Unlocking The Potential Of Spatial Information Through Data Sharing - It's A Two Way Street

K. McDougall
Faculty of Engineering and Surveying
Australian Centre for Sustainable Catchments
University of Southern Queensland, Toowoomba, Australia.

Abstract
The majority of spatial information and mapping has traditionally been captured, managed and controlled by the public sector agencies. Over the past decade with the value and potential of spatial information slowly being realised, and the gradual down-sizing of government mapping agencies, the private sector has now become a significant holder of spatial information, particularly street and road information. However, the exchange mechanisms for value adding of spatial information are still only primarily one-way. The improvements in quality of many data sets which are undertaken in the private sector are not finding their way into the public sector databases. Data exchange arrangements have still not yet matured to enable a full two way exchange of value added data. The result is a significant duplication of effort by both sectors which inevitably leads to inefficiencies and reduced data quality. This paper will look at the developments in the spatial information industry in the past decade, particularly the rise of the concept of information infrastructures and specifically spatial data infrastructures (SDI). The concept of data sharing will be examined with a focus on the issues that limit the effective sharing of information. The data being utilised for vehicle navigation will be used to illustrate the complexity of data sharing models. Finally, a possible model for the two way exchange of spatial information is presented and its wider application to the industry is discussed.

Keywords: *data sharing, SDI, information exchange, information access*

Introduction

During the past decade spatial information holdings in the public and private sectors have matured. It is now commonplace for spatial information portals to be present at federal (e.g. Geoscience Australia), state (e.g. VicMap NRE Victoria, LIST Tasmania and local government (e.g. Mackay City, Caloundra City). Many private sector organisations are now utilising spatial databases and tools to interact with their customers using providers such as Sensis Pty Ltd. There is also growing evidence that the spatial information industry has now moved from spatial data collection as a primary focus of the industry, to becoming an information integrator, developer and re-user of spatial information. A recent economic study of the SI industry has found that spatial information and technology services have increased Australia's Gross Domestic Product by between $6-12 billion (ACIL Tasman 2007).

However, although the spatial information held by both the public and private sector has matured, the potential wider economic and community benefits from the spatial information are being limited by poorly developed or managed institutional and policy arrangements. For example, although most state agencies have now developed policies for access and pricing of their spatial data, the implementation of these policies is often hindered by issues such as the need to protect existing revenue streams, inconsistent policies across state government agencies or the lack of resources required to maintain and exchange data. Additionally, as the number of users of spatial information continues to increase, issues such as currency and accuracy of spatial information data sets are now being acknowledged. This is increasingly obvious with one of the fastest growing applications for spatial information, vehicle navigation.

Personal navigation devices or PNDs have grown dramatically in the past few years as both the technology and the availability of street network data has matured. In Australia, total unit sales for in-car navigation sector are expected to grow to approximately 1 million units in 2008 as the PND moves from being a luxury car item to the mass market. (Hearn 2007). Internationally the market for in-car navigation has seen an exponential growth, driven by sales of 20 million PNDs in 2007 in the USA and 30 million in Europe. Users of these devices are now expecting the quality of street network and additional functionality to continue to improve. However, many users are finding that data updates are expensive and the improvements in quality are not meeting expectations.

This paper will look at the developments in the spatial information industry in the past decade, particularly the rise of the concept of information infrastructures and specifically spatial information infrastructures (SDI). The concept of data sharing will be examined with a focus on the issues that limit the effective sharing of information. The data being utilised for vehicle navigation will be used to illustrate the complexity of data sharing models. Finally, a possible model for the two way exchange of spatial information is presented and its wider application to the industry is discussed.

Information as an Infrastructure

The consideration of information as an infrastructure began to take form in the late 1980s and was somewhat pushed to the fore when, in September 1993, the Clinton administration released a statement elaborating its National Information Infrastructure (NII) agenda (Executive Office of the President 1993). Its objectives were to:

(a) promote private sector investment;
(b) extend the concept of "universal service";
(c) promote seamless user interaction;
(d) improve the management of radio frequencies;
(e) act as a catalyst to promote technical innovation;
(f) protect intellectual property rights;
(g) coordinate the other levels of government; and
(h) provide access to government information.

