

The Role of Spatial Data Infrastructures in Establishing an Enabling Platform for Decision Making in Australia

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Abstract

In order to deliver a greater range of services and information to users across jurisdictions, the concept of Spatial Data Infrastructures is beginning to progress towards the development of an enabling platform, helping to link services across national, state and local jurisdictions, organisations and disciplines. This cross-jurisdictional approach aims to provide users with the ability to access and utilise precise information, in real time about both the built and natural environments within the sphere of decision-making, something that is beyond the ability of single organisations to deliver.

This paper describes the changing role that Spatial Data Infrastructures are playing in the development of such an enabling platform within Australia, with its particular demands as a country that is a federation of states. This includes the growing demand for sub-national government and private sector involvement in SDI development. Technical and institutional issues and observations that have arisen from investigation into establishing an enabling platform across state government jurisdictions in Australia are also discussed.

Introduction

The role that Spatial Data Infrastructure (SDI) initiatives are playing within society is changing. SDIs were initially conceived as a mechanism to facilitate access and sharing of spatial data for use within a GIS environment. This was achieved through the use of a distributed network of data custodians and stakeholders in the spatial information community. Users however, now require the ability to gain access to precise spatial information in real time about real world objects, in order to support more effective cross-jurisdictional and inter-agency decision making in priority areas such as emergency management, disaster relief, natural resource management and water rights. The ability to gain access to information and services has moved well beyond the domain of single organisations, and SDIs now require an enabling platform to support the chaining of services across participating organisations.

The ability to generate solutions to cross-jurisdictional issues has become a national priority for countries such as Australia and the development of effective decision-making tools is a major area of business for the spatial information industry. Much of the technology needed to create these solutions already exists, however it also depends on an institutional and cultural willingness to share outside of ones immediate work group. This creates the need for jurisdictional governance and inter-agency collaborative arrangements to bring together both information and users.

This paper outlines the role of Spatial Data Infrastructures (SDI) in creating more effective decision-making processes to deal with cross-jurisdictional issues through the creation of an enabling platform that links services and information across jurisdictions and organisations. The creation of an enabling platform will be more than just the representation of feature based structures of the world but will also include the administration and institutional aspects of such features, enabling both technical and institutional considerations to be incorporated into decision-making. This would support a knowledge base to access information derived from a model of integrated datasets from different perspectives such as the natural and built environments and support the creation of a virtual jurisdiction.

Changing role of SDI

SDIs aim to facilitate and coordinate the sharing of spatial data between stakeholders, based on a dynamic and multi-hierarchical concept that encompasses the policies, organisational remits, data, technologies, standards, delivery mechanisms and financial and human resources necessary to ensure that those working at the appropriate (global, regional, national, local) scale are not impeded in meeting their objectives (GSDI 1997). This in turn supports decision making at different scales for multiple purposes and increases benefits to society arising from the availability of spatial data. 'The benefits will accrue through the reduction of duplication of effort in collecting and maintaining of spatial data as well as through the increased use of this potentially valuable information' (MSC 1993).

The first generation of SDIs developed from the mid 1980s were designed to promote economic development, to stimulate better government and to foster environmental sustainability (Masser 1998). These first generation countries including the USA and Australia relied on developing data access relationships, which became the precursor to the development of National SDI initiatives. Countries designed and developed SDIs based on their specific national characteristics, requirements and priorities, paving the way for the documentation of experiences through status reports on SDI initiatives (such as Onsrud 1998). From this documentation, most countries developed a product-based approach to SDI development driven largely by national governments (Rajabifard et al. 2003).

In 2000, the second generation of SDI development occurred, with some of the leading countries developing SDIs by changing and updating the SDI conceptual model. This was brought about by the creation of a much more user-oriented SDI perspective which was more effective in maximising the added value of a nation's spatial information assets and more cost effective as a data dissemination mechanism (Masser 2005). This second generation, as witnessed in countries such as Australia and the USA focussed much more on the creation of an infrastructure to facilitate the management of information assets instead of accessing databases, changing the development model to a process-based approach at the same time. These 1st and 2nd generation models are described in Figure 1 below (Rajabifard et al. 2006a).

