CADASTRE 2034

Powering Land & Real Property

Cadastral Reform and Innovation for Australia - A National Strategy

ICSM

ANZLIC COMMITTEE ON SURVEYING & MAPPING

A Vision for Cadastre 2034

"A cadastral system that enables people to readily and confidently identify the location and extent of all rights, restrictions and responsibilities related to land and real property."

In future, citizens will know what can be done on land (rights), what cannot be done (restrictions) and what must be done (responsibilities).

Foreword

We are facing change in many facets of life and our cadastral environment is no different; state and territory governments are on the brink of reforming cadastral systems.

In preparing Cadastre 2034, the objective of the Intergovernmental Committee on Surveying and Mapping (ICSM) is to promote an organised and consistent approach to managing these changes in a way that supports both jurisdictional and national interests.

Our aim is to establish a shared vision and aspirational goals for the cadastral surveying and spatial sector nationally. Our intent is for jurisdictions to converge on important issues to achieve a unified approach to the management of cadastral information.

At the heart of our mission is consumer expectations and the opportunities afforded through integrated social, economic and land-related information.

The emphasis is toward achieving a cadastral system that enables the community to readily and confidently identify the location and broader interests that relate to land and real property. This includes enhancing the usability and visualisation of cadastral information by embracing 3 and 4 dimensional capabilities.

A key element of this strategy is to ensure the longevity of our cadastral systems. This requires a strong commitment to improving the management and sharing of cadastral information and the dedication to preserve this valuable resource for future generations.

I would like to thank all of the individuals, organisations and businesses who took part in the consultation period and provided us with their experience, visions and ideas for our future. Contributions came from those engaged in advancing the cadastral surveying and spatial sciences, either through their day-to-day business endeavours, or through research and development.

Without these contributions we simply would not have been able to develop a strategy that targets the right issues. Nor would we have a plan that can be translated and applied to real situations over time.

In delivering this strategy, we will not be working alone. During the consultation period many professional bodies, businesses and research organisations indicated support for the strategy and are keen to participate in future implementation stages.

Close collaboration with industry is vital. Over the coming years we intend to make the most of the relationships we have built and are keen to find more ways to secure the expert advice of many in our industry. The hard work required to deliver on this strategy can only succeed through the collective endeavours of the surveying and spatial community.

Michael Burdett
Chair
Intergovernmental Committee on
Surveying and Mapping


M1
WEST GATE FWY
West Gate Br
Geelong

Contents

Cadastre 2034

Outlook

Cadastre 2034 anticipates that the modern cadastral system we know today will not fulfil community expectations in the future; we can already see a gap emerging between what we have and what will be needed.

Societal demands will change substantially over the next 20 years as new technologies, environmental challenges and social and political influences gradually transform our inherent accountabilities, traditions, practices and thinking.

Cadastre 2034 responds to these changes and the challenges they represent. It builds on the achievements of Cadastre 2014 that heralded the creation of digital cadastres and continues the journey to link cadastral information with broader social and legal interests on land [1, 2].

Purpose

The purpose of Cadastre 2034 is to establish a single point philosophy on what the community can expect and what the government has to deliver in the future.

Cadastre 2034 is intended to guide the evolution of jurisdictional systems and ensure a coordinated and consistent approach to planning future policies, legislation, standards, models and research.

Each jurisdiction will use this high level strategy to work towards achieving the identified goals from their own unique starting points. This includes New Zealand, which shares the same vision and expectations but has a different physical and administrative environment [3].

Objectives

Cadastre 2034 identifies where current information falls short of consumer expectations today, and considers the user scenarios that will trigger changing needs in the future. The intent is to capture the trends and articulate the vision of what the community will require of our cadastral system in the future.

The objectives of Cadastre 2034 are to:

- Establish a common vision for all jurisdictions, industry and academia.
- Set down enduring principles to preserve the essential components of the cadastral system over time.
- Express the goals required to achieve a consistent and coordinated approach to the transformation of the Australian cadastral infrastructure over the next 20 years.
- Identify the required outcomes that will guide the governance, policy development, standards, research programs and the design of future systems.
- Recommend actions and innovations that will lead to the achievement of our vision.

Vision

In developing a vision for Cadastre 2034, a fundamental principle is that land (and/or real property) is the basis for human activity; and that having knowledge about land is essential for wise decision making in a modern society.

The cadastral system of the future is envisioned as being a highly influential part of tomorrow's decision support systems; powering land and real property management, development and investment.

This will require property and all other interests on land to be managed in an integrated manner.

Our vision is:

A cadastral system that enables people to readily and confidently identify the location and extent of all rights, restrictions and responsibilities related to land and real property.

Mission

Planning for the future is only one part of the journey. The most important aspect is taking ownership of the plan and bringing together all facets, from strategic actions to smart innovations, in order to create a cadastral system we can continue to be proud of in the future.

The challenge will be to manage the convergence of consumer expectations for integrated social, economic and land related systems, and opportunities for growth, with the disruption that comes with the phasing out of one technology and the start of another.

Our mission is:

To promote and support innovation and provide the leadership, coordination and standards necessary to deliver a unified cadastral system that can be leveraged to find sustainable solutions to meet emerging needs and opportunities.

This mission recognises that if we do not have actions aligned with the issues, opportunities and needs of the future; then Cadastre 2034, as we imagine it today, is unlikely to be realised.

Goals

The aspirational goals consider how we design, organise, access, operate and leverage the cadastral system of the future; doing so in a way that considers not only the impact on the environment today, but also how we develop, use and preserve cadastral information resources for the future.

Cadastre 2034 has five goals. Their purpose is to achieve a cadastral system that:

- is fundamental to land and property ownership and is sustainably managed;
- is truly accessible, easily visualised, and readily understood and used;
- is fully integrated with broader legal and social interests on land;
- provides a digital representation of the real world that is survey accurate, 3- dimensional and dynamic[1]; and
- is a federated cadastral system based on common standards.

The overarching objectives, and strategic actions and innovations required to achieve these goals are detailed in the Strategic Framework (page 17) and following sections.

[1] 3-dimensional (or 3D) refers to information that contains length, height and depth; 4-dimensional (or 4D) refers to changes over time and thus captures the dynamic nature of land and property elements.

The Cadastral System

The cadastral systems of Australia underpin stable and reliable registration of land based property rights. They serve as the foundation for effective land tenure transactions and in securing the legal status of property boundaries.

The cadastral system defines and records the location and extent of property rights, restrictions and responsibilities. It includes a geometric description of land and real property boundaries (Figure 1) linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements [4,5].

With an estimated 7.8 million households across Australia today and an anticipated 11.6 million by 2031[2], it is essential that our cadastral system endures as a resource for the continued prosperity of future generations.

The cadastral system comprises mechanisms that collectively ensure all land and real property can be easily, uniquely and accurately identified in a common reference system. This includes a digital representation of land parcels (digital cadastre), instruments defining land, information delivery and access systems, a legal framework, survey marks and other physical evidence of property boundaries, registered surveyors, records of surveys such as plans, and standards for definition and surveying of land (Figure 2).