The term global information infrastructure gained popularity, particularly in the USA, as it was seen to more adequately describe the global inter-connectedness of the information network. From 1994-1996, the USA Advisory Council on National Information Infrastructure developed principles, policies and recommendations for the development of the 'information superhighway'.

Spatial Data Infrastructures (SDI)

The evolution of the spatial or geographic data infrastructure concept can be traced back to the late 1980s when discussion on information infrastructures and the information superhighway was occurring. In 1987, The British Government Committee of Enquiry on the Handling of Geographic Information, chaired by Lord Chorley, identified the advent of GIS as 'the biggest step forward in handling geographic information since the invention of the map" (Cited in Masser 2005, p. 3). Although the recommendations by the Chorley Report, including the establishment of an independent geographic information management agency were rejected, it set the scene for subsequent discussion on SDIs in the UK, including the formation of the Association of Geographic Information (AGI) in 1989 and the National Geospatial Data Framework initiated in 1996 (Masser 2005).

In the United States, the concept of a National SDI initially began in the academic communities around 1989 (Tosta 1999), and soon after in government with the formation of the Federal Geographic Data Committee (FGDC) in 1990 by the Office of Management and Budget. During the early 1990s, the FGDC developed coordination strategies, standards and best practice with the objective of building "a national digital spatial data resource" (Reichardt & Moeller 2000). A major study by the National Research Council in early 1990 further supported the development of a National Spatial Data Infrastructure (National Research Council 1993). The NII agenda proposed by the Clinton/Gore administration in 1993 was followed by the issuing of Executive Order 12096 in April 1994, which called for the establishment of a National Spatial Data Infrastructure as a key component of the National Information Infrastructure.

In Australia in the early 1990s, a number of state government agencies promoted the proposition that land and spatial information should be considered as an infrastructure (Davies & Lyons 1991; Kelly 1993). Australian efforts towards a National Spatial Data Infrastructure were promoted by ANZLIC in 1996, through a position paper on "Spatial Data Infrastructure for Australia and New Zealand" (ANZLIC 1996). Coordination efforts by ANZLIC activated this vision through the development of policy, standards and metadata toolkits.

Sub-National SDI and the Private Sector

In recent years the focus of SDI has moved from the national to sub-national levels involving state and local governments. In the United States, the complexity of building the sub-national framework data cannot be under-stated. Co-ordination efforts must encompass many federal agencies, the 50 states, the private sector and the numerous counties, municipalities, townships and special purpose districts. In the 2002 Census of Governments, there were over 87,000 local government units identified in the USA (US Census Bureau 2002). These local government agencies spend significantly more on geographic information related activities than US Federal Government agencies (Harvey et al. 1999).

In Australia, state governments play a significant role in policy development and the building and managing of spatial data infrastructures. Each of the Australian states and territories has established a coordination agency or group to reflect each of their mandates and state goals with respect to spatial data infrastructures. The state government agencies are active in pursuing SDI development with most activity generally focussed on delivering product outcomes. Each state has an overarching policy to facilitate SDI development which usually includes encouraging the active participation of the private sector in their SDI vision.

Many of the state government activities are project based. A significant number of project activities focus on proto-typing of infrastructure developments, capacity building, information access and partnering arrangements (Grant & Williamson 2003). In most states the interface between state and local government has been identified as an important

linkage in achieving the vision and goals of the government. Most of these state SDI co-ordinating bodies have emerged from within the previous "Land Mapping Agencies" and continue to have a strong focus on their core jurisdictional responsibilities relating to cadastral land management and land administration (Warnest 2005).

In countries such as Australia, Canada, the USA and Germany which are organised federally, the state or provincial level may actually perform more core mapping activities than their central mapping agency counterpart (Rhind 1997). By contrast in non-federated countries, central government maintains the primary responsibility for national mapping as observed in France, Russia, India, Sweden and the United Kingdom.