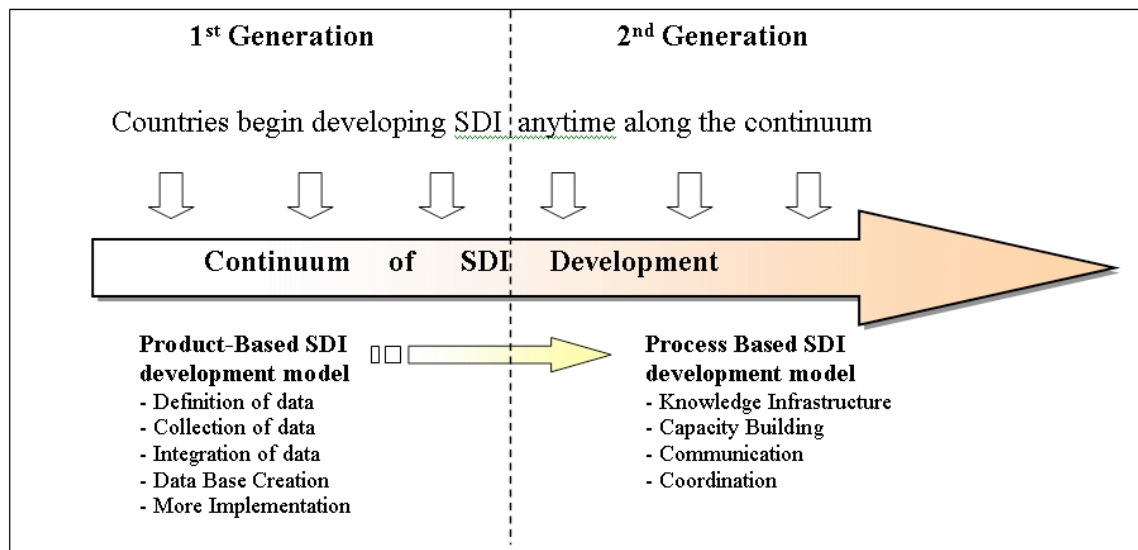


Figure 1: Relationship between the first and second generation of SDI development

Within the first generation of SDIs, data was the key driver in development and the focus of initiative development driven by a top-down National Government. The second generation however is driven by the needs of users, with the focus on the use of data and data applications as opposed to the data itself, with one result being that sub-national governments and the private sector gained greater influence in SDI development. This influence can be seen in the Federal Geographic Data Committee (FGDC) Future Directions Project which states that 'the continued development of the NSDI requires that

the private sector, academia, the utility industries as well as state, tribal and local governments play a major role' in order to effectively achieve the NSDI vision for the country (FGDC 2004).

Role of sub-national government and the private sector in SDI development. SDI development over the past 15 years has seen three main players emerge including Federal/National governments, sub-national governments and the private sector, with the role of each being quite different. As described in Figure 2, initial SDI development was the domain of National Governments whose role was to map and collect small scale data about a nation, playing both a strategic and operational role in SDI activity. As policy development came from the national level, there was no clear role for sub-national governments and the private sector within SDI development.

