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**SPATIALLY ENABLING GOVERNMENTS:
A NEW VISION FOR SPATIAL INFORMATION**

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Spatially enabling governments: A new vision for spatial information

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SUMMARY

The vision of a spatially enabled government involves establishing an enabling infrastructure to facilitate use of place or location to organise information about activities of people and businesses, and about government actions, decisions and polices. Once the infrastructure is built, spatial enablement allows government information and services, business transactions and community activities to be linked to places or locations. Given the potential of new technologies, use of place or location will facilitate the evaluation and analysis of both spatial and non-spatial relationships between people, business transactions and government.

Most governments already have considerable infrastructure and administrative systems for better management of land and resources. Basic information creating processes are cadastral surveying that identifies land and running a digital cadastral database (DCDB) providing the spatial integrity and unique land parcel identification, registering land that supports simple land trading (buying, selling, mortgaging and leasing land); running land information systems (LIS); and geographic information systems (GIS) that provide mapping and resource information. For modern governments at all stages of development, one question is how best to integrate these processes, especially to offer them in an Internet enabled eGovernment environment.

Twenty years ago, each process and collection of information, was distinct and separate. Two changes in the world at large challenged this silo approach. First, thanks to improvements in technology, the infrastructure available to support modern land and resource management now spans three distinct environments: the natural, the built and the virtual environments. Second, the pressures on managers created by increased populations, environmental degradation, water scarcity and climate change, require governments to have much more accurate and comprehensive information than ever before.

One commodity in particular - land information - has the ability to transform the way government and private sector organisations do business. The *eLand* administration concept as part of *eGovernment* initiatives is now moving to a wider use of spatially enabled land information, expressed in the concept of *iLand*, integrated, interactive spatial information available on the Internet.

1.   INTRODUCTION

1.1   Themes for organising information

In 2004, the Centre for Spatial Data Infrastructures and Land Administration began a project on *Incorporating Sustainable Development Objectives into ICT Enabled Land Administration in Australia*. The research concerned the future development of land administration systems (LASs) in highly developed countries with extensive experience in administration and capacity for good governance. The systems developed by highly successful countries will continue to form global models for land management and administration (UNECE, 2005). A major collaborative effort, an Expert Group Meeting, of 9-11 November, 2005 held in Melbourne and attended by European and Australian experts, contributed significantly to the research results (Williamson et al., 2006).

The project involved a comparison of Australian and European LAS. Australian LAS use the latest information and communications technology (ICT). However, their data is held in agency silos and is focused on individual parcels, reflecting historical creation of maps by a "part to whole" approach. These LASs cannot adequately support the management and decision making needed about wider fiscal, environment and social issues. The project demonstrated that, in the future, these systems need to refocus activities and information management on sustainability accounting (Wallace and

Williamson, 2006a, Williamson and Wallace, 2006) particularly by delivering higher quality, comprehensive, and reliable social, economic and environmental information. By contrast, European LAS installed a complete map base or cadastre for taxation purposes, and later added land registration functions. Their classic "whole to part" approach assists integrated land management. Given their highly developed land management approaches, European nations need to focus on ICT delivery and information exchange.

While the project reviewed existing institutional structures, its principal findings concerned global trends in ICT, particularly geographic information systems (GIS), as they applied to land administration. This background research, and the case studies in Denmark, Germany, The Netherlands and Switzerland in Europe and Victoria, New South Wales and Western Australia in Australia, revealed a much larger capacity for LASs to deliver sustainability than that identified in existing literature. This anticipated improvement in use of technology relies especially on three cross-cutting themes for creating and organizing land information. These are:

1   **Designing land management systems for sustainable development**, particularly to focus on sustainability accounting to evaluate and monitor social, economic and environmental policies

2   **Building on new technical support in land administration**, particularly to organise land and spatial information

3   **Moving into spatial enablement technologies**, particularly to retrieve the value from land and spatial information for whole of government, not merely land management.