Like their national counterparts, sub-national governments are increasingly outsourcing their traditional data capture and management activities to the private sector. In Canada, the Alberta Environment Protection outsourced the updating, storing and distribution of its digital map base by establishing a new company, Spatial Data Warehouse (SDW). The not-for-profit company, owned by a consortium comprised of different levels of government and the utility sector, underestimated the efforts required to maintain the data sets, and in 1998 set up a joint venture arrangement with a private sector firm to manage the data (Masser 2005).

The private sector's role in SDI development in Australia is ongoing. Initially, the private sector's involvement began in the mid 1990s as a data collector when government mapping services were outsourced. Progressively private businesses are now specialising not only in the collection but also in the on-going maintenance of government databases. More recently however, the private sector involvement has included marketing and value-adding. This engagement has brought with it challenges for government to balance their control of their information investments with the need to encourage spatial business opportunities (Grant & Williamson 2003).

Data Sharing Initiatives

Sharing of spatial data is critical to the development of comprehensive and inclusive SDIs. Sharing of data is more often about people and organisations than the data itself. It seems quite wasteful that publicly funded organisations cannot readily co-operate to share resources or information (Onsrud & Rushton 1995). However, the reality is that it is easier for individual public sector agencies to work within their sphere of influence than outside of it. Historical bureaucratic structures carry with them a significant "organisational inertia" which is reinforced by departmental silo structures, traditional public service systems and an increasingly complex legislative framework that is difficult to change.

The reason to share spatial information was clearly summarised by the Mapping Sciences Committee of the National Research Council in 1993, namely:

"The principle of a spatial data sharing program is to increase the 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 spatial data as well as through the increased use of this potentially valuable information. The exposure of these data to the wider community of users may also result in improvements in the quality of data. This will eventually benefit the donor and other users" (National Research Council 1993, p. 89)

The sentiments expressed by the Mapping Sciences Committee as they put forward a framework for building a national spatial data infrastructure reflect the true role of governments, namely a service for the common benefit of society. Onsrud & Rushton (1995) argue that the value and utility of geographic information comes from its use, and that the more that geographic information is used, the greater becomes society's ability to evaluate and address the wide range of pressing problems to which the information may be applied. Another perspective is that the objective of spatial data sharing is to create "connections" among widely dispersed databases (Calkins & Weatherbe 1995). However, spatial data sharing is most commonly advocated on the basis that there are tangible benefits through improved efficiencies (Azad & Wiggins 1995).

The role of government agencies, particularly those such as mapping and surveying, has changed dramatically in the past 10-15 years. Production and service based agencies have been downsized and their operations outsourced to private enterprise. The focus of governments is far more business orientated and budget driven in contrast to the traditional "public good and service" perspective. The reasons for sharing public information have remained the same, but it is the imperatives and business needs that have become the new focus. Development of data sharing cultures is important to successful implementation of geographic information technologies and advancement of GIS (Onsrud & Craglia 2003). There is also no doubt that the lack of information exchange among local, state and federal government and the private sector remains a significant impediment to more effective and efficient use of GIS throughout society (Pinto & Onsrud 1995). The reality is that data sharing is easier to advocate than to practice (Azad & Wiggins 1995).

The value of information can increase when it is shared. Kelly (1995) identified that spatial information is increasingly valuable for making decisions and solving problems in private sector economic development, environmental management, emergency response and public health and safety. However, the author also notes that although the value

of the application and sharing of spatial information is often self evident, better quantitative measures are required to measure the benefits and costs. Although GIS technology has been rapidly adopted by many organisations, the propensity to share this information or to make the information publicly available has been disappointing, particularly with respect to the coordination efforts at state government level (Warnecke et al. 2003). Nebert (2004) also identifies that the value of geographic information will be more readily realised through improved coordination, common conventions and technical agreements.