Figure 1: Cadastral systems include a geometric representation of land and real property boundaries

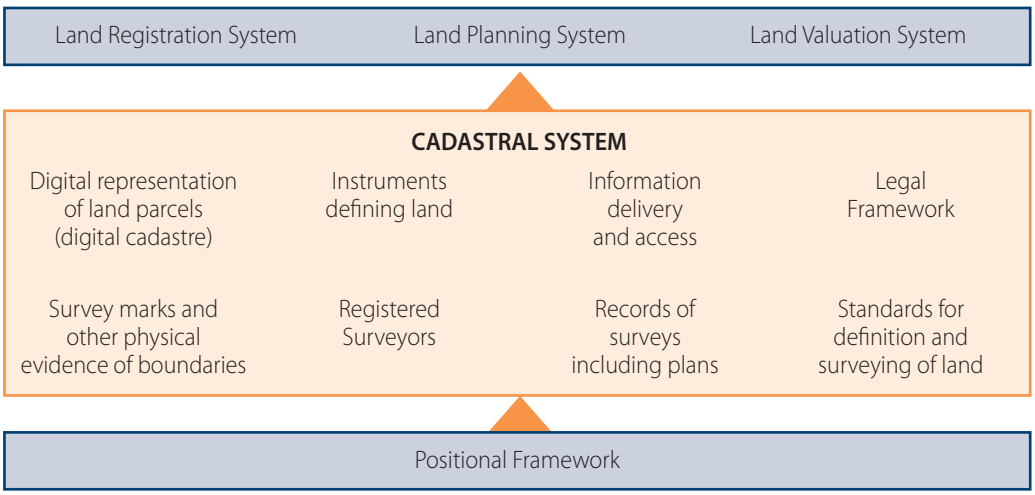

Figure 2: The Cadastral System

[2] Australian Bureau of Statistics, prediction as at January 2013.


615C
CAT
615C
CATERPILLAR
Leica

Significance of the Cadastral System

Cadastral systems play an important and ongoing role, contributing towards the economic and social prosperity we know today and expect in our future.

The cadastral system, in combination with the land registration system, is a powerful economic lever. It assembles, manages and shares information that defines and reinforces property rights. In turn, these property rights translate into economic development, social stability and physical well-being.

At the end of 2014, there were $1.4 trillion in housing loans secured against land titles [6]. At the same time the total value of all real property held in title in Australia was estimated as $5.2 trillion [7]. Given that the size of the Australian economy is $1.6 trillion per annum (as at November 2014) [8], the value of a sustainable cadastral system is self-evident.

The cadastral and land registration systems allow people, businesses and governments to leverage and manage this huge national asset base.

Best use of this fundamental national information asset by government, land owners, investors and land managers has the potential to benefit the economy by an estimated $4.7 billion[3] annually above normal growth; in the short term through better knowledge of earning capacity and in the long term through sustainable management of our natural resources, reduced financing risk on mortgage lending and other initiatives.

Looking to the future, investment certainty and thus economic sustainability can be delivered at three levels:

- on a global level, investor confidence can be increased through mortgage-backed securities if the cadastral and land registry systems are more closely coupled with financial and share markets;
- at a national level, by shifting to a more detailed and consistent model to improve decision making and usability of the digital cadastre for trans-border land management and development; and
- at a jurisdictional level, by increasing productivity and reducing transactional costs through improved cadastral supply chains, use of community crowd sourced data for broader interests on land, and the elimination of duplicated processes across the land and utility sectors.

[3]Calculated on improved return on investment of 0.1%

Anticipating 2034

In 2034 cadastral systems will be further embedded in our social and economic structures - playing a significant role in traditional land tenure, valuation and utility systems, and in the governance frameworks that stipulate how we develop, use and occupy land.

The following will impact on the way we respond as an industry.

Consumer Expectations

Today's online citizens are able to access location information faster than ever before and this trend is set to continue.

Virtual knowledge environments will be the norm. The next generation will be a massively online society wearing devices that record, store and index the things we see and hear.

Mobile devices are likely to be used by citizens and property developers for locating land boundaries and the position of utilities below ground to an accuracy that meets most needs other than legal definition.

This cultural shift towards self-sufficiency is prevalent across many industries today. People want to be more self-reliant and have access to the right information and tools to make sound judgments for themselves.

Land information will need to be available 'on-demand' anyplace, anytime. The community will expect to be warned immediately of an impending threat to their property, such as fire, flood and storm. This will require an integrated knowledge-base with the digital cadastre a central component.

Uncertainty around data quality and spatial accuracy is an issue that will require safeguards to avoid inappropriate use.

Digital Economy

It is widely accepted that traditional sectors will increasingly be impacted by growth in the digital economy as new technologies and ways of doing business evolve. The national electronic conveyancing system and rise in crowd-funded property websites are contemporary examples.

The Australian government is investing in broadband technologies that will reach 93% of the population over the next 10 years. Given this broad impact the cadastral sector will need to continually assess and respond to progressive changes, develop new tools to improve traditional business and consider new services to compete in new markets.

Vertical Living

Vertical living lifestyles will create complex property scenarios that the future cadastral system will need to contend with.

More people will be living in urban environments and multistorey buildings will have shared services and facilities. Transportation systems will be constructed above ground as skyways to reach upper building levels. Future skyscrapers will be characterised by vertical market farming and used as a community food source in addition to inner city carbon benefits.

New legislation will be required to enable the increasing complexity of land and property ownership to be administered.

Smart Cities

Cadastral information has a significant role to play in the development of 'smart' cities. As society strives for safer, more liveable and resilient communities, digital technologies will be more integrated and embedded across government functions and commercial services.

Linking cadastral information with other information will be an imperative. The collective intelligence achieved through system integration will lead to more effective and active engagement with citizens through smart transportation systems, emergency services, health care, protection of the environment, and the provision of utilities such as energy, water and waste management.

Enabling technologies

Given the way the surveying and spatial industry has embraced technological change in the past, the potential for future innovations is likely to be substantial.

Cadastral supply chains will be far more efficient, taking full advantage of automated workflows and integrated systems that enable mobile business and online consumer transactions. This will be made possible through semantic web technologies that simplify and decode complex data so that it is easily accessible and understood by the wider community.

It will be feasible for survey accurate data to be transferred directly from the field to the cadastral database in real-time.

Big data sets containing information about land and property will increasingly be collected by sensors in machine readable form and shared directly with data readers and other technologies without requiring human intervention.

The challenge for industry will be to find ways to capitalise on technological advances.

Enquiring on Interests

Landgate's Interest Enquiry is a spatial information system that leverages the digital cadastre as a point of intersection with other datasets to determine if interests overlap. Consumers query the register to identify if there is any interest impacting an individual property.

Interest Enquiry relies on the collaborative effort of several government agencies that provide the base datasets, from which the property 'interest' information is sourced and processed. There are currently 66 interests available including, Aboriginal Heritage, Bush Forever, Geothermal and Mining Titles, Regional Planning Schemes and Acid Sulphate Soil Risk zones.

The Dampier to Bunbury Pipeline (Consortium) use Interest Enquiry to mitigate the risk that developers will unknowingly purchase land that falls within their hazardous industrial plant buffer zone. This buffer is stipulated by the Environmental Protection Authority as a measure to minimise risk associated with hazardous materials.

"The system is proving so successful that the conveyancing industry are keen for the inclusion of more interests on land as stipulated in government legislation and policy" advises Mike Bradford, Chief Executive Landgate.