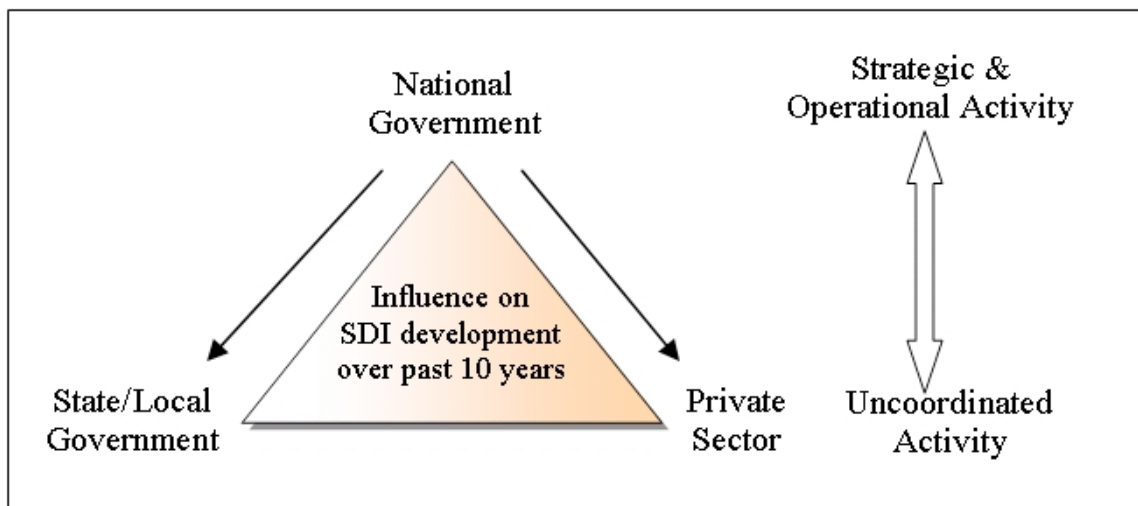


Figure 2: Role of national government, sub-national government and the private sector in SDI development over the past decade (Rajabifard et al. 2006a)

The roles are now changing however, as can be seen within Australia, with the national focus moving from being at both a strategic and operational level to more of a strategic focus. This is especially so for countries that are a federation of states. National datasets are generally small-scale which lessens the need for updating and maintenance, also lessening the need for infrastructure development. The operational role of SDI infrastructure development is moving to sub-national government, where large scale data is being used in everyday decision making in emergency management, natural resource management and policy development. This data is highly detailed and dynamic requiring systems for updating and maintenance. In countries such as Australia this does not mean that National government and its agencies are not involved in operational activities, just that sub-national governments are now playing a larger role in SDI development.

Within the USA, local governments and the private sector are devoting considerable resources to complete spatial data they need to serve business clients and the citizens in their communities (National Research Council 2001). This is also occurring within Australia with the private sectors' operational role in SDI development increasing as they lead the drive for greater access to large scale "people relevant" data (property and socio-

economic data). Sub-national governments are also moving forward in relation to creating policies and initiatives that aid in the development of SDIs and utilise the expertise and cooperation of the private sector. These two sectors are now responsible for building infrastructure in a collaborative manner, with the national governments providing the overall framework in which such infrastructure can operate. In Australia, communication now flows between these three players as seen in Figure 3, rather than from a top-down national government focus, as seen in Figure 2 (Rajabifard et al. 2006a). This overcomes inherent problems in having purely a top-down or bottom-up approach to SDI development. As described by van Loenen (2006), a top down approach to SDI development has the advantage that top decision makers believe in the potential of an SDI, although they do not have an actual commitment at the coalface. A bottom up approach has the opposite problem: the bottom acknowledges some successful experiences, but without the support from the top will not lead to introduction on a broad scale.