Data Sharing Issues – Barriers and Motivations

The underlying premise for sharing data is that it will eventuate in a range of benefits for the organisations involved. The primary benefits or drivers for data sharing as introduced in the previous section, include cost savings through lack of duplication of data collection and maintenance efforts, improved data availability, and enhanced organisational relationships through promotion of cross organisational relationships (Nedovic-Budic & Pinto 2000). Another important benefit of data exchange may also be the improvement in the quality of the data sets, particularly where there are multi-organisational efforts to contribute to a common or shared data base. Reduction in risk can also be seen as a benefit (Evans 1997) if organisations are prepared to both contribute to the costs or development time for a shared initiative.

The issues of cost recovery, copyright and legal liability have done little to encourage organisations to provide access to spatial information (Rhind 1992). The majority of issues relating to spatial data sharing are considered to be related to an organisational framework in one form or another. For example the legal issues are primarily related to the perspective of an individual organisation with regard to their organisation's liability as a result of sharing. Economic issues are also related to organisational budgets rather than external funding in a large proportion of data sharing initiatives. Table 1 identifies some of the constraints on data access and sharing.

Table 1. Constraints on data access and sharing

• Cost is the major fact for all users
• Ownership, intellectual property rights and restrictive licensing on a project by project basis
• Spatial accuracy of the data is often not known
• Limited knowledge of data transfer formats available and incompatibility
• Data made available often not raw, but has been manipulated by the collector/creator
• Some datasets have been compiled by aggregation of local data to regional with no reference to the source data
• Requirements of community interest groups not known
• Privacy and the difficulties in ensuring confidentiality with sensitive data
• Distinction between desirability of sharing or sell of data is unclear
• Ownership of information derived through the use of government data, accessed under license, remains with the data owning and license agency, which prohibits on-selling or ex-project distribution of information (copyright issues)
• The full cost-recovery and profit making policies being applied by government departments
• Lack of knowledge and understanding of the nature, power and value of SI systems
• Lack of knowledge and understanding by decision makers of the technology available and its application and use
• Legislation does not always eliminate uncertain legal situations
• Communication problems, within and between various agencies
• Incompatibility between system designs
• Business ethic versus the community service capability
• Lack of access to (central) metadata dictionaries/databases.

(Ronaldson *et al.* 2000)

The Role of Partnerships

Partnerships are emerging as a preferred model for inter-organisational collaboration, particularly to facilitate the exchange of spatial data across jurisdictional boundaries. Partnerships or alliances are generally at the higher end of the collaboration continuum. Partnership agreements may comprise informal or formal agreements. Informal agreements may consist of a letter of intent, a heads of agreement or memorandum of understanding. In each case the intent is to establish a non-legally binding framework that provides each party defined objectives over a specified period of time (Gerdes 2003). On the other hand, formal agreements may take many forms including licensing and distribution agreements, marketing agreements, or master agreements.

Since the events of 11 September 2001, there have been new perspectives on the access and availability of spatial information. In the United States, the early policy initiatives to provide access to geographic data at little or no cost

have been somewhat wound back. In recent years there have been a growing number of examples where there has been an increased level of political consideration in accessing spatial information based on either security concerns or issues such as revenue loss. A recent initiative in the USA has been the development of a National Strategy for Sharing of Information (NSSI) which is promoting the increased sharing of critical information to support the fight on terrorism. The strategy recognises that information related to terrorism can come from multiple sources, all levels of government, as well as from private sector organizations and foreign sources. It promotes the use of "trusted" partnerships between federal, state and local governments and the private sector to detect and prevent the growth of terrorism (National Security Council 2007).

Application of SDI to Vehicle Navigation Data

With vehicle and personal navigation devices predicted to grow at between 50-100% annually for the next few years, the provision of accurate and reliable navigation data will be a priority. Currently in Australia, the majority of street network data has been provided to navigation manufacturers by Sensis Pty Ltd through its range of Whereis® products. The Whereis® suite of digital mapping products support a range of private, corporate and government customers with content to be used in mapping, routing and scheduling applications by transport, logistics and Geographic Information System (GIS) users.