An ultimate goal is to improve the quality of spatial information as this will lead to improved consumer confidence and trust. Currently, spatial information is collected and managed at differing levels of precision. Inaccurate data impacts the quality of decision making at the parcel level.

The spatial relationships between data themes are logistically difficult to manage when data is streamed from different agencies.

Research needs to deliver real-time data management solutions that enable updates to be automatically propagated between themes. In this way, if a cadastral boundary shifts, then so too will the spatial representation of the interests on the land, such as heritage precincts or planning zones.

Building New Foundations

Rights, Restrictions and Responsibilities

There are various rights, restrictions and responsibilities (RRR) on land, created and managed in legislation and policy, which may have an impact on a landowner's enjoyment of land.

The densification of our cities is creating a complex data management environment that is stretching the capabilities of our existing cadastral systems.

Currently, our cadastral systems do not adequately capture the relationships between what can be done on land (rights), what cannot be done (restrictions) and what must be done (responsibilities).

Our community has a growing expectation that information will be available in a format that can be used to make good decisions for the best use and management of their land. This includes:

- Rights under mining and commercial fishing licences, or licences to use water or discharge waste (or not).
- Responsibilities under different Acts to maintain heritage sites, public drains, utility poles and other infrastructure.
- Planning and water restrictions to protect the environment, including prohibited acts, such as land clearing, water use, chemical use.
- Land development controls to protect infrastructure against potential sea level rise and storm surge.
- Fire and flood zones that have specific insurance exclusions.
- Consents granted under the environmental protection and resource management Acts.
- Rights and interests under the Native Title Act.
- Location of unexploded ordinance, hazardous materials and contaminated sites.
- Registrable interests such as life and remainder interests, as well as imposition, ownership structures and registrations of trusts.

Legal and environmental information will increase significantly over the coming decades as consecutive governments introduce policy to better manage climate change, water security, land development, urbanisation, emergency management, social inclusion, affordable housing, environmental monitoring and global humanity etc.

This increase will put pressure on our digital cadastre to become a central decision support tool for government and the broader community. Better information is needed about what is happening within these different spheres, and in particular, information about how the different systems of management and policy interact.

The cadastral system can bridge this gap, providing context within an integrated property management model that links rights, restrictions and responsibilities to land and real property in a way that is accurate, readily visualised and includes the dynamic nature of interests on land. This information can then be queried by those making decisions.

Image: Gordon Bell / Shutterstock.com

Realising Full Automation

Cadastre 2034 is envisaged as a fully automated cadastral infrastructure where surveyed land parcels are registered in real-time directly from the field to the desktop. This means a paperless process, void of duplication and with significantly reduced turnaround times.

Arriving at this point will require planned research activities and these will need to consider the enduring principles in their application and intent.

The Cooperative Research Centre for Spatial Information (CRCSI) is supporting the realisation of Cadastre 2034 through its strategic research priorities in modernising our spatial infrastructure. Peter Woodgate Chief Executive of the CRCSI advises that research projects are focused towards improving spatial data supply chains, building federated spatial models, and developing crowd sourcing capabilities and query-based spatial systems.

These research methods are concentrating on the Web 3.0 paradigm and the semantic tagging of content. This will prepare the cadastral industry to use an environment where information will be categorised and stored in a way that a computer can understand as well as a human.

Next generation Web 3.0 will make information searching much faster. Instead of multiple searches, a single complex question will suffice. "I want to view a property for sale in the hills region, with no water use restrictions and where I can get to work in the city within 30 minutes. What are my options?" The Web 3.0 browser will analyse your query, search the Internet for possible matches, and organise the results in a logical way.

Automated methods are currently being developed by industry. The new ePlan lodgement and validation system will provide a fast, more secure and more efficient way of processing land title plans. Several Australian State and Territory agencies are currently engaging with the surveying industry to integrate ePlan into existing work practices. They are using industry standard software produced by local vendors.

Enduring Principles

Despite the technological disruption and changing societal needs that will occur over the next 20 years, a secure transparent system of land registration will remain an enduring need.

This will be achieved through the continued application of rigorous processes, standards and policies that will create reliable and complete information about each parcel of land, and through a supporting legislative framework that accurately reflects evolving community needs and aspirations.

With any new undertaking, there are fundamental principles that must be incorporated into future innovations to ensure that cadastral systems remain secure, accessible, transparent and efficient over time.

The enduring principles are:

- Certainty in the spatial extent of ownership.
- Uniquely defined land (and/or property) that is common to all registers – ownership, valuation, land use.
- Integrity and security of the parcel boundary system.
- Strong relationship between regulators and the industry.
- Appropriate regulatory standards.

These enduring principles will continue to be an integral part of the design of environments in which cadastral systems are managed.

Creating a Virtual World of Property

In the last 20 years we have seen a significant increase in the number of tunnels, underground parking places, shopping malls, aboveground road and railway networks, multistorey apartments combining commercial and residential, and roof top gardens.

These types of infrastructure have one thing in common, their ownership is difficult to visualise in a 2-dimensional digital cadastre.

During this same period we have seen a huge leap in computer graphics and visualisation technologies and in the development of Building Information Models (BIM). Building information modelling has the potential to significantly advance cadastral data management as it captures the planned and actual built environment in 3-dimensions.

At the University of Melbourne researchers are investigating 3-dimensional digital cadastres and examining the problems and issues associated with incorporating the third dimension into our land administration systems [18]. "This research is showing that it is not just data modelling and visualisation that is proving complex. A 3-dimensional digital cadastre needs to consider policy, legal and institutional aspects as well," said Professor Abbas Rajabifard of the University of Melbourne.

This means the current cadastral system needs to evolve in a way that satisfies the legal status, positional accuracy, registration of interests and technology requirements of a future 3-dimensional cadastral system.

The Queensland government is taking advantage of the fact that society has become avid users of 3-dimensional computer simulated environments, and is developing a new look spatial infrastructure called 3dQLD for everyday business.

The 3dQLD infrastructure will require land surveying professionals to incorporate survey accurate boundaries and 3-dimensional measurements into everyday practice resulting in an accurate 3-dimensional digital cadastre evolving over time [19].

