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## **SDI governance: Bridging the Gap Between People and Geospatial Resources**

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### **Abstract**

Organisational arrangements have long been recognised as a critical enabler and fundamental component of Spatial Data Infrastructure (SDI). More recently, the term “governance” has become increasingly used to refer to aspects of institutional frameworks that support SDI. However, given the polysemous nature of the term and the evolving nature of approaches to implementing SDI, it not clear exactly what is meant by the term “SDI governance” and thus the scope, nature and challenges of governance are not well understood.

Through an exploration of concepts and model of governance in a variety of contexts, a conceptual model of SDI governance is being developed. An investigation of practical realities of governance in four Australian SDI initiatives has been used to inform the development of this model. This paper provides an overview of the concepts of governance, presents some key findings from the Australian SDI cases studies; and describes an initial conceptual model of governance.

**Keywords:** governance, SDI, Australia, institutional arrangements, SDI coordination

### **1. INTRODUCTION**

The importance of institutional (or organizational) arrangements as an enabler and critical element of Spatial Data Infrastructure (SDI) has long been recognized (Coleman & McLaughlin 1998; Rajabifard et al. 1999). During the last few years, governance has gained prominence in SDI literature with calls to

develop appropriate governance arrangements to address contemporary SDI implementation challenges (Kok & van Loenen 2005; Masser 2005; Masser et al. 2008). Similarly in practice, the need for improved governance has been recognized (Federal Geographic Data Committee (FGDC) 2005; Kelly 2007; Finney 2007).

Governance, which deals with collective decision-making is clearly a function or aspect of organizational arrangements. However, given the typically large number and diversity of SDI stakeholders linked through multiple overlapping, interacting networks and the need to facilitate the rapidly evolving and increasingly collaborative approaches to SDI implementation, governance represents a significant challenge. This challenge is compounded by the fact that the term is interpreted in different ways and thus it is unclear exactly what the term means in relation to SDI. In addition, the adoption of Service Oriented Architecture (SOA) approaches to building SDI brings a whole new set of governance challenges that are not as yet, clearly understood.

The lack of common understanding about SDI governance means that each SDI initiative must tackle the same set of governance challenges afresh. This results in inconsistent approaches to governance: reduces the prospects of achieving interoperability between SDIs and limits opportunities for re-using governance resources between SDIs.

This paper aims to contribute to an improved understanding of governance through:

- an exploration of the meaning of governance in a number of contexts;
- offering some initial findings from research into governance of four Australian SDIs; and
- presenting an initial model of SDI governance.

## **2. WHAT DOES GOVERNANCE MEAN**

In broad terms, governance is about collective decision making. The term originates from the Greek verb *κυβερνάω* meaning to steer or pilot a ship (Kjær 2004) and was first used in the context of collective societal decision-making by Plato to describe the role of a society's rulers. Although the term was originally used to describe the act and capabilities of government to govern a political unit, governance can operate on a collective activity of any scale from several people to the global level. The Commission on Global Governance (1995, p.2) defines governance as:

*"the sum of many ways in which individuals, institutions, public and private, manage their common affairs. It is the continuing process through*

*which conflicting or diverse interests maybe accommodated and cooperative action taken.”*

Today, governance is a key concept in a number of disciplines but its meaning varies according to the context in which it is used and in many contexts it is a contested concept. Therefore, to provide some context for a discussion of SDI governance, an exploration of governance in following inter-related contexts is provided in next section:

- Societal or public governance at domestic, global and regional levels
- Corporate governance
- Information Technology (IT) governance
  - within the context of an individual organization
  - Service Oriented Architecture (SOA) governance the governance of services within and increasingly between organizations

The relationship between these related governance contexts is shown in figure 1 below.

Given the socio-technical nature of information infrastructures such as SDI (Aanestad et al. 2007), a focus on governance in the political sciences, and IT are considered to be of particular relevance to a discussion of SDI governance.

## **2.1 Public Governance**

Public governance or the governing of societies can be viewed from two interrelated viewpoints; that of internal, domestic affairs and that of a system of political units in the international domain (Mitchell 2007).

### **2.1.1 Domestic Governance**

In western democracies, governance or the act of governing was traditionally considered to be the sole responsibility of government using top-down hierarchical, bureaucratic structures. In this context, until the middle of the 20th century, the role of governments was principally that of a regulatory authority providing basic infrastructure. From the 1950's many western democracies saw the role of the state expand to increase the provision of social services (Kjær 2004). In the 1970s, it was recognised that the traditional rigid, hierarchical, bureaucratic structures of government were not well suited to deliver social services and it was argued that government should focus on policy setting or "steering" rather than service delivery or "rowing" (Osborne & Gaebler 1993)

The 1980s and 1990s saw major public sector reforms focusing on privatisation (Rhodes 1996), increased citizen participation in public affairs (Bogason & Musso

2006); and decentralisation of government functions to lower levels of government (Kjær 2004; Marks & Hooghe 2004).

