT:

Australia is currently shaping its strategy for spatial information research for the next decade. This strategy will cover the development of new infrastructure in spatial data systems, frameworks to support precise positioning nationwide, development and application of new technologies including unmanned aerial systems, hyperspectral imaging and advanced analysis systems capable of integrating 3D and 4D analyses. The proposed research is underpinned by a comprehensive economic analysis together with in-depth consideration of the environmental and social issues that need to be tackled in Australia's national interest. The overall strategy will drive Australia towards a position where organisations in the public and private sectors are capable of exercising greater intelligence in their decision-making from the vast amounts of data that are available to them. The paper examines specific research propositions in a number of sectors including energy, agriculture, natural resources, defence and health.

1. INTRODUCTION

Australia is facing a number of serious challenges including water shortages, declining agricultural terms of trade, rapid changes in the energy sector, heightened awareness of the need for self sufficiency in national defence, and almost intractable increases in the provision of health and welfare services. New and innovative approaches need to be found as a matter of high priority in each area. Spatial information will be central to the management of these issues.

Eighty percent of government decision making involves geographic information (Tomlinson, 1994). Over the next decade much decision making, in both the public and private sectors, will require quite precise knowledge of the location of assets and human resources. The driver will be the need to know within centimetres the position of people, vehicles, built infrastructure and natural assets both on and under land and on and under water. Decision makers will want their information in real time, wherever they are, and in the form that they need it.

Users will demand access to the enormous stocks of data held by public and private sector organisations and will require new forms of analytical capability, methods of presentation of information, and delivery mechanisms for communication. By getting this right, Australia hopes to derive substantial productivity gains, increase public benefits and realise internal business efficiencies.

Australia is yet to unlock the potential of its government data holdings because the vast majority of these data are not available to the private sector or the general public. Much economic research (OECD, 2005, Cumming, 1998) both locally and overseas has demonstrated the value of the contribution of innovation to the economies of nations and markets. Tremendous innovation, value adding and ultimately economic growth will occur when willing organisations, especially those

in the private sector, are allowed to innovatively access and use this information for commercial gain and to pursue the national interest.

2 CONTRIBUTION OF THE SPATIAL INFORMATION INDUSTRY TO THE AUSTRALIAN ECONOMY

In March 2008 ACIL Tasman (ACIL Tasman, 2008) released a comprehensive study into the value of spatial information to the Australian economy. The study was commissioned by the CRCSI and ANZLIC – Australia's Spatial Information Council. The study found that in 2006-2007 Australia's spatial information industry contributed between \$6.4 and \$12.6 billion to Gross Domestic Product, had a positive impact on the balance of trade with exports increasing by up to \$2.3 billion and increased real wages by between 0.6% and 1.2%.

The study concluded that overall and with the right policies the contribution of the spatial information sector to the economy over the medium term could be 50% higher than in 2006-07. The next generation of research programs will be designed to help achieve this economic growth.

3. BACKGROUND ON THE COOPERATIVE RESEARCH CENTRE FOR SPATIAL INFORMATION

Investing in science and innovation is crucial for Australia to stay competitive in an increasingly knowledge-based global economy. One important means of doing this in Australia is the Cooperative Research Centre (CRC) Program. This program was commenced in 1990 to develop collaboration between industry, Australian universities and public sector research agencies. It seeks to foster research that leads to innovative products and services, and education activities that help build greater skilled capacity in the workforce (DEST, 2006).

The CRC for Spatial Information (CRCSI) was founded in 2003 with the vision to be a world leader in spatial information applications that are affordable, useful and readily available to all – at any time and in any place. The CRCSI brings together AUD95 million in cash and in-kind over seven years from its partners to help provision Australia's future spatial information needs. The CRCSI uses the collective wisdom of a broad base of participants to accelerate industry growth, generate intellectual property, seek efficiency gains for government, and better position the research and education programs of universities and other institutions (CRCSI, 2008).

Currently the CRC for Spatial Information has 70 partnering organisations, including six universities, eight government agencies (including Defence) and 56 companies. Over 300 full and part time researchers are involved in various programs of the CRCSI.