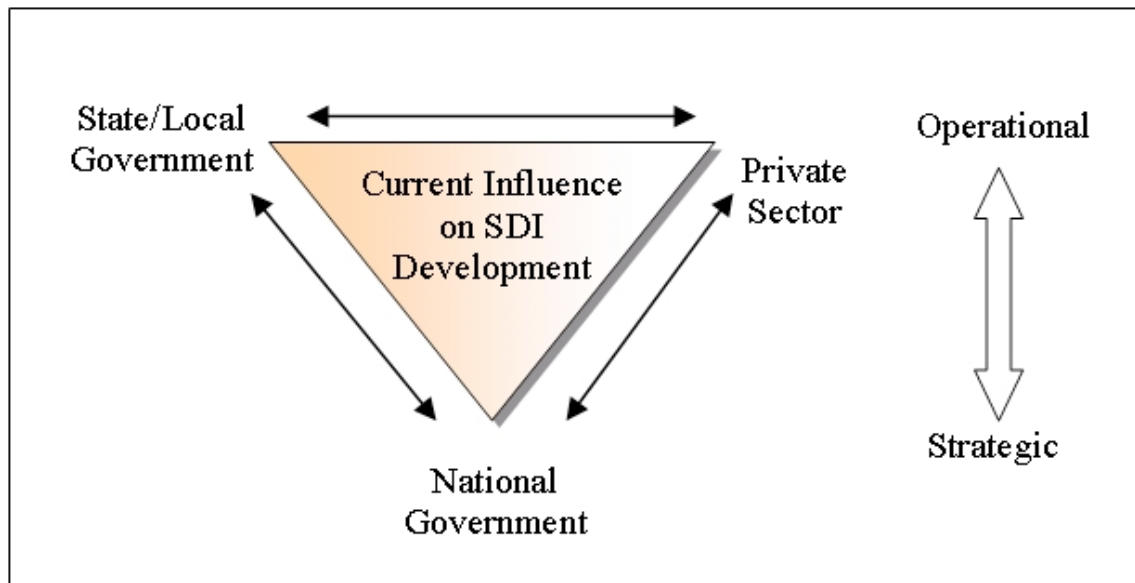


Figure 3: Current role of national government, sub-national government and the private sector in SDI development.

This changing role in SDI development has also been the driving force behind governments moving forward in relation to creating policies and initiatives that open up more information to the public and this change needs to continue. According to Radwan et al. (2005), to address today's information needs, the role of the traditional SDI needs to continue to be adjusted. There is a need for a service-oriented infrastructure in which citizens and organisations can rely for the provision of required services. This goes beyond current 1st and 2nd Generation SDIs of a data discovery and retrieval nature.

Enabling Platform

Current understanding of SDIs has seen the development of SDI models that have not met all user needs as expected, currently providing mainly an ability to access and

retrieve spatial data. Hence the concept of an SDI needs to progress so that it allows more than just the ability to access spatial information. It needs to become an entity that is enhanced so that it is possible to share data, business goals, strategies, processes, operations and value-added products and services in order to support government and business activities – an enabling platform. The creation of such an enabling platform will help to achieve the broader objectives of the development of SDIs – creating services and functions that can be utilised at further levels up the information chain (Rajabifard et al. 2005).

The rapid advancement and development of information and communications technologies (ICT) and changes in business opportunities make today's spatial information market very dynamic. This has forced spatial data stakeholders (data producers, value adders and data users) to change the way they deliver and use services to facilitate better decision making. The result is that meeting user needs with a variety of spatial data/information services across various jurisdictions, in large volumes and in near real-time, goes beyond the capacity of single organizations or government agencies. Therefore, many jurisdictions are investing in mechanisms that encourage their stakeholders (both government and private sector) to work together in a more collaborative way. This has also led to an increased involvement of sub-national governments and the private sector in SDI development, as described earlier in this paper.

A key element to the increased involvement of the private sector is the requirement that SDIs now need to meet business needs, with focus moving from data to services, similar to the creation of a Service Oriented Spatial Infrastructure, as defined by Todd (2005). This will aid in meeting the long term objective of the creation of a virtual jurisdiction or environment such as a Virtual Australia.

The creation of an enabling platform attempts to add further intelligence to current SDI practice in order to better support the vision of a virtual jurisdiction. According to Radwan et al. (2003), in a virtual jurisdiction, individual (small as well as large) organisations or partners work as a collaborative network to deliver specialised products or services on the basis of common standards and business understanding. It is structured and managed in such a way that it is seen by third parties as one single enterprise. According to Rajabifard et al. (2006b) this would support a knowledge base to provide a major point of discovery and communication to complete, correct and current information about the environment and related spatial information applications.

In Australia, the Cooperative Research Centre for Spatial Information (CRC-SI) is also investing in activities that contribute to the creation of a Virtual Australia, defined as a virtual [digital] model containing and representing all non-trivial objects and their contextual environment — from blue sky to bedrock — in [real world] Australia (CRC-SI 2005). The CRC-SI brings together over 40 small to medium spatial information companies as well as federal and state based governments to create spatial information applications that are affordable, useful and readily available to all (CRC-SI 2006). The ability to create a Virtual Australia is limited if current understanding of SDIs in their traditional sense only are utilised as the underlying infrastructure. If applications,

services, business models and functions are each created for specific users, as illustrated in Figure 4, future uses that span applications and services may be difficult to achieve.