Whereis® digital mapping products include:
StreetNet *Routable* database - provides road names, address ranges, road hierarchy, contextual information and navigational attributes
StreetNet *Display* database - provides road names, road hierarchy and contextual information (such as railways, stations and major parks)
Whereis® *Image* database - details the national road network, identical in appearance to those in the printed UBD™ street directories

In July 2007, Navteq made a preliminary announcement that it will be entering the Australian mapping market. Navteq is one of the main providers of digital geographic data and, as such, provides the data which is used in GPS devices and on Web sites such as Google Maps and Yahoo Maps. NAVTEQ maps span over 50 countries and territories on five continents. Concentrated heavily in North America and Europe, the NAVTEQ map database continues its expansion into numerous markets around the world. NAVTEQ has over 500 field researchers strategically located around the world. NAVTEQ field researchers actually drive the roads, verifying and updating information in the NAVTEQ database. This in-depth "human factor" has delivered data consistent with real world conditions and results in a multi-faceted and comprehensive product. NAVTEQ's has significant market domination in Europe with most major automotive manufacturers in North America and Europe utilising NAVTEQ maps in one or more of their models.

Building and maintaining road and street mapping for the Australian continent is no trivial task. In the case of Sensis, it is understood that a large part of the original map base was derived from various state government databases such as digital cadastral databases and road centreline data which were acquired and built in the late 1980s and early 1990s. However, each state mapping agency had adopted a different data collection, building process and format, so Telstra as it was then, had to negotiate a varying range of formats, qualities and bureaucracies. Much of this data was then supplemented with data obtained from local government authorities and field data collection. Initially, a primary driver for their data collection was to support their telecommunication operations and management of its fixed line network. However, this has now grown beyond the servicing of Telstra with Whereis providing location based solutions for navigation, business applications and government.

NAVTEQ as indicated above, has only entered the market recently and will gradually seek to build their market share through sales in navigation devices, advertising and location based services. In 2007, NAVTEQ was acquired by Nokkia and its location databases will be used worldwide to support the advances in location based services and technology. The NAVTEQ data acquisition process of Australian streets and roads was quite different to the Sensis capture process. NAVTEQ utilised their field resources from all over the world with approximately 50 geographic analysts participating in the data collection. As NAVTEQ analysts use the same equipment and processes worldwide, their analysts simply brought their laptops and collection equipment to Australia and went to work. The data collection process used their specialised collection equipment to ensure each road was correctly positioned, including:

- Verified street names and addresses
- Collected road details, including turn restrictions, toll roads and tunnels, speed categories, and more
- Collected and verified thousands of Points of Interest (NAVTEQ 2008)

NAVTEQ have also partnered with PSMA Pty Ltd to build and validate their database. PSMA currently manage the Geocoded National Address File (G-NAF). The planning for a national geocoded address file began in 1995. Further feasibility studies and testing identified the need for a national address file and a national standard for street addressing (Paull 2003). The national street address standards were completed in 2003, PSMA put the G-NAF project to tender in mid 2003, and the first version of G-NAF was completed in 2004. G-NAF is Australia's first authoritative geocoded address index for the whole country, listing all valid physical addresses in Australia (PSMA 2005). It contains

approximately 12.6 million physical addresses, each linked to an unique geocoded address and has been validated through data integration process which confirm aggregated state government databases, Australian Electoral Commission data and Australia Post datasets.

The quality of navigation data across Australia varies dramatically and is dependent on the updated information collected by the two main private sector data providers. Below is an example of the road network data over an area near Noosa in Queensland. Figure 1 shows the recent satellite image over the area with a new major road across the centre of the image. Figure 2 shows the existing digital road network with none of the new road data shown.

Figure 1. 2008 Satellite image over an area near Noosa.

Figure 2. 2008 Satellite image and the digital road network data showing mis-match over an area near Noosa.

From One Way to Two Way Sharing of Information

Within Australia, and other countries, there has been a progressive outsourcing of spatial data capture and the value-adding of data by the private sector. This strategy has largely been imposed on governments through micro-economic reform and national competition policies. In general, the efficiencies achieved by the private sector agencies in data collection, mapping and development of new products have been justified with new technologies and initiatives appearing across the spatial information landscape. However, it is prudent to step back and take a whole of industry perspective of spatial information collection and management in order to understand where the future may lie. This is particularly important with respect to fundamental spatial information data which originates from public agencies and progressively is value added by the private sector.