These cross-cutting themes provide guidance about future policy, administrative, and IT strategies to be adopted by governments, businesses and communities. The themes need to be brought into land and spatial information policy making and forward planning processes through effective, useful programs that are capable of national, regional, and even global, implementation. The scale of the issues involved in managing and implementing these themes and understanding how they interrelate is vast. Three forward visions are therefore proposed to assist incorporating the themes into future decisions.

1.2   Natural, built and virtual environments

The project used collaborative efforts to build two new visions, and to incorporate a third vision of spatial data into forward planning processes. These visions are:

–   a land management vision

–   a spatial data infrastructure (SDI) vision: SDI as an enabling platform, and

–   a virtual environment vision: *iLand* in a virtual jurisdiction.

These visions will inform reengineering of land administration and mapping to better deliver sustainable development and government IT strategies. The visions reflect historical, technical and professional divisions familiar to practitioners in land administration, land information, spatial information and mapping. For those outside this range of expertise, the distinctions reflect three distinct but interrelated environments and their respective information policies and processes. The environments and their IT support processes are:

the natural environment of the world, where small scale information about hydrology, contours, rainfall, land use, vegetation, and hundreds of other data sets, exist, supported by geographic information systems (GIS), that utilize images and visualizations

the built environment constructed by human action, where surveyors gather information about land parcels and use this to build a large scale, digital, cadastral database (DCDB), and

the virtual environment where combinations of scientific, engineering and technological endeavours reproduce natural and built reality on digital screens.

The messages in the visions drive one overarching conclusion. **Information policy is the key to future successful management of all three environments**. Each of the visions is designed to inform decisions about future IT support, government administrative infrastructures, and the global approach to land management. They are discussed below.

2   LAND MANAGEMENT VISION

The cross-cutting themes potentially apply to all nation states, and to regional and global organisations. The broad land management vision in Figure 1, below, (Williamson et al., 2006) allows a significant national flavour to permeate the institutional arrangements. It recognizes the unique situation of each country, and respects the variety of people to land relationships that now operate. The overarching design of the vision is to facilitate sustainable development. Because it was designed in the context of LAS, it proposes to extend the familiar activities in land tenure, valuation, use and development to promote national land policies for sustainable development.
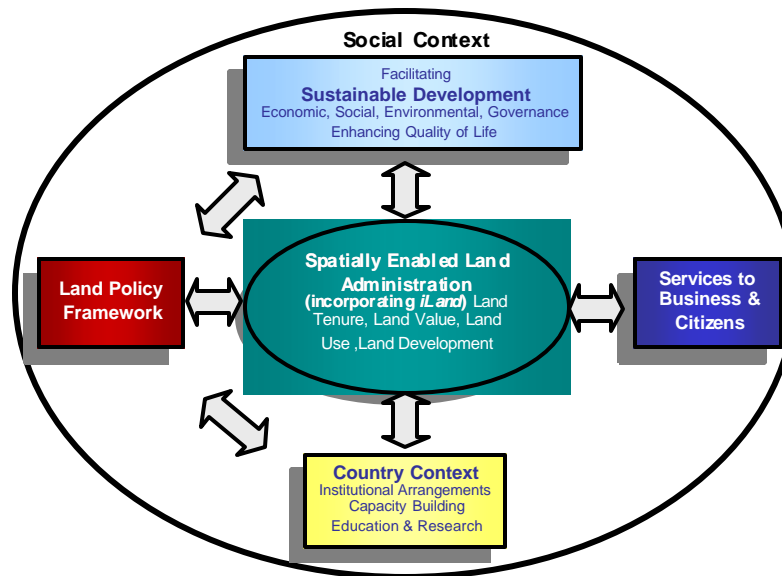

Figure 1 – Land management vision (Williamson *et al.,* 2006)

LAS functions of land registration and tenure, valuation, planning and development remain the institutional core of successful economies. These functions change continually in response to new ideas about sustainable development, demand driven processes, and challenges of technology.