Strategic Framework

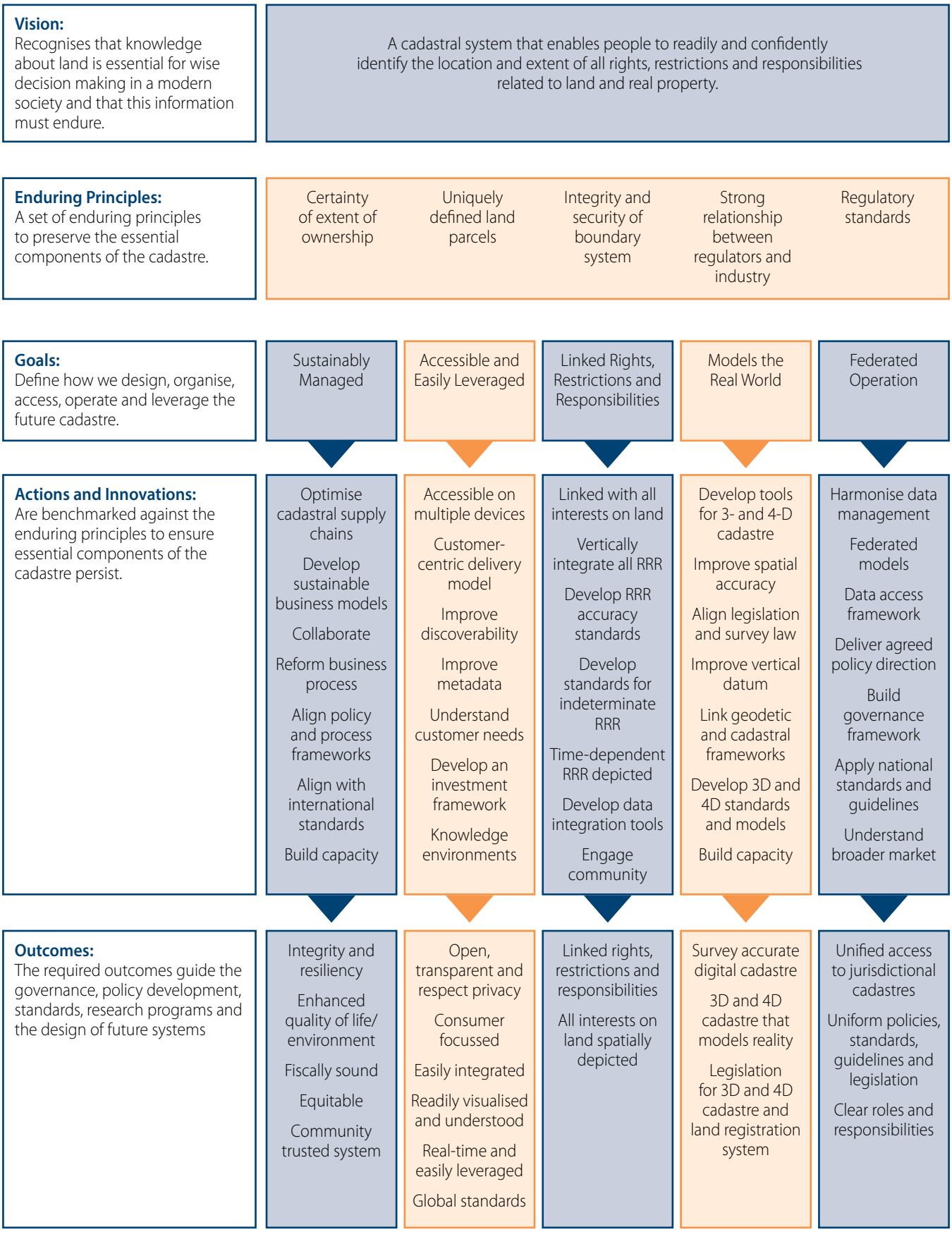

Figure 3. The Cadastre 2034 Framework

Goal 1:

A cadastral system that is fundamental to land ownership and managed sustainably

Objective

To retain the integrity and societal benefits of the cadastral system, whilst increasing the efficiency and effectiveness of its management and preserving the information resource for future generations.

Current Situation

Cadastral databases in many jurisdictions utilise outdated technologies that have limited capacity to meet emerging business needs.

State and territory governments are considering new information technology environments to improve business integration.

Workflow automation and update propagation are on the agenda with many jurisdictions keen to generate efficiencies, and reduce costs associated with land transactions and data handing in general.

Establishing point of truth data sets is a significant requirement as areas of data duplication exist due to historical methods. There is a real need to increase opportunities for data reuse, achieve productivity improvements, reduce our environmental footprint and enable flexibility to use cadastral information in new ways.

In streamlining service delivery it is necessary to take an all-encompassing view of how cadastral systems are designed, organised and operated. This includes examining the entire cadastral supply chain from data collection to product delivery, and consider the people, programs, processing and storage of information when we commit to improving, automating, sharing and preserving our land and property information.

Sustaining the integrity of the system over time is paramount.

Outcomes

Goal one aims to achieve the following outcomes:

- Processes, data and systems have integrity and security, and are resilient.
- Systems function in a way that maintain and enhance quality of life and the environment.
- Financial, regulatory and risk management practices are sound.
- Social and intergenerational equity is preserved.
- The community has a strong sense of trust in the cadastral system.

Actions and Innovations

The following actions and innovations are recommended to deliver outcomes:

- Optimise cadastral supply chains to reduce duplication across the land and utilities sectors and, in doing so, reduce our environmental footprint and increase profit margins.
- Develop a sustainable business model to manage and upgrade the digital cadastre including intellectual property management, return on investment and funding.
- Invest in public/private partnerships to collaboratively maintain the digital cadastre.
- Reform business and automate processes to reduce the amount of effort required per land transaction, eliminating red tape and reducing consumer compliance costs.
- Ensure legislation, policy, record keeping, data storage and data management systems are aligned with any technological advancements.
- Work towards alignment with international standards.
- Build skills and knowledge resources aligned to new methods.

Enablers

- ICSM Permanent Committee on Cadastre to provide leadership for achieving Cadastre 2034.
- Recognised cadastral custodial responsibilities.
- Partnerships with relevant agencies, industry groups and community.
- Adoption and adherence to standards.
- Strategic approach to investment in research.
- Sustainable funding model.
- Sustained growth in qualified professionals.

Benefits

Improved government cadastral information management processes, resulting in:

- Reduced government administrative effort and better allocation of skills and resources.
- Greater responsiveness in land-related processes and more timely land supply thereby promoting a competitive economy.
- More streamlined government services and reduced transaction times.

Goal 2:

A cadastral system that is accessible, easily visualised and readily understood and used

Objective

To maximise the potential of the cadastral system by creating more options for its use so that it can be leveraged by society economically, socially and environmentally.

Current Situation

Today's digital networking and communication infrastructures are providing a global platform over which people and organisations interact, collaborate and search for information.

However, inefficient access to land and property information is currently limiting potential innovation in the private sector [12]. This needs to change. Today's society want to be able to stream information directly to their mobile devices for social and business transactions.

An easily visualised digital cadastre will generate a stronger community understanding of land and real property ownership, particularly when combined with other property data such as Building Information Models. Owners will be able to evaluate different aspects of their property and enhance their home improvement and land development experience.

Augmented reality has reached a new level of capability with mobile devices and high-tech eyewear now capable of superimposing information, pictures and video over the physical world in front of us. This means future building developments, underground utilities, and rights, restrictions and responsibilities on land can be visualised and communicated in the field by professional users and the community alike.

Ready access to cadastral information will be a step towards more collaborative organisational environments. Partnerships are currently restricted by older technologies as these are limiting online capabilities.

Outcomes

Goal two aims to achieve the following outcomes:

- Open and transparent access to information, balanced with respect for individuals' privacy.
- Consumer focussed.
- A digital cadastre that can be utilised in multiple environments and easily combined with other information.
- A digital cadastre capable of being readily visualised and understood.
- Current information is available in real-time, and easily leveraged and analysed.
- A digital cadastre that is interoperable with global standards.