With multiple public, private and societal stakeholders now involved in public service provision, 'policy networks' comprising inter-organisational linkages and dependencies that enable exchange of resources necessary to achieving common goals, become increasingly important governance structures (Rhodes 1996).

Today, governance is still a contested concept in the political sciences but in broad terms is considered to be an interaction between stakeholders to influence public policies (Bovaird 2005) And improve public outcomes. It is recognized that network governance models, co-exist with hierarchical governance models upon which political representation is based (Kjær 2004). In his context, governance can be viewed as a set of relations between actors coordinated by regulatory agencies, (Mitchell 2007) and the critical challenges of governance relate to the steering of policy networks (Kjær 2003; Rhodes 1996).

### **2.1.2 Globalisation and International Relations**

In the field of international relations, globalization with increased volume, intensity and speed of flows of people, capital and information across national borders has led to global "interconnectedness" (Held & McGrew 2003, p.3). Driven by economic, technological, socio-cultural and political forces and enabled by advances in physical infrastructure such as roads, IT and normative infrastructure, such as regulatory frameworks, globalisation is transforming people from citizens of separate sovereign states to citizens of a 'global village'. Through phenomena such as climate change and the global economic crisis, there has been a realization that humanity is economically, ecologically and socio-politically connected and that the scale of the problems and thus the solutions, transcend national borders. This has led to recognition that global governance is required.

### **2.1.3 Multi-level Governance**

At the regional scale, the processes of member state integration into the European Union and de-concentration and decentralization within member states, have resulted in the dispersion of national authority upwards to supranational and downwards to sub-national levels (Marks & Hooghe 2004). The resulting pattern of governance is characterised as multi-level governance (MLG), a system of negotiation between nested governments at several territorial levels with tiers of government involved in policy networks that transcend territorial boundaries (Marks 1993, pp.402-3). Both vertical interactions (between levels of government) and horizontal interaction (between government and non-government actors) occurs at each level (Flinders & Bache 2004) with tiers of

government acting increasingly independently of the hierarchical structure within which they are embedded to pursue their own interests in other fora (Peters & Pierre 2004).

The dispersion of governance across multiple jurisdictions is considered to be more efficient than a centralised governance monopoly, as governance operates at multiple scales that respond effectively to issues that have varying scales and territorial reach (Marks & Hooghe 2004). For instance, global governance is required to tackle a global scale issue such as climate change while local governance is more appropriate to respond to local scales issues such as transportation.

## **2.2 Corporate Governance**

Within organizations which are established to carry out specific functions, corporate governance is a key concept, which traces its roots to the 17th century when companies first developed a legal identity separate from their owners (Kakabadse et al. 2004). The separation of ownership and management required the establishment of mechanisms to ensure that management operated a company inline with the interests of its owners (Bloem 2005). In this system, a board appointed by owners, which delegates authority to management to run the company, is responsible for accountability for the actions of the company to its owners and the regulatory systems in which they operate together with oversight of company management. Principles of and approaches to corporate governance are also applied to public organizations.

## **2.3 Information Technology (IT) Governance**

IT governance is a subset of corporate governance. As IT assets of organisations have typically grown in an uncontrolled chaotic manner with business units typically responsible for meeting their own IT needs, IT management efforts have focused on bringing IT assets under control and management, thus enabling systems integration and the reuse of data and functions and effective maintenance. Given the number of stakeholders involved in IT within organizations, there has been a realization that IT governance mechanisms are also required (Bloem 2005).

The IT Governance Institute (ITGI) (2005, p.10) takes a broad view of IT governance encompassing “the leadership and organizational structures and processes that ensure that the organisation’s IT sustains and extends the organisation’s strategies and objectives”. A narrower view of IT governance is reflected in the decision rights framework (Weill & Ross 2004, p.2) comprising three main elements; domains, styles and mechanisms. Domains represent five related areas of IT governance decisions including IT principles, infrastructure

and business applications. Styles represent groups that are involved in the decision-making process, based on six 'political archetypes' (Clark 2005) ranging from business and IT monarchies to federal, feudal, duopoly and anarchic archetypes. The domains and styles are presented in a matrix and used to document which groups provide input, and have authority to make decisions in each of the domains. Having identified the decision input and authority styles for each decision domain, decision-making mechanisms (structures and processes) are documented. This enables an analysis of the complete IT governance approach.

#### 2.4. Service Oriented Architecture Governance

Service Oriented Architecture (SOA) is an IT architectural style based around discrete software services that can be aggregated to create applications. Although services are heterogeneous, distributed and under the control of different owners, they are interdependent. This necessitates collaboration between the owners, developers, operators, and users of the service across departmental and organisational boundaries (Josuttis 2007). Experiences in the deployment and maintenance of production services have led to an increased emphasis on the importance of service governance to support service operation and management. This is due to the need to involve multiple stakeholders in decision-making about service design, operation modification. Although the broader IT community has some experience dealing with services in the requirements for service governance in the context of SDI is not yet fully understood (Finney 2007).