A key CRCSI initiative is Virtual Australia. CRCSI invests in activities that promote Australia's ability to progressively contribute to the creation of "Virtual Australia" (CRCSI, 2008)

4. BACKGROUND ON VIRTUAL AUSTRALIA

Virtual Australia was proposed as a virtual [digital] model containing and representing all non-trivial objects and their contextual environment - from blue sky to bedrock - in [real world] Australia. It is to be an information system that progressively seeks to provide complete, correct and current information about Australia to anyone, at any time, at an affordable cost (Thompson *et al*, 2008).

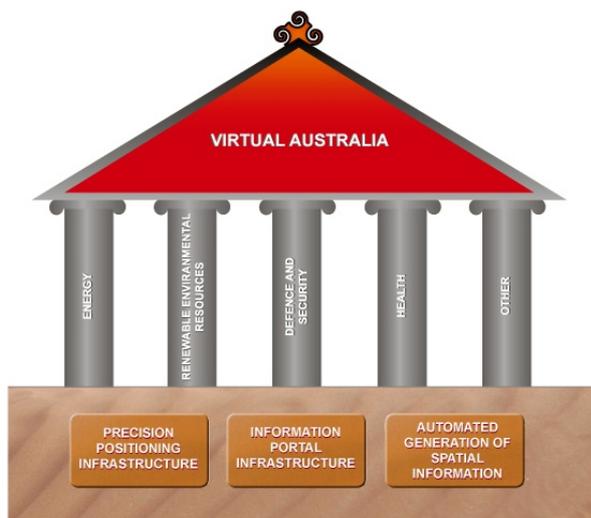


Figure 1. Relationship between the infrastructure programs and the science programs in the proposed next generation of Virtual Australia research investments.

5 PROPOSED RESEARCH PROGRAMS

The CRCSI is currently formulating its research and development programs for the next decade. The strategic intent involves three fundamental infrastructure programs (precision positioning, an information portal, and processes for automated generation of spatial information) to support a number of market sectors (including energy, natural resources, agriculture, climate change, defence and security, and health). Other

programs may also be developed. The relationship between these programs is illustrated in Figure 1. The programs are discussed in the following sections.

5.1 Precision Positioning Infrastructure

Typically, infrastructure is built in response to, or in anticipation of, societal needs. Failing or inadequate infrastructure can have serious impacts environmentally, economically and socially. Transport, energy, water supply and communications are some of the most essential activities for the effective operation and on-going growth of a developed economy. They all require a properly functioning infrastructure.

The last decade has seen the burgeoning availability and wide scale exploitation of spatial information of various forms. The public release and far reaching penetration of the Google Earth technology is a familiar example. Of comparable significance has been the proliferation of commercial in-car navigation systems based on satellite navigation and digital mapping technologies.

As people become more familiar with the use of spatial information and more dependent on ready access to such information, Australia will witness the emergence of a *spatially enabled society*. Indeed, spatial information is, and will increasingly, become an essential building block for the functions and activities of business, government, science and the broader community.

In much the same way as we turn on a tap and expect water to flow or flick a switch and expect the light to come on, government, industry and private citizens will soon be demanding a *precision positioning infrastructure* to support their positioning needs.

In ideal terms, a *precision positioning infrastructure* will provide a framework for the determination of ubiquitous, reliable, real-time, three dimensional positioning with an absolute accuracy of a few centimetres. Assistance in the achievement of this goal is the underlying aim of the Precision Positioning Infrastructure program.

This new positioning infrastructure will eventually allow the determination of position in any location and at any time. It will be available to all and will support any task where information about location is required. Some examples include precision farming, mineral ore extraction, emergency services response, environmental monitoring, construction, vehicle and personal tracking and commercially-oriented location-based services.

While the concept of a positioning infrastructure is relatively simple and the benefits are largely self-evident, the realisation of this objective is not without its challenges – technical, political, scientific and economic. It is likely that Australia will be the only developed country in the world that will have complete coverage of GPS, GLONASS, GALILEO and the regional systems of China, Japan and India. This puts Australia in a unique position to develop new applications and to offer a test-bed for the world.