Actions and Innovations

The following actions and innovations are recommended to deliver outcomes:

- Position the cadastral system to deliver on sustainable development objectives by enabling its use in multiple information environments.
- Establish a customer-centric service delivery approach.
- Develop methods to serve cadastral information straight to the desktop or portable device of anyone, anytime, anywhere - to maximise use.
- Improve the discoverability of cadastral information using next generation semantic web technologies.
- Make the reliability of data clear to the community of users so they can make informed decisions on what data will best suit their needs.
- Understand the cadastral system's key value streams in delivering future business opportunities to a modern society.
- Develop a public/private investment framework to increase the utility and commercial value for on-selling new products and services.
- Present cadastral information in virtual 'collaborative' knowledge environments so the community can draw the most value from its application.
- Develop a participatory model to include community volunteered land and property features.

Enablers

- Strong government, industry, community partnerships.
- Commitment to transparency reforms and sharing principles.
- Consistent guidelines and standards.
- Data access and interoperability frameworks.
- An intellectual property culture that supports innovation and investment.
- Research into semantic web, data schemas and knowledge representation.

Benefits

Real-time access to the digital cadastre through various channels, resulting in:

- Better use and integration of the cadastral information across government, industry and the community.
- Meeting community expectations for access to cadastral and land-related information anywhere, anytime, and on any device.
- A better understanding of what the social and economic benefits to the community are, and how these can be quantified to support future triple bottom line reporting.
- Industry value added services and new business opportunities leading to a more diverse market place.

Goal 3:

A cadastral system linked with broader legal and social interests on land

Objective

A cadastral system linked to knowledge about registered and unregistered land-related rights, restrictions and responsibilities so that people can interact and make wise decisions about land.

Current Situation

The digital cadastre is proving a valuable source of land boundary data that can be incorporated within a spatial infrastructure and compared and contrasted with other registered and unregistered interests on land.

However, many rights, restrictions and responsibilities are not spatially depicted, and some cannot be accessed easily.

Property rights are traditionally embedded within a land title, but over the years successive reforms, such as the national Water Act 2007 [13] and climate change initiatives, have led to new interests on land being enacted but not formally linked with land ownership. This means that land owners could be adversely impacted socially and financially (value and tradability) because of their lack of awareness about their rights, restrictions and responsibilities.

If we are to improve decision making and make informed use of land, we need to link a wider range of interests on land within a broader cadastral framework.

This is not a new objective. A cadastral system that shows the complete legal situation of land, including public rights and restrictions was recognised as a major challenge for Cadastre 2014 [1]. Since then some significant work has been undertaken to a stage where we have moved well beyond conceptual models to operational systems that allow citizens to enquire upon interests over any specific land parcel.

Nonetheless, our systems are far from complete, and consolidated information on all land-related rights, restrictions and responsibilities is not readily available in a single reference framework. In addition, some rights, restrictions and responsibilities are best articulated in the third dimension, and in the fourth dimension (time) if one considers seasonal criteria such as water restrictions and fire bans.

Traditional work practises and cultures will need to change to take full advantage of volunteered geographic information for the collection of social interests on land. Solutions to differentiate authoritative and anecdotal sources will be required to maintain the integrity of a broader cadastral framework.

A new approach to property rights management is required.

Outcomes

Goal three aims to achieve the following outcomes:

- A cadastral system linked with all rights, restrictions and responsibilities on land and real property.
- The spatial extent of all interests on land and property are represented unambiguously and depicted in a manner that meets the requirements of evolving tenures.

Actions and Innovations

The following actions and innovations are recommended to deliver outcomes:

- Enable the cadastral system to be linked to the spatial extent of de facto and de jure rights and interests on land and marine environments.
- Build models that enable vertical linkages between data themes depicting interests on land.
- Develop accuracy standards and models for the definition and depiction of all rights, restrictions and responsibilities in the broader cadastral system.
- Develop methods and standards to depict and manage indeterminate 'fuzzy' boundaries related to rights, restrictions and responsibilities, such as noise levels.
- Build a capability to manage the dynamic nature of rights, restrictions and responsibilities, such as daily and seasonal variations.
- Develop validation and automatic linking tools to integrate with third party data.
- Develop a participatory model to include community volunteered data for sustainable data collection of land and property features relating to interests on land.

Enablers

- ICSM governance model to sustain and guide inclusion of all rights, restrictions and responsibilities in the broader cadastral system.
- ANZLIC/ICSM policy direction and legal framework for defining the extent of all rights, restrictions and responsibilities.
- Industry standards for the broader cadastral system.
- Agency and industry partnerships to fast track spatial depiction of all rights, restrictions and responsibilities.
- ANZ Foundation Spatial Data Framework.

Benefits

Better government and community decision making, through:

- Improved access to information on the rights, restrictions and responsibilities pertaining to land and real property, thus reducing consumer investment risk.
- Information being available in an understandable form making it easier for citizens to comprehend government policies and laws.

Goal 4:

A digital cadastre that is 3-dimensional, dynamic and survey accurate

Objective

To modernise the digital cadastre by incorporating survey accurate, time series, and height data to capture the complexity of our environment.

Current Situation

The digital cadastre is an underutilised community asset due to its current limitation in positional accuracy and because it does not adequately represent the 3 and 4 dimensional nature and dynamic characteristics of mixed land use and real property; where land and property have extent, adjacency, height, depth and volume, as well as, usage, materials and condition at any point in time.

To create a digital cadastre capable of supporting the needs of emerging Smart Cities, a highly accurate 3-dimensional model is needed; one that is able to better manage the ever increasing densification and complexity of future developments both above and below ground.

Land parcels that are limited in vertical dimension are not adequately represented in the current digital cadastre making it difficult to visualise security of tenure as it relates to a building or an apartment within a building.

The ownership of an apartment (volume of space) and its associated shared property regimes (tenants in common) can be more readily recognised and authorised in a future 3-dimensional representation. Institutional and legislative frameworks, that provide the legal mandate for regulatory operation of the cadastral system, will need to be reviewed to ensure adequate provision for a 3-dimensional digital representation.

The digital cadastre is now being used in integrated information environments and for more purposes than were ever imagined when first built.

Existing digital cadastres, largely collected by digitising maps, are proving inadequate for emerging business needs. When overlaid with other geographic data and aerial photography, inaccuracies in the data are apparent. While cadastral surveyors have been submitting high-precision survey data, cadastral data managers have had to adjust this survey data to fit

the lower accuracy coordinates contained within the existing digital cadastre. This has compounded the data accuracy problem.

While our systems uphold integrity of ownership, it is the varying accuracies across the data that is the issue. We currently do not deliver to industry an accurate digital boundary framework (digital cadastre) and the assurance that infrastructure delivery and precision farming is being performed within titled boundaries.[19]

Outcomes

Goal four aims to achieve the following outcomes:

- A digital cadastre that is survey accurate.
- A 3-dimensional digital cadastre that aligns with the real-world.
- A legislative framework that underpins a 3-dimensional digital cadastre and land registration system.
- A digital cadastre that is capable of depicting dynamic (4-dimensional) elements.