As Shown in Figure 3, the information flows for information related address and street information is primarily a one way street. This is particularly problematic at the state government level where information flows are highly siloed by the existing departmental structures. Existing government revenue streams and policies on information access are to larger extent to blame for the lack of intra-governmental sharing. A complex array of data licensing arrangements and

cost shifting has exacerbated the information silos that currently exist. Attempts to compile a single authoritative source of street address information has only yielded modest success. In Queensland, the Property Location Index or PLI was initially stifled by a one sided information grab by the state government that left local government authorities unwilling to participate. The development of the information sharing approach and a review of state government access and licensing arrangements in 2004 greatly improved information flows between the state government and LGAs. However, two way information flows are yet to be achieved.

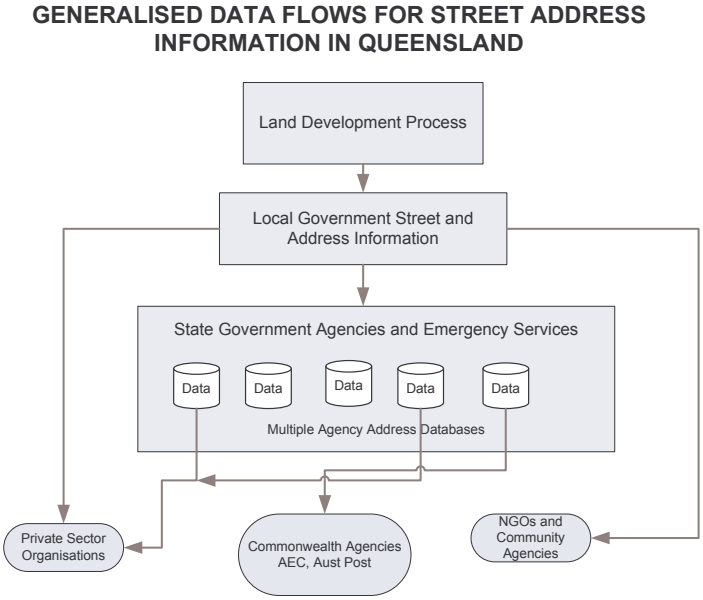

Figure 3: Information flows for street address information in Queensland

So what model can work and how can it be achieved. There is no doubt that solutions to the improved sharing of information exist and the use of existing distributed information networks such as the internet will have a significant role to play. Models for information sharing which not only utilise the existing resources of government but establish a "many to many" information exchange model that facilitates the timely exchange of information where multiple benefits for the community are achieved. Numerous examples of information exchange in practice are now appearing all over the world. Examples such as environmental alerts and monitoring, crime prevention and emergency and disaster management have prompted government agencies to consider alternatives to their existing information approaches.

Vehicle navigation systems and mobile phone technology are platforms that could enable the update of street information to progressively improve its accuracy and reliability. These systems are now being widely used by local, state and federal governments and private sector. Users of the system should be able to report problem in street address information to a central repository where a request be initiated to investigate and correct the data if required. To reduce the amount of spurious requests, a system of trusted partners could be established to ensure that information that is being exchanged is of a suitable standard. Alternatively, the system could be opened up to all road navigation users and a suitable system of real-time validation may need to be developed to ensure the correct information is being exchanged. The immediate beneficiaries for such a system might be the private sector data providers, but there is no doubt that the custodians of this data, particularly local and state governments would also benefit.

Conclusions

The development of spatial data infrastructures has progressed significantly in Australia and around the world. However, with the limited amount of resources available to governments and the increasing amount of spatial information being held within the private sector, new models for building and maintain these valuable infrastructures needs to be explored. The traditional one way information flow of spatial data does not recognise the changing balance of the holdings of public and private sector information. Two way models, which recognise the need to disseminate and maintain data, should be explored. New technology such as vehicle navigation systems and mobile phone networks should now become the tools for improving data exchange and thereby reducing the duplication of effort.

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