5.2 Information Portal Infrastructure

Australia's government agencies, through the Australia and New Zealand Land Information Council ('ANZLIC- the Spatial

Information Council') and the Australian Spatial Information Business Association (ASIBA) have identified as a fundamental need in Australia the development of a nation-wide online information portal (or coordinated and linked suite of portals) for sharing datasets within government and by the private sector.

There are compelling arguments to show that provisioning information more efficiently to the end user is a critical driver of innovation. An emerging proposition for the use of data over the Internet and the Web is that the more interactions that end users can undertake, and the more complex these interactions become, the more valuable the outcome. Moreover, if the outcome can be achieved in near real time, even greater value is added.

This program will drive much greater utility for end users of information online. It will tackle the processes of linking disparate data stores (including spatial data), custodial and legal arrangements, licensing, governance arrangements, tensions between open access and proprietary requirements, and the development of new standards, protocols and default-use conditions. It will be underpinned by a Creative Commons approach that will look to create a new on-line culture of data sharing.

The development of this program will help underpin Australia's need to develop a national spatial data infrastructure strategy that is endorsed by all key sectors.

5.3 Automated Spatial Information Generation

In order to optimally and comprehensively manage its resources, Australia relies heavily upon spatial information generated from a range of sensor technologies. High-resolution satellite imagery within the visible spectrum is nowadays employed for topographic mapping, as is panchromatic and multispectral imagery from a new generation of digital aerial cameras. Higher-resolution satellite imagery is also having an impact upon environmental remote sensing, allowing finer scale, local area analysis of various biophysical phenomena. Airborne laser scanning, over both land and shallow water, is providing a new means to extract the high accuracy digital elevation model (DEM) data necessary for coastal vulnerability assessment and flood inundation studies. This same technology is also being used for 3D city modeling, and it lends itself to integration with imagery to provide, in effect, a direct orthoimagery and DEM mapping system. Airborne and spaceborne interferometric synthetic aperture radar (IfSAR) also produces imagery to complement the ranging data that produces broadscale DEMs. On the ground, terrestrial laser scanners are being increasingly employed for a host of automated measurement tasks ranging from engineering and plant documentation to heritage recording and geomorphological analysis.

While all these technologies 'remotely sense' the earth or objects upon it in order to produce specific measurement data, most fall short of the ultimate requirement for automated generation of spatial information. For example, while an airborne laser scanning can be used to provide an accurate 3D digital surface model of a city, there is currently no commercial system that can ingest this data and fully automatically classify and map the buildings and man-made structures, as well as detecting changed conditions and subsequently updating corresponding spatial databases with the new information.

In a broader sense, the research challenges associated with modern data acquisition systems go beyond the familiar technological aspects of sensor calibration, algorithm development, data processing and quality analysis, into the realm of automated information extraction from the generated data. The current manual process of detecting the desired features to be 'mapped' as part of various spatial information production processes, from bare-earth terrain modeling to biomass estimation, remains a significant and costly impediment to the expeditious generation of information products. Automated feature extraction and subsequent spatial information product generation remains an area requiring extensive research.

5.4 Energy

There are 14 electrical transmission and distribution organisations currently operating in Australia with a regulated asset base of \$26 billion and a capital expenditure of \$13 billion. Capital works currently under construction in South East Queensland alone total in excess of \$4.8 billion. Delivery of this power is by way of a vast infrastructure including 750,000km of lines, 4.5 million power poles and approximately 16,000 towers (Mark Watt pers com, 2007).

Effective management of the network and its ability to meet safety, reliability and quality of service demands is an increasingly difficult and challenging task in the context of ageing infrastructure, increasing power demands and bushfire risk, security, political and societal demands (eg carbon footprint), regulatory and legislative reforms and the *financial realities around bottom line returns*.

Australia needs an intelligent utility network for these reasons and to help stimulate innovation of emerging technologies and implement carbon neutral strategies through a nationally coordinated approach.