Actions and Innovations

The following actions and innovations are recommended to deliver outcomes:

- Develop tools and legislation to model, manage, transfer and visualise 3-dimensional property data.
- Develop methods to capture the dynamic 'people-land' relationship to support future land policy including the temporal nature of RRR and property history.
- Apply new technologies to improve positional and semantic accuracy of the digital cadastre, and the currency of the digital cadastre through implementation of automated processes.
- Implement a demand driven spatial upgrade to achieve survey accurate boundary representation in priority areas.
- Revise survey laws to ensure alignment of the 3-dimensional digital cadastre with the cadastre on the ground.
- Develop accuracy standards and models for the depiction of 3-dimensional property (below and above ground).
- Propagate the dynamics of the geodetic reference system to cadastral boundaries in a way that is accurate and transparent to users.
- Improve the integration of the vertical datum to support complex 3 and 4-dimensional depiction of rights, restrictions and responsibilities.
- Skills development for land surveying professionals to ensure 3-dimensional system elements are maintained with integrity.

Enablers

- Geodetic Strategy for a dynamic datum.
- Industry consultation on revised Survey Law.
- Research and development into 3-dimensional digital cadastres.
- Investigation of temporal and historical elements associated with land and real property.
- An extended ePlan Framework that includes 3-dimensional elements.

Benefits

Better managed land and real property, through:

- The availability of high quality cadastral information to support land use and land development decision making.
- The ability to visualise land and property in 3-dimensions and as a dynamic time series of property events.
- Clear representation of common property in complex developments.

Goal 5:

A federated cadastral system based on common standards

Objective

To operate in the national interest and equip society with broader land and real property models to deal with local, cross-jurisdictional and global challenges.

Current Situation

Making trade between countries simpler is increasingly important to our nation's business sector. More services are becoming available online and businesses operate across jurisdictions as a single market. Nonetheless, there is still much to do before our cadastral system becomes a major contributor to Digital First, an Australian Government initiative committed to achieving end-to-end digital transaction services by 2017 [14].

Having to deal with individual jurisdictions for land and property developments can be complex due to the different methods of operation and laws. To compete in a global economy, jurisdictions need to consider common trade hubs or single window systems that provide consumers with access to nationwide land and property information.

This is the imperative behind the federated approach.

To understand global and regional issues, government needs a cadastral framework with which to collect, collate and analyse regional needs.

Ultimately, Cadastre 2034 will lead to the provision of seamless access to state and territory based digital cadastres. This will be assisted through the Australian and New Zealand Foundation Spatial Data Framework [15]. As one of the ten fundamental themes this cadastral information will enable us to understand and manage trans-boundary issues and address economic, environmental, social and cultural issues in the national interest.

In addition, the Property Law Reform Alliance is working towards a Uniform Torrens Title Act through a coalition of legal and industry associations. They are committed to increasing productivity and reducing transaction costs involving multiple properties across jurisdictions. Its adoption will provide a basis for further national reforms [16].

Outcomes

Goal five aims to achieve the following outcomes:

- Unified access to jurisdictional cadastral information in real-time.
- Uniformity in polices, standards, guidelines and legislation.
- Roles of custodianship and stewardship of a federated cadastral system are clearly defined.

Actions and Innovations

The following actions and innovations are recommended to deliver outcomes:

- Create harmonised cadastral data management processes and federated cadastral data models leading to national outcomes.
- Develop a data access framework that supports common access to a consolidated version of the broader digital cadastre.
- Establish an agreed policy direction and governance framework for a federated cadastral system.
- Develop standards and guidelines to facilitate data discoverability, access and integration, nationally.
- Understand industry and community needs for national data sets to enable the delivery of future business opportunities in a broader marketplace.

Enablers

- National Collaborative Framework.
- ANZ Foundation Spatial Data Framework Land and Property Theme.
- Uniform Torrens Title Act through the Property Law Reform Alliance.
- Common vision among stakeholders for a federated cadastral system.
- ICSM governance framework providing leadership, accountability, transparency, openness, integrity and efficiency.
- Application of open standards/interoperability.
- Jurisdiction collaboration to achieve mutual benefits for the public, government, and corporations, as well as the land agencies themselves.
- ICSM communication framework to ensure a unified vision and comprehensive stakeholder engagement.

Benefits

Improved response to global, regional and trans-boundary issues via:

- Unified access to nationwide land and property information.
- Adoption of interoperable standards, models, policies and laws.

The Delivery Model

Citizens today have an expectation that government information and services will be delivered seamlessly and through multiple channels.

They are not concerned about which agencies or levels of government deliver the services, but rather that they have access to a consolidated view of all available sources - government, industry and community gathered data. They also expect that this information can be relied upon for making sound investment and lifestyle decisions.

To meet community expectations the cadastral service delivery model of the future will be characterised by:

- clear custodianship and stewardship;
- a mix of authoritative and crowd sourced data with clearly defined origin;
- seamless nationwide access to multi-agency data;
- the integration of government information in understandable forms;
- a financially sustainable maintenance and delivery model;
- real-time data access via multiple channels;
- a knowledge proposition, not just a standard information offering;
- a choice of 2, 3 and 4-dimensional virtual models; and
- a customer-centric service delivery approach where feedback is embedded at key delivery points.

The goals identified in this strategy are aligned with a culture of reform and innovation along the cadastral information supply chain. This is depicted in Figure 4.

Delivery of Cadastre 2034 will require holistic thinking, innovative planning and a collaborative approach to the stewardship of information.