One kind of pressure is particularly challenging for LAS. Australia is leading the world in "unbundling land" into separate, tradeable commodities of water, biota, carbon credits, planning permissions and market based instruments. Thus far, the unbundling processes have mainly relied on existing LASs, particularly the registration processes used in Australia's Torrens systems. The expansion of modern LAS s to support the trading of complex commodities offers many opportunities for surveyors and cadastral administrators. However, one particular commodity - land information - has great potential to significantly change the way societies operate and how governments and the private sector do business. The growth of markets in complex commodities is a logical evolution of our people to land relationship and our evolving cadastral and land administration systems. The changing people to land relationships, the demand for sustainable development, and the increasing need to administer complex commodities, all within an ICT enabled virtual world, offer new opportunities for our LA and mapping systems. However, many challenges need to be overcome before these opportunities can be achieved.

Technology will play a significant role in the organisation of these new markets,. One aspect of organisation of information about land, "layering" of visual datasets, is particularly useful. The application of layering is highly developed in web-based mapping systems that allow integration of topographical information, shown in Figure 2, opposite.

In GIS, spatial enablement of each data layer allows information to be presented as a set of "overlays" of images, text (road and place names), boundaries (waterways, parcels and buildings), and utility infrastructure (pipelines, wires and cables, sewers and d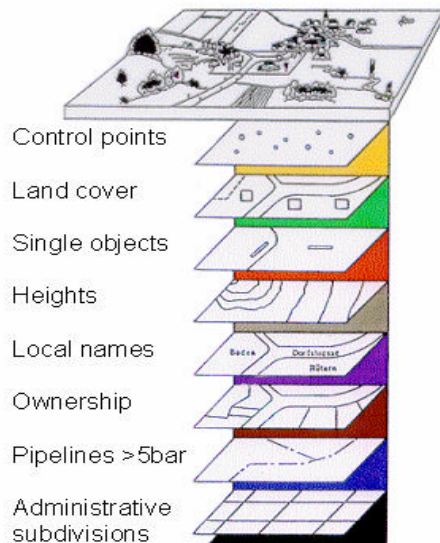rains). The efficiency of spatial enablement of information related to land and its built features lies in the replication of reality in the virtual environment. This can only succeed if the various information layers are similarly geo-coded and organised. Visual layering accounts for the world-wide popularity of GIS as a means of organizing and presenting land data. To achieve the maximum opportunities out of GIS technology, however, a great deal of inter-agency, inter-government and international cooperation is essential. The development of an SDI is the key process to building this cooperation.

Figure 2: Different layers of information (Steudler, 2006)

The capacity for these visualizations to support land and resource management is apparent to all. In a context of national "unbundled" interests in land, the technology can assist owners and administrators to understand what interests directly and indirectly impact on specific land, whether it is arranged in a parcel configuration or a geographic area. However, the cost of building and maintaining these technical facilities is enormous and not justified unless the out-puts of efficiencies and savings, and their availability to government and business, extend far beyond mere LAS. The story of the future, then, involves extending the utility of this virtual environment about land into a whole of government facility. To do this, we offer the concept of *iLand* as a vision for the future. To build iLand, however, a nation must first build an SDI platform.

3   SPATIAL DATA INFRASTRUCTURE VISION

Spatial data infrastructure (SDI) is an evolving concept. In simple terms it is as an enabling platform linking data producers, providers and value adders to data users. SDIs are crucial tool in facilitating use of spatial data and spatial information systems. They allow the sharing of data, which enables users to save resources, time and effort when acquiring new datasets. Many nations and jurisdictions are investing in developing these platforms and infrastructures to enable their stakeholders to adopt compatible approaches to creation of distributed virtual systems to support better decision-making. The success of these systems depends on collaboration between all parties and their design to support efficient access, retrieval and delivery of spatial information.