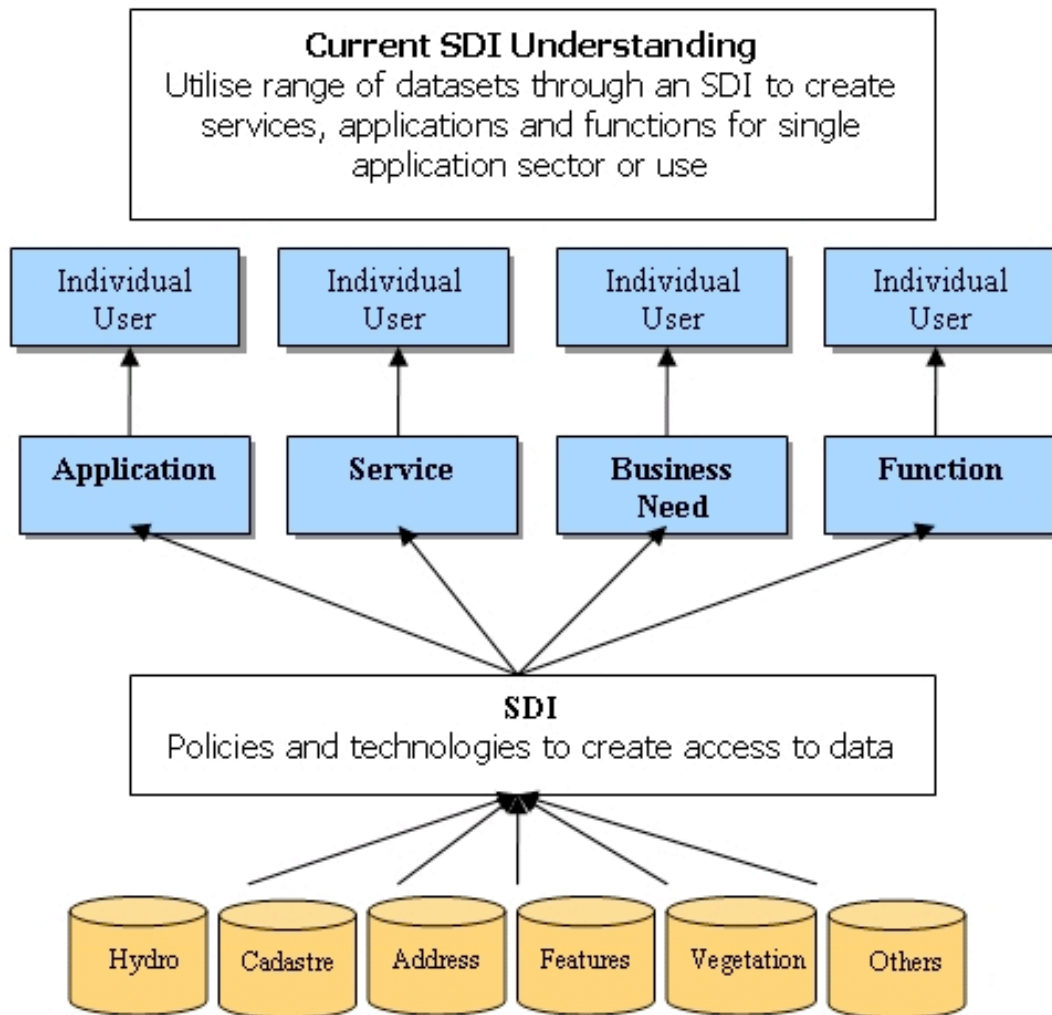


Figure 4: Current SDI Understanding

An enabling platform aims to support a virtual jurisdiction, forming the underpinning structure. It is more than simply an access mechanism, although this feature of an SDI is pervasive in any move to an enabling platform. It enables the linking of data, services, products and real world objects through the creation of appropriate governance and legal support, built on an open sourced, distributed technical infrastructure. The creation of applications and tools by an entity such as the CRC-SI need to not only be available, but linked together if the Virtual Australia concept is to become a reality.