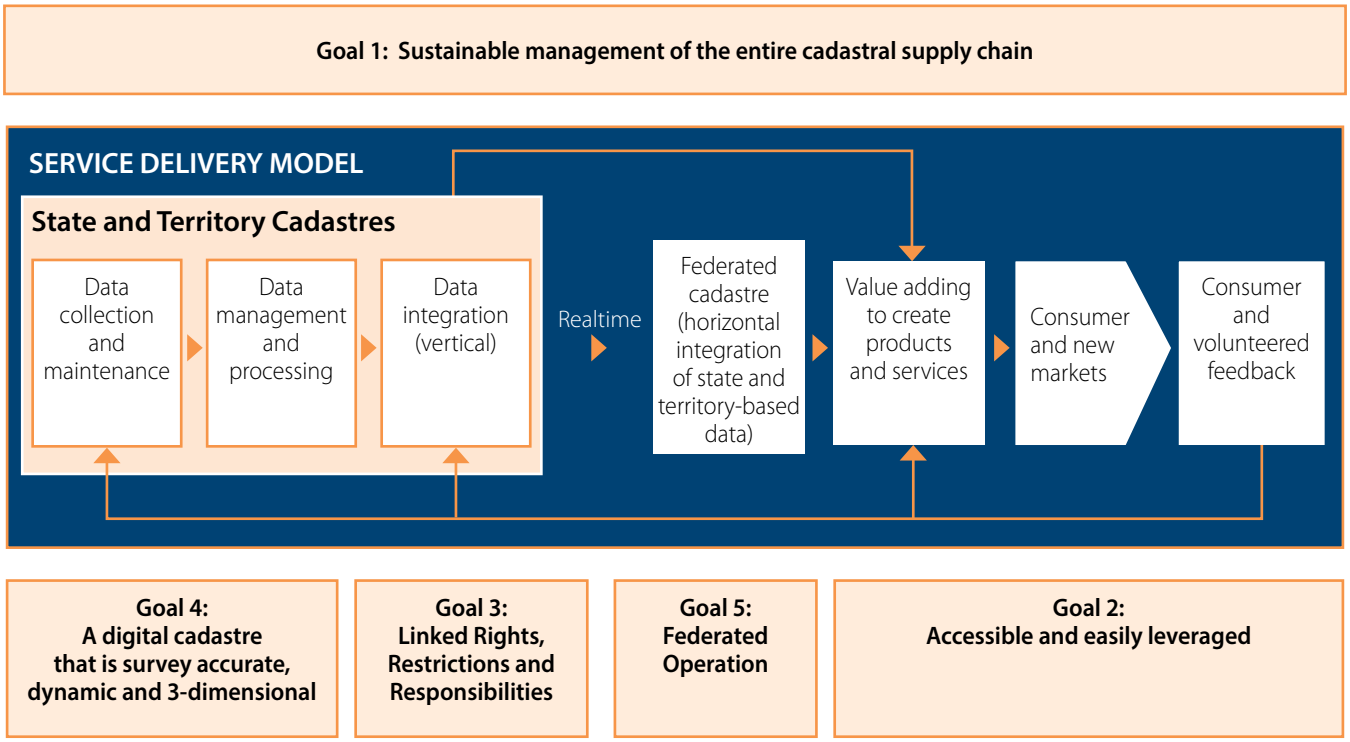

Figure 4. The Service Delivery model envisaged for integrated Cadastral Information

Responding to National Priorities

Did you know that the regions of Port Phillip and Westernport have the highest primary production land values in Victoria, at $17 billion, even though the primary production land is the second smallest area in the state?

According to Karen Connaughton, Director of Environmental Account, Australian Bureau of Statistics (ABS), "this and other knowledge can be derived through the Land Account Victoria, an integrated system of spatial and statistical information themes."

Further analysis of spatial relationships show that the high value primary production area of Port Phillip and Westernport is the result of the high value of horticultural crops grown in the region, the close proximity of markets and infrastructure, and competition for land near Melbourne [17].

The Land Account Victoria demonstrates how spatial information is transformed into knowledge though data linking, and how this knowledge can be used to inform debate on issues that matter nationally.

Finding solutions to national priorities requires access to nationwide data. In the case of land and property, this requires cross-jurisdiction cooperation and a consolidated view of state and territory data sets.

Current models require extending to include vertically linked concepts for evidence-based decision making, and not just traditional horizontal integration to address trans-border issues.

A fully integrated land and property model is currently not available nationally. Consumers are required to source data from multiple agencies, and collate and manage the data independent of other users. According to Helen Owens, Assistant Secretary, Data Policy, Department of Communications, this is problematic and expensive.

ANZLIC in conjunction with the Department of Communications, Geoscience Australia and PSMA Australia, is working toward a Foundation Spatial Data Framework that will provide access to a national view of land and property, which can be used in multiple applications, similarly to the Land Account Victoria.

A Collaborative Approach

Successful delivery of the actions and innovations, to achieve strategic outcomes, will require a collective effort.

Achievement of goals will be approached in a multi-disciplinary and multi-sectoral way (Figure 5).

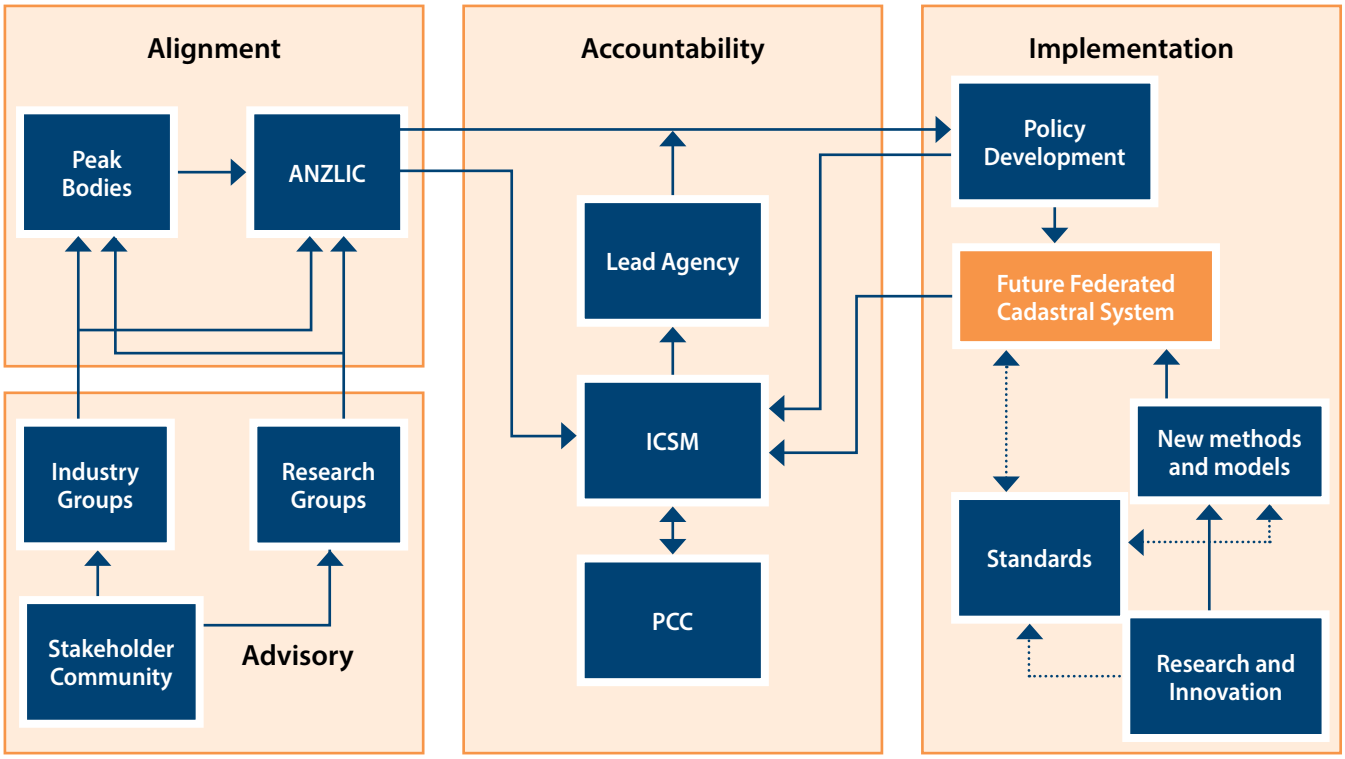

Figure 5 Inter-relationship between the stakeholder communities

The inter-relationships between organisations and the role they play in the evolution of the cadastral system is illustrated above and includes:

- Accountability: ICSM and Permanent Committee on Cadastre (PCC), Lead agency (often the land agency) in each jurisdiction.
- Alignment: ANZLIC, Peak Bodies: Registrars General.
- Policy Development: Land agencies in each jurisdiction, Land Surveyors Licensing Boards and Department of Communications.
- New Methods and Models: Government, Industry and Academia.
- Standards: ICSM, PCC, ePlan Working Group.
- Research: CRCSI, Melbourne University, RMIT, Curtin University, CSIRO.
- Advisory: SIBA, SSSI, other professional surveying bodies, GITA, NIMLI, Community of users.