The steps to develop an SDI model vary, depending on a country's background and needs. However, it is important that countries develop and follow a roadmap for SDI implementation. Aspects identified in the roadmap include the development of an SDI vision, the required improvements in national capacity, the integration of different spatial datasets, the establishment of partnerships, and the financial support for an SDI. A vision within the SDI initiative is essential for sectors involved within an SDI project and for the general public. The SDI vision helps people to understand the government's objectives and work towards them.

With these considerations in mind, Masser *et al.* (2006) addressed three strategic challenges involved in creating this new environment. The first of these is the need for more inclusive models of coordination, given that SDI formulation and implementation involves a very large number of stakeholders from all levels of government, as well as the private sector and academia. The second concerns the promotion of data sharing between different kinds of organisation. In some cases this may require new forms of organisation to carry out these tasks. The third challenge relates to the establishment of enabling platforms to facilitate access to spatial data and the delivery of data related services.

3.1   SDI as an enabling platform

Effective use of spatial information requires the optimisation of SDIs to support spatial information system design and applications, and subsequent business uses. Initially SDIs were implemented as a mechanism to facilitate access and sharing of spatial data hosted in distributed GISs. Users, however, now require precise spatial information in real time about real world objects and the ability to develop and implement cross-jurisdictional and inter-agency solutions to meet priorities such as emergency management, natural resource management, water rights trading, and animal, pest and disease control.

To achieve this, the concept of an SDI is moving to a new business model, in which the SDI promotes partnerships of spatial information organisations (public/private), allowing access to a wider scope of data and services, of greater size and complexity than they could individually provide. SDI as an enabling platform can be viewed as an infrastructure linking people to data (Rajabifard *et al.*, 2005a) through linking data users and providers on the basis of the common goal of data sharing (Figure 3). However, there is a need to move beyond a simple understanding of SDI, and to create a common rail gauge to support initiatives aimed at solving cross-jurisdictional and national issues. This SDI will be the main gateway through which to discover, access and communicate spatially enabled data and information about the jurisdiction.
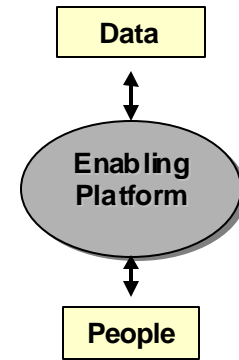
According to Masser and other, (2006), the development of SDIs over the last 15 years and the vision of spatially enabled government outlined earlier have many parallels, but there are also important differences. The challenge is to develop an effective SDI that will support the vast majority of society, who are not spatially aware, in a transparent manner. All types of participating organisations (including governments, industries, and academic) can thus gain access to a wider share of the information market. This is done through organisations providing access to their own spatial data and services, and in return, becoming contributors, and hence gaining access to the next generation of different and more complex services. The vision is to facilitate the integration of existing government spatial data initiatives for access and delivery of data and information. The benefits of such an environment will be more than just the representation of feature based structures of the world. It will also include the administration and institutional aspects of these features, enabling both technical and institutional aspects to be incorporated into decision-making. Following this direction, in Australia for example, they have started to develop an enabling platform called **Virtual Australia** (Rajabifard *et al.,* 2006). The concept and delivery of Virtual Australia aims to enable government and other users from all industries and information sectors to access both spatial information (generally held by governments) and applications which utilise spatial information (developed by the private sector and governments).

Figure 3: SDI connecting people to data

3.2   SDI to facilitate integration of natural and built environment datasets

Achievement of sustainable development is not possible without a comprehensive understanding of the changing natural environment, and monitoring the impact of human activities by integrating the components both built and natural environments. Despite the significance of data integration however, many jurisdictions have fragmented institutional arrangements and data custodianship in the built and natural information areas. The fragmentation of data custodians has brought about a diversity of approaches in data acquisition, data models, maintenance and sharing. Many countries are attempting to address these inconsistencies through development of national SDIs. However, further steps of a framework and associated tools to facilitate integration of multi-sourced data, are also needed. (Mohammadi *et al.*, 2006). An SDI can provide the institutional, political, and technical basis to ensure the national consistency of content to meet user needs in the context of sustainable development; particularly if it allows access built and natural environmental datasets.