As described by van Loenen (2006), both technical and non-technical characteristics are important within a dataset if it is to be used appropriately, and the same can be applied to the concept of an enabling platform. An enabling platform as defined for Australia is the creation of appropriate technical, governance and legal structures to link data, services, products and real world objects, underpinning the creation of a virtual jurisdiction. The

platform itself is the next step in the SDI process. It will facilitate interoperability and inter-working of functional entities within a heterogeneous environment through the use of both technical characteristics and appropriate access policies. This creates multiple uses of the one application or service, as described in Figure 5 below.

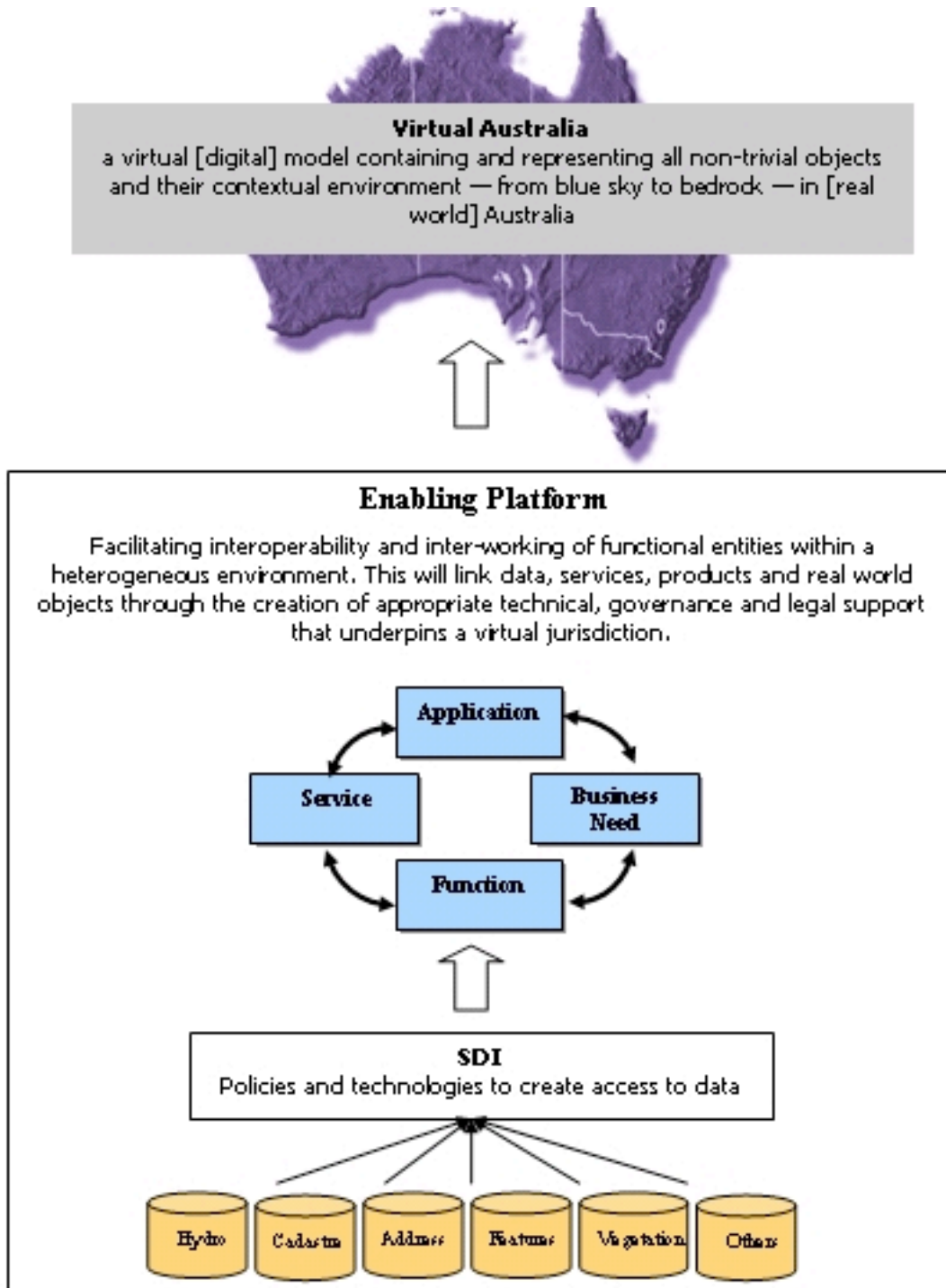


Figure 5: Utilising an Enabling Platform to Achieve a Virtual Australia

The information and services available through delivering an enabling platform should be combined and interoperable in such a way that all data can be analysed and acted on together within a single environment, subject to appropriate security, privacy and commercial considerations. These considerations will need to be carefully investigated within the creation of an enabling platform in order to break down institutional barriers that the development of SDIs has begun to achieve. This will ensure that information from a range of jurisdictions and applications such as land administration, environmental management, statistics, social development, land use patterns etc. is accessible and useable both within each application sector and between each sector.

Overall, the development of an enabling platform aims to build a common rail gauge and lower barriers for access to information and services from various government agencies, industry and the public. If barriers are minimised, then entities would be able to pursue their core business objectives with greater efficiency and effectiveness. In particular, industry would reduce their costs, which would encourage investment in capacity for generating and delivering a wider range of spatial information products and services to a broader market, both in Australia and internationally.

Creating an Enabling Platform – an Australian Experience

Research into current arrangements for the sharing and access of spatial data within Australia has shown that current arrangements generally do not meet or only meet very basic, user requirements (Rajabifard et al. 2006b). In order to address this concern, within Australia for example, a range of progressive and positive approaches to utilising, managing and accessing spatial information can be observed within various jurisdictions at both a national and sub-national level. National leadership is being provided by ANZLIC – the Australian and New Zealand Spatial Information Council, and various whole-of-government spatial information initiatives are being developed, especially at a sub-national government level.