5.5 Natural Resources, Agriculture and Climate Change

Much of Australia's renewable natural resources, principally agriculture and water, are currently in crisis as a result of our current approach to their exploitation. Most of Australia's agricultural systems are currently not operating sustainably when viewed in the long term. There is increasing competition between the desire to sequester carbon in forests and the need to extract more water from the environment for agricultural and human use. Forest extension is reducing the availability of land traditionally allocated to agriculture. These competing forces are causing profound changes to Australia's rural, social fabric. There is a clear and emerging consensus that Australia needs to take a whole of landscape approach to land use planning by integrating decision-making for agriculture, natural resources (especially forestry), carbon sequestration (and yield) and water management. Critical to supporting this integrated decision-making will be the provisioning of the right information products, their interoperability and the flow of those information products to users.

The CRCSI proposes assessment of the amount and composition of biomass in entire farming systems using a range of remote sensing data as well as on-ground sensors. Furthermore improved measures of sustainability, carbon footprints, whole of landscape outputs and risks to natural resources are intended to be researched.

5.6 Defence

Australia currently spends about \$22 billion per annum on military activity (Commonwealth of Australia, 2007). This expenditure is forecast to increase as a proportion of government spending in coming years. Australia recognises that as a medium sized power with a number of very large neighbours, with whom it cannot compete on defence spending on a dollar for dollar basis, that it will need to be much smarter in its use of technologies for defence purposes. Australia will be increasingly looking to its own spatial information business sector to provide leverage for local expertise and research capabilities.

There is a view emerging that Australia needs to reconsider the level of autonomy that it wishes to exercise over the control of spatial information that critically contributes to its national defence and national sovereignty. Australia does not own any space based infrastructure that governs the provision of imagery and positioning information although there are 50 other nations that do for their own purposes (OECD, 2007).

Hence CRCSI defence research interests are likely to include improved feature extraction algorithms from radar imagery, seamless integration of topographic and hydrographic data for littoral research, data aspects related to Unmanned Aerial Systems (UAS) as well as contributions to the national space strategy.

5.7 Health

Australia does not have a single consolidated database of the location of its most important health assets including hospitals, clinics, and nursing homes. Nor does it have a complementary database of the number and skill sets of the people (medically trained and other medical support staff) who work within these facilities, nor does it know their geographic distribution with any precision. It is therefore very cumbersome for Australia to properly undertake health-related workforce and asset management planning (new buildings, refurbishing and decommissioning).

Secondly, there is no facility for a single consolidated flow of clinical information from the 7,000 general practitioners (medical doctors) in Australia to an aggregated national and regional picture for the purpose of analysing the demographics and epidemiological issues that influence so much of Australia's preventative and clinical health medicine needs.

The role of spatial information and spatial technologies in both instances is potentially very large although very modest at present. Moreover, when one considers that the current Australian Government allocation for health and welfare alone is over \$100 billion per annum (50% of the total Federal budget allocation (Commonwealth of Australia, 2007)), the potential for the rigorous application of spatial technologies to improve the management of these issues is compelling.

In the development phase the CRCSI would help build databases of assets linked to the location of the workforce, as well as the network to facilitate the flow of electronic information. A research phase would follow to assess the current and future needs regarding the distribution of medical facilities and skilled medical resources. Furthermore patterns of expression of medical problems will be analysed to put more effective preventative programs in place.

6. CONCLUSIONS

Spatial information is becoming ubiquitous in Australia. It is increasingly driving activities of many organisations and individuals. The activities that rely on spatial information are coming together in complex ways and are strongly influenced by the national systems of information flow and uses. If Australia can improve those systems enormous innovation potential will be unleashed and Australia will become an even more spatially intelligent society.

The CRCSI is well positioned as an 'innovation hub', bringing together specialists and resources to develop the science underpinning spatial information infrastructure and spatial information science applications. Virtual Australia will change the way Australians live, helping informed citizens make better decisions faster.

ACKNOWLEDGEMENTS

This work was conducted within the CRC for Spatial Information, established and supported under the Australian Government's Cooperative Research Centres Program.

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