4 VIRTUAL ENVIRIONMENT VISION - *iLand*

Most land administration processes, apart from the cadastre itself, are not yet spatially enabled, that is, organised through software that recognizes the geo-coding of the data, particularly for land parcels. As yet, the layering of visual information, described above cannot be achieved. But, if the conclusions drawn from the analysis of ICT trends and use of the cadastre below are accurate, this will soon change.

4.1 Central place of the cadastre

Central to a successful LAS is a cadastre or its equivalent of a large scale parcel map that describes the actual way people use and describe their land. All modern economies recognize its importance and either incorporate a cadastre or its components in their LAS. For example, while Australian LAS did not evolve a cadastral focus like their European counterparts, today they use cadastres which equal and sometimes improve upon the classic European approach. The cadastre provides a spatial integrity and unique identification for land parcels within aLAS. The data collection process relies on rigorous methods to measure and mark the Earth used by surveyors who establish the **legal boundaries** of parcels. As a result, the cadastre is the only "map" with both definitive legal authority (as a socio/legal construct) and definitive technical authority (as a scientifically verifiable data set). The geo-referencing of information in the cadastre is therefore determinative in many normative systems, not merely in a technical, scientific system. It is always legally determinative, even if the machinery used for standard surreys is obsolete. More importantly, it is determinative in the sense that it reflects how people think about and use their land. The cadastre is the basic, people-friendly, easily understood layer of information about land. Its digital partner, the DCDB, takes these qualities into the virtual environment.

4.2 New demands on cadastres

Initiatives of the International Federation of Surveyors (FIG) highlight the changing roles of the cadastre, particularly the **Statement on the Cadastre**, (FIG, 1995), **Cadastre 2014** (FIG, 1998) and the **Bathurst Declaration** on land administration for sustainable development (FIG, 1999).The standard model of parcel layout with text attributes about owners and interests does not entertain the evolving and complex rights, restrictions and responsibilities that a modern society demands in order to deliver sustainable development objectives. It also does not show the important role the cadastre plays in supporting integrated land management or in providing critically important land information to enable the creation of a virtual society and *eGovernment*. Meanwhile, the demand for new kinds of digital services are sufficiently recognized for initiatives in land information systems (LIS), especially taking up GIS, to fill obvious gaps that cadastres in their current form cannot meet. In Australia, the technical support for the mining industry provides the best example of non-cadastral based, highly successful information systems, often with international acclaim: for instance the Open Geospatial Consortium Gardels award 2006 to Simon Cox for his contributions to the OpenGIS(R) Geography Markup Language (GML), Sensor Web Enablement (SWE) and Web Feature Service (WFS).

Technology is not the only change. The land market of 1940 is unrecognisable in today's modern market: Figure 4 below. After WW II, new trading opportunities and new products were invented. Vertical villages, time shares, mortgage backed certificates used in the secondary mortgage market, insurance based products (including deposit bonds), land information, property and unit trusts and many more commodities now offer investment and participation opportunities to millions either directly or through investment or superannuation schemes. The controls and restrictions over land became multi-purpose, and aimed at ensuring safety standards, durable building structures, adequate service provision, business standards, social and land use planning, and sustainable development. The replication of land related systems in resource and water contexts is demanding new flexibilities in our approaches to land administration (Wallace and Williamson, 2006b). These emerging demands will stimulate different approaches to cadastral information.