The major aim of these initiatives is to give cross-jurisdictional agencies access to spatial information in a more efficient and effective manner. Instead of people having to deal with several different agencies to obtain information, one online system will eventually provide access to key information controlled by various agencies. This is an attempt to move from a ‘silos’ mentality – where agencies keep their expertise, data and knowledge within the agency – to a more accessible approach, reducing duplication and inefficiencies, improving service delivery and yielding strategic and commercial benefits to government (Rajabifard et al. 2006b). This builds on the work of Wallace et al (2006) to develop systems and policies to spatially enable government and broader society.

Despite this there is still duplication of effort and expense occurring in creating data, infrastructure and a framework for data sharing throughout jurisdictions at all levels of administration within Australia. There is a need to integrate the existing national, state and local spatial data initiatives and policies for access and delivery of data/information. This will enhance the capability of government, the private sector and the general

community to engage in systems based, integrated and holistic decision making about the future of Australia.

Technical Basis. Current service and data delivery within Australia utilises on-line systems through an interoperability architecture based on distributed, custodial data management and open standards. This is being implemented in the form of uniform and consistent managed access to distributed web services operated by authoritative custodians (Staling et al. 2004). The aim of this architecture is to allow initiatives to grow in an open environment that gives agencies the ability to operate in an integrated manner.

It is important that an enabling platform be built on the network of state based systems within Australia (currently based on SDI technology), the installation and operation of which shall be the responsibility of each state. The costs associated with building a new platform would be very high and if the platform was not compatible with current spatial information initiatives, it would not be utilised.

Harmonization of data standards and specifications through the adoption of common data definitions, formats, models and exchange formats will be crucial to the success of an enabling platform. This will ensure that there is an unimpeded flow of data and information between the various levels of government and the private sector. An enabling platform must also generate the ability to observe and monitor change, and create realistic simulations of the evolving world. This is possible if information and applications regarding both the built (legal, land rights etc.) and natural (environmental, natural resource etc.) environments is available in an integrated form. Generally these two forms of data have been developed to serve different purposes and are usually managed separately. An enabling platform must provide the technical ability to integrate not only these forms of data, but applications and services that utilise these different datasets. This will enable more holistic decision making.

There is also the need for an investigation into the way that data, particularly spatial data can be stored. New database management software and technology, along with the concepts of virtual libraries, GRID computing technologies and super servers are changing the way in which data is stored, managed and used. This in turn will have an impact on the development of an enabling platform.