Appendix A

Explanation of Terms

Term	Definition
Cadastral System	A system that defines, records and delivers land parcel information in support of tenure (ownership), land use and land value.
De jure and de facto rights	Rights concerning law and concerning fact, respectively.
Digital Cadastre	A digital model of cadastral boundaries and properties.
Interoperability	Ability to exchange and use information.
Land	In this document the term 'Land' not only applies to dry land. It may extend over water (marine cadastre), underground, in the airspace and water column. It is used in the context of land-related rights.
Ontologies	The structural frameworks for organising information.
Real Property	Property that includes land and buildings, and anything affixed to the land.
Semantic Web	An extension of the World Wide Web that enables people to share content beyond the boundaries of applications and websites.
Spatial Information	Spatial Information describes the physical location of objects and the metric relationships between objects.
Sub-decimetre	A metric unit of length that is within one tenth of a metre to a specified location.
Survey Accurate Digital Cadastre	A digital cadastre based on the best survey information available and not a digitised representation.
Supply Chain	A network comprising different companies that contribute to the production and distribution of cadastral information.
Tenure System	A tenure system is a legal system for recording and transferring rights, restrictions and responsibilities in land.
Value Chain	The process or activities by which an organisation adds value to cadastral information, including production, marketing, and the provision of after-sales service.
Ubiquitous	Everywhere

Appendix B

Glossary of Abbreviations

Acronym	Explanation
ABS	Australian Bureau of Statistics
ANZLIC	Australian and New Zealand Spatial Information Council
CRCSI	Cooperative Research Centre for Spatial Information
CSIRO	Commonwealth Science and Industrial Research Organisation
ICSM	Intergovernmental Committee on Surveying and Mapping
ePlan	Electronic Plan
FIG	International Federation of Surveyors
IE	Interest Enquiry
GITA	Geographic Information Technology Association
GNAF	Geocoded National Address File
GNSS	Global Navigation Satellite System
NIMLI	National Infrastructure for Managing Land Information
PCC	Permanent Committee on Cadastre
PSMA	PSMA Australia Limited
ROI	Return on Investment
RRR	Rights, Restrictions and Responsibilities
RMIT	Royal Melbourne Institute of Technology
SIBA	Spatial Industries Business Association
SSSI	Surveying and Spatial Sciences Institute
VGI	Volunteered Geographic Information

Appendix C

References

[1] Kaufmann, J. and Steudler, D., (1998), Cadastre 2014: A Vision for a Future Cadastral System, International Federation of Surveyors, Switzerland.

[2] Hirst, B. (2010) Cadastre 2014 – Australia and New Zealand: Now and the Future, Paper presented at FIG 2010, Sydney, Australia, available at http://www.icsm.gov.au/publications/fig/CongressPaper3824.pdf, accessed December 2014.

[3] Land Information New Zealand (2014) Cadastre 2034: A 10-20 Year Strategy for Developing the Cadastre: Knowing the Where of Land-Related Rights, available at http://www.linz.govt.nz/land/surveying/survey-system/cadastre-2034, accessed December 2014.

[4] International Federation of Surveyors (1995) Statement of the Cadastre, available at http://www.fig.net/commission7/reports/cadastre/statement_on_cadastre.html, accessed December 2013.

[5] Intergovernmental Committee on Surveying and Mapping (ICSM) (2009] Fundamentals of Land Ownership, Land Boundaries, and Surveying, available at http://www.icsm.gov.au/cadastral/Fundamentals_of_Land_Ownership_Land_Boundaries_and_Surveying.pdf, accessed December 2013

[6] Australian Bureau of Statistics (2014) Housing Finance, Australia, available at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5609.0Sep%202014?OpenDocument - Table 12, accessed November 2014.

[7] Australian Bureau of Statistics (2014) Total Value of Dwelling Stock, available at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6416.0Sep%202014?OpenDocument - Table 6, accessed November 2014.

[8] Australian Bureau of Statistics (2013) Gross Value Added by Industry, available at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5204.02013-14?OpenDocument - Table 5 accessed January 2014.

[9] ACT Government (2011) Draft Act Planning Strategy: Planning for a Sustainable City, available at http://www.actpla.act.gov.au, accessed September 2013.

[10] SA Government (2013) The 30-year Plan for Greater Adelaide, available at http://www.plan4adelaide.sa.gov.au/index.cfm, accessed September 2013.

[11] Khoshnevis, B (2012) Contour Crafting: Automated Construction, available at http://www.wimp.com/printerhouse/, video, accessed October 2013

[12] ACIL Tasman (2008) The Value of Spatial Information: The impact of modern spatial information technologies on the Australian economy, available at http://www.crcsi.com.au/Resources/general-interest, accessed Oct 2013.

[13] Bureau of Meteorology (2007), Water Act 2007, Australian Government, available at http://www.comlaw.gov.au/Series/C2007A00137, accessed October 2013

[14] Australian Government, Department of Broadband, Communications and the Digital Economy (2013) Advancing Australia as a Digital Economy: An Update to the National Digital Economy Strategy, available at http://apo.org.au/files/Resource/Advancing-Australia-as-a-Digital-Economy-BOOK-WEB.pdf, accessed December 2014.

[15] ANZLIC (2014) The Australian and New Zealand Foundation Spatial Data Framework, Edition 2, published by the Commonwealth of Australia, Department of Communications, 2014, available at http://www.anzlic.gov.au/foundation_spatial_data_framework, last accessed December 2014.

[16] Property Law Reform Alliance (2013) Draft Uniform Torrens Title Act, available at http://www.plra.com.au/, accessed December 2014.

[17] Australian Bureau of Statistics (2012) ABS releases state land account for the first time, Media Release, available at http://www.abs.gov.au/ausstats/abs@.nsf/MediaRealesesByCatalogue/5EE0D50E58E4F864CA257AD2000F1551?OpenDocument, accessed October 2013.

[18] Rohan Bennett, Abbas Rajabifard, Mohsen Kalantari, Jude Wallace, Ian Williamson (2011) Cadastral Futures: Building a New Vision for the Nature and Role of Cadastres, International Federation of Surveyors, Article of the Month – June 2011

[19] Hellen, L (2013) Discussion Paper, 3dQLD - Building the boundaries and positioning Queensland, Version 1.1, available at http://3dqld.org/, accessed October 2013, pp16

More Details

For further information regarding this strategy or to acquire additional copies please contact:

Lesley Waterhouse, Executive Officer
Intergovernmental Committee on Surveying and Mapping - ICSM

Phone: +61 2 6249 9677 Mobile: +61 419 694 669 Fax: +61 2 6249 9921
Email: icsm@ga.gov.au Web: www.icsm.gov.au

Cnr Jerrabomberra Avenue and Hindmarsh Drive Symonston ACT 2609
GPO Box 378 Canberra ACT 2601 Australia

Production Notes:

Cadastre 2034: Powering Land and Real Property represents the position and deliberations of the Intergovernmental Committee on Surveying and Mapping and has been produced by Geospatial Frameworks Pty Ltd, Darlington, Western Australia www.geospatialframeworks.com.au

Graphic Design by Creative Loop www.creative-loop.co.uk

Cover Photography Courtesy Land and Property Information, NSW Department of Finance & Services

ICSM

ANZLIC COMMITTEE ON
SURVEYING & MAPPING

GEOSPATIAL
FRAMEWORKS

Maximising your spatial investment