Figure 4 - Evolution of land markets   (Wallace and Williamson, 2005a)

4.3   Land information

The traditional concept of cadastral parcels representing the built environmental is being replaced by a complex arrangement of over-lapping tenures reflecting a wide range of rights, restrictions and responsibilities. Many of these are amenable to visual display in a digital environment if their boundaries are geo-coded. A new range of complex commodities building on this trend, and similarly amenable to incorporation in the virtual environment, has emerged. To a large extent, these developments are driven by the desire of societies to better meet sustainable development objectives. These trends will continue. The growth of complex commodities therefore offers huge potential for cadastral systems to play greater roles to support delivery of sustainable development objectives and new trading systems. However, the greater potential of cadastral systems lies in the scale and nature of the information they provide, especially in their reflection of familiar patterns of land use and distribution.

A glimpse of this potential is given by Google Earth and Microsoft's Virtual Earth, but this is barely a start. These predictions of the importance of spatial information are also recognized in many other influential forums, including the prestigious journal NATURE, in the Australian Prime Minister's statement on frontier technologies for building and transforming Australia's industries (December, 2002), and in the launch of Australia's *eGovernment* agenda by Minister Gary Nairn, 30 March 2006. These examples place the growth and importance of the geosciences alongside nanotechnology and biotechnology as transformational technologies in the decade ahead.

The increasing significance of land administration and its cadastral core, as shown in Figure 5, increases if a technology focus is used to track changes over a forty year span. The figure shows five stages in the evolution of cadastral systems from a technology perspective. The first stage recognizes that cadastral systems originally depended on manual systems with all maps and indexes hard copy. At this stage the cadastre focused on security of tenure and simple land trading. Many countries still rely on manually organised cadastres. The 1980s saw the computersiation of paper hard copy cadastral records with the creation of DCDBs and computerized indexes. Computerization did not change the role of the land registry or cadastre; however, it was a catalyst for world wide, institutional, change that brought together both traditionally separate functions of surveying and mapping, and management of the cadastre and land registration processes.
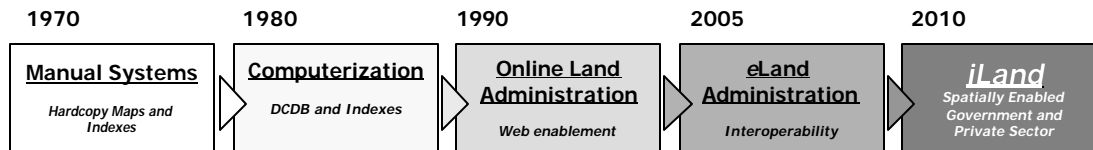
1970	1980	1990	2005	2010
Manual Systems *Hardcopy Maps and Indexes*	**Computerization** *DCDB and Indexes*	**Online Land Administration** *Web enablement*	**eLand Administration** *Interoperability*	*iLand* *Spatially Enabled Government and Private Sector*

Figure 5 - Technical evolution of land administration

With the growth of the Internet, the 1990s saw governments start to Web enable their land administration systems as they became more service oriented. Access to cadastral maps and data over the Internet became possible. Digital lodgment of cadastral data and *eConveyancing* followed. However, the focus on security of tenure and simple land trading within separate institutional data silos still continued. At the same time, this era also saw the establishment of the SDI concept (Williamson *et al.* 2003; Rajabifard *et al.,* 2005b). The SDI concept, together with Web enablement, exposed the need to integrate different data sets (particularly the natural and built environmental data sets), and identified integrated data sets as critical infrastructure for any nation. In the future, ICT will drive more mergers: most obviously between digital surveying and mapping systems, and between spatially enabled land information systems and spatially enabled general administration systems. These developments underpin the idea of *iLand*.