Institutionally. Implementation of an enabling platform would need to be done progressively, with data and services populating and linking off a basic technical platform. This will allow the funding, technology and institutional arrangements needed to create such a platform to be implemented as they are finalised. Technically, existing state-based spatial information and SDI initiatives have the potential to contribute to the development of an enabling platform. However, socio-technical issues including economic, educational, cultural, institutional, legal, political and organisational are all current impediments to sharing and accessing spatial information, rather than simply technical alone (Groot and McLaughlin 2000; Crompvoets 2006). A lot of work needs to be done with respect to such socio-technical issues if SDI technology is to be utilised effectively. An enabling environment for all needs to be created that includes both a top-

down and bottom-up approach to building an enabling platform, based on current spatial information initiatives.

There is also the need for a common policy framework for good data/information management, including metadata management and custodianship, common data access arrangements, including pricing, data sharing agreements and access arrangement. These have been implemented within several state based jurisdictions in Australia and have been proven to provide a platform from which the spatial information industry can expand. This would also provide for organizations representing different jurisdictions to bring their spatial information, tools and services together into interoperable formats.

Issues and observations that have been observed throughout various state jurisdictions in Australia which will impact on the ability to implement an enabling platform include:

- SDI moving from 'data access' focus to a 'service/business deliver' focus – development needs to be driven by user needs.
- Need to create an enabling environment to support government and business activities. The environment should be open sourced and interoperable.
- Lack of spatial awareness and education – existing work practices do not include a strong culture of using maps and spatial information.
- Lack of cross-jurisdictional relationships.
- Implied control and privacy concerns over spatial information by various agencies – limits availability and access.
- Institutional and cultural issues are still the big barrier to implementing an effective SDI.
- Ability to research issues of governance models or frameworks and institutional aspects of the development of an enabling platform.

(Rajabifard et al. 2006b)

Not only will these issues and observations need to be taken into account, but an investigation in to the business needs of stakeholders and the broader community within the spatial information sector will need to be undertaken. This will ensure that business drivers are the catalyst in the creation of an enabling platform.

Future Directions

In order to meet today's information needs, the traditional role of SDIs is changing. There is a need for a service-oriented infrastructure in which citizens and organizations can rely on for the provision of required services, going beyond what has been described as the first and second generation of SDI development. This includes a focus for spatial information managers on the delivery of a virtual world which facilitates decision making at a community level within a national context.

The development of SDI initiatives driven by sub-national governments differ from the top-down approach that is implied by the development of national led SDIs, implicit in much of the current SDI literature. This new bottom-up sub-national view is important as it highlights the importance of diversity and heterogeneity given the different aspirations

of various stakeholders. Consequently, the challenge to those involved in SDI development is to find ways of ensuring some measure of standardisation and uniformity while recognising the diversity and heterogeneity of various stakeholders. The use of open standards and an interoperable enabling platform will allow functions and services that meet business needs to be brought together at a sub-national and application level, reducing duplication of effort and furthering the development of a spatially enabled society.

There is also the need to develop institutional practices to make existing and future technology more effective. Research has found that very few jurisdictions have developed a framework for establishing a spatial infrastructure that addresses comprehensively operational, organisational and legal issues. It is these processes that will enable the infrastructure to be readily useable and available to all stakeholders.

Conclusions

An enabling platform aims to facilitate interoperability and inter-working of functional entities within a heterogeneous environment, enabling the linking and sharing of cross-jurisdictional services and functions that meet business needs. The inclusion of the private sector is an important aspect to the development of an enabling platform. The development of effective institutional practices and the creation of linkages between government agencies, SDI initiatives (at both national and sub-national level) and the private sector will enable a range of products and services from across agencies to be delivered through an enabling platform.

Design strategies for an enabling platform need to be able to link current sub-national SDI based infrastructure development with new and developed functions identified within research, by end-users and service providers. This will help overcome inherent locked-in effects that current systems have created over time. It must be remembered however that the achievement of an enabling platform is firstly largely dependent on collaboration between all parties. Secondly it is important to have effective SDI and spatial information system designs to support efficient access, retrieval and delivery of spatial information to locations where it is needed from locations where it is stored.

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