Meanwhile, innovations in handling land information are well underway. Significant refinement of Web enabled LAS, driven by the demand for interoperability between disparate data sets, is being facilitated by the partnership business model. This marks the beginning of an era in which basic land, property and cadastral information is used as an integrating technology between many different businesses in government, including as planning, taxation, land development, and local government. Examples of this are the new Shared Land Information Platform (SLIP) being developed by the state Government of Western Australia (Searle and Britton, 2005). A catalyst for these developments is also formation of high integrity, geocoded, national, street address files, particularly the Australian GNAF (Paull and Marwick, 2005). These developments are similar in nature to "mesh blocks" which revolutionalise collection and use of census and demographic data by using small aggregations of land parcels (Toole and Blanchfield, 2005). An expected and needed outcome will replace polygons focused on parcel arrangements with open-ended capacity to visualize land affected by restrictions and responsibilities (Bennett *et al.,* 2005). Re-engineering of cadastral data models will facilitate interoperability between the cadastre, land use planning and land taxation, for example (Kalantari *et al.*, 2005). The modern cadastre no longer stops at the water's edge. Cadastres must include a marine dimension where there is a continuum between the land and marine environments. Without the basic infrastructure, management of the exceptionally sensitive coastal zone is very difficult, if not impossible (Strain *et al.* 2005).

These innovations identify new ways for governments to realize potential of land and cadastral data. They use cadastral data as an enabling technology or infrastructure in which its potential value outstrips its current value as a support for simple land trading and delivering security of tenure.

Significant though these innovations are, popular, ICT uses of land information show even more dynamism. Researchers, practitioners, big business and government are now seeing how "location" or the "where" can be linked to most activities, polices and strategies. Companies like Google and Microsoft are actively negotiating access to the world's large scale built and natural environmental data bases. In Australia, the computer giants are negotiating to get access to the national cadastral and property maps, as well as to GNAF. At the same time, more innovatory ideas are being built on top of these enabling infrastructures, such as the Spatial Smart Tag, a joint initiative in Australia between government, the private sector and Microsoft (McKenzie, 2005).

4.3   Spatial enablement of *Whole of Government*

Cadastral and land related information now have the potential to spatially enable government, the private sectors, and society in general, and to expand computer support for processes of visualization,

organisation and management of useful information, not just land information. In the near future, spatially enabled systems will underpin health delivery, many forms of taxation, counter-terrorism, environmental management, most business processes, elections and emergency response, for example (Wallace *et al.*, 2006).

In the scheme of things, information about land is small in amount. Information about people is much more extensive. Information about business activities, for instance, banking transactions, is also enormous in quantity. It is in the organisation of all this non-land information that spatial enablement will make the greatest difference. The point is to make the key information about land (the parcel, its address, use and description and all the geo-coded information attached) available to organise the estimated 80% of decisions that involve a place. These are not spatial in nature. The address or place is incidental. But with the advantage of geo-coding and digital visualization, the "where" or the place things happen can be used as a method of organizing and analyzing layers data that was not previously available (Wallace *et al.*, 2006; Williamson and Wallace, 2006a).

The future will see an era when cadastral data will be shared information and a new concept called *iLand* will become the paradigm for the next decade. *iLand* is a vision of integrated, interoperable, spatially enabled land information available on the Internet. *iLand* enables the computer to define the "where" in government policies and information. The vision as shown diagrammatically in **Figure 6** is based on the engineering paradigm where hard questions receive "designed, constructed, implemented and managed" solutions. In *iLand* all major government information systems are spatially enabled, and the "where" or location provided by spatial information is regarded as a common good made available to citizens and businesses to encourage creativity, efficiency and product development. The LAS and cadastre are even more significant in *iLand*. Modern LA demands this fundamental infrastructure of land information is to be capable of supporting those "relative" information attributes (owner's income, business arrangements, expenses, and so on) that are vital for land markets and equitable tax collection.

While future markets of complex commodities will continue to rely on the underlying cadastre and LAS, surveyors, land and mapping administrators need to embrace the definition and management of complex commodities that do not rely on traditional cadastral boundaries and that require merging of value, building purpose, land use and personal owner information (Williamson, 2005). How many LAS and mapping administrators are capable of seeing the international context of land information and its importance to their national government in presentation of its investment face to the world? Will they embrace *iLand*?

The future presents a challenge to LA and mapping officials to design and build modern land administration, cadastral and mapping systems that use land information to spatially enable LAS, whole of government and society in general. Unfortunately, without these systems, modern economies will have difficulty meeting sustainable development objectives and achieving their economic potential.

Design features of modern integrated LAS and mapping are -

– a collaborative, whole of government, approach to managing spatial information using SDI principles
– better understanding of the role played by LAS and mapping in integrated land management (land markets, land use planning, land taxation etc)
– seamless integration of built and environmental spatial data in order to deliver sustainable development objectives
– improvement of interoperability between our land information silos through *eLand* administration
– better management ever increasing restrictions and responsibilities relating to land, and
– incorporation of the marine dimension into both our cadastres and LAS.

All these initiatives come together to support a new vision for managing land information - *iLand*.
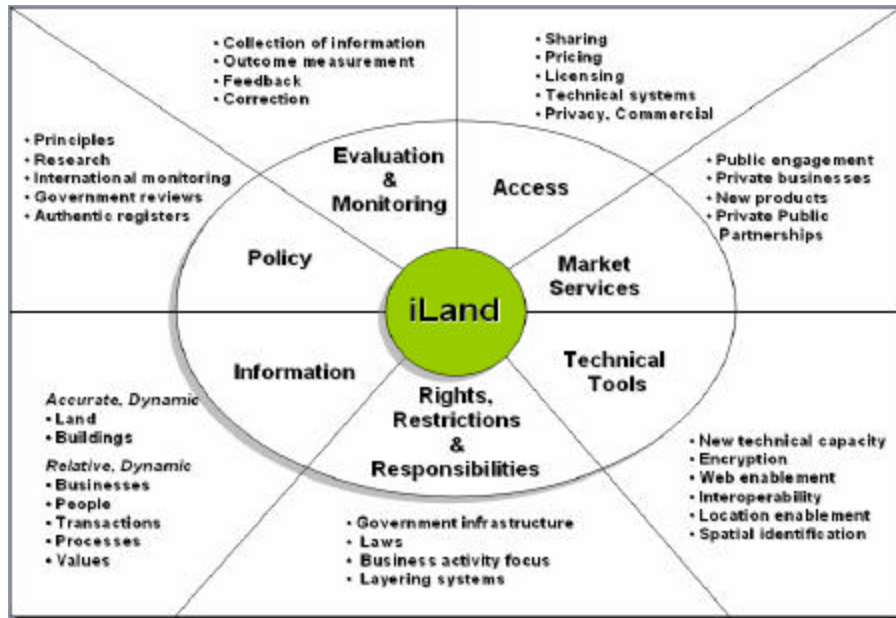
Figure 6: The *iland* vision (Wallace and Williamson, 2005)

CONCLUSIONS

People to land relationships are dynamic with the result that the land administration and cadastral responses to managing the relationship is also dynamic and continually evolving. LASs are expensive to operate and will continue to be funded primarily through efficient and effective land markets. This lies behind the focus of land surveyors and LA administrators on the more traditional processes supporting simple land trading. Sustainable development and technology drivers, offer many opportunities for LA administrators if they are prepared to think laterally and more strategically.

Governments can be regarded as spatially enabled they treat location and spatial information as common goods made available to citizens and businesses to encourage creativity and product development. The three visions (land management vision; SDI vision and virtual environment vision) were presented to assist understanding and implementation of the spatially enablement of governments. The visions reflect historical, technical and professional divisions familiar to practitioners in land administration, land information, spatial information and mapping. They also show that these divisions are no longer relevant and that reengineering of land administration and mapping to deliver sustainable development and government IT strategies will transform natural, built and virtual environments.

One particular complex commodity, land information, has grown in importance since 1990. In the emerging virtual environment, information generated by LASs and organised through SDIs will be much more important and useful to government than it was in its traditional roles of supporting security of tenure and simple land trading.

ACKNOWLEDGEMENTS

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