Figure 1 Governance contexts

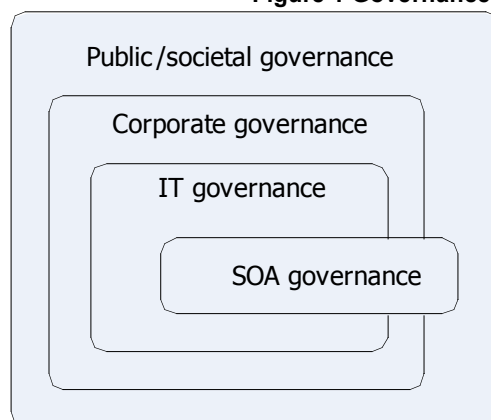


Figure 1, depicts the governance contexts described above, as being inter-related and nested, with IT governance taking place within corporate governance which itself is embedded within public governance. SOA governance crosses IT

and organizational governance boundaries, as it may involve collective decision-making with external stakeholders.

In summary, governance can be viewed as a framework that enables communities of any scale to manage their collective affairs through a process of negotiation and decision-making. The framework enables the creation of and operates through mechanisms, processes and rules designed to reconcile the needs and interests of a community, and to steer individual and collective initiatives of stakeholders to achieve agreed, collective goals. Some of the common principles of governance include, consensus based inclusive decision making, equity, transparency, accountability and a strategic vision (UNDP 1997) . The following section explores SDI governance

### **3. SDI GOVERNANCE**

Given the complexity of SDI with inter-related and interconnected technical and institutional elements and the multiplicity of stakeholders involved, it is clear that governance is an important aspect of the institutional framework necessary to support decision making about all aspects of an SDI. *The following sections briefly describe the emergence of the term “governance” as it applies to SDI, and briefly describes SDI hierarchical and networked governance models.*

#### **3.1 From Coordination to Governance**

The recent emergence of, and interest in, SDI governance reflects the evolving nature of SDI, and the socio-political context in which SDI exists. As noted by Masser (1999) some current SDI initiatives have evolved out of pre-existing coordination arrangements and in many cases are embedded within them. Early initiatives to coordinate geospatial information activities focused on the needs of central government mapping agencies. With the shift from product to process based SDI models (Rajabifard et al. 2003) came a shift in emphasis from concerns of the geospatial information producers to those of the users (Masser 2006) and a move from centralised organisational structures, to decentralised and distributed networks (Masser 2005). SDI operations have also been increasingly de-centralised to local levels (Masser et al. 2008). With decentralisation, the increased role of the private sector and the need to involve a large group of diverse stakeholders in decision-making, legacy organisational arrangements reflecting the focus of early initiatives, are not necessarily the most appropriate mechanisms to enable SDI (Masser et al. 2008). These realities have led to attempts to develop improved governance models aimed at more inclusive, whole of industry approaches to SDI (Masser 2005).

This is evidenced by ongoing efforts to find improved governance models in, for example, the US (Federal Geographic Data Committee (FGDC) 2005) and Australia (ANZLIC Spatial Data Infrastructure Standing Committee 2003).

### **3.2 Top-down and Bottom-up Governance**

To address decision making in the context of multi-level SDI implementation, Masser (2008) notes that hierarchical governance structures are required to enable the participation of national and local governments and the private sector in decision making. However, hierarchical structures are typically perceived (and in reality often are) as operating 'top-down', with authority flowing from higher to lower levels. However, SDIs are typically built at local levels from the bottom-up. In Australia experience gained in developing a marine community SDI, has led to a proposal for a bottom-up governance framework (Finney 2007). The framework is premised on the development of an SDI using an SOA approach, and is based around open source community governance models.

Given that the coexistence of the two governance models - networked governance mechanisms that typify bottom-up approaches and the hierarchical political and regulatory governance models in which they are embedded- the challenge of SDI governance is essentially the same as that for public or societal governance i.e. the need to reconcile the two models. At the heart of this challenge is balancing the needs of bottom-up heterogeneous, creative, community-driven development with the requirements for standardization and conformance that will enable different initiatives to interoperate.

## **4. SDI GOVERNANCE IN AUSTRALIA**

Given the limited SDI governance literature and documented practice, research into the governance of SDI in Australia was undertaken. The aim of the research was to explore the issues and realities of SDI governance in multi-agency, public good SDI initiatives.. The case studies described below were selected to represent different types of SDI based upon hierarchical level, scope and organizational arrangements. As Australia is a Federation, comprising a national (Federal) government, 5 state and 2 territory governments, the research focused on the following initiatives at state/territory and national levels:

- Public Sector Mapping Agency (PSMA) - a public company established and owned by Australian Federal, State and Territory governments to integrate and deliver key State and Territory datasets for which consistent national coverage was required.
- New South Wales State Natural Resource and Environment Sector SDI. The case study focused on the Community Atlas for Natural Resources (CANRI), an interagency programme to develop an SDI to improve management of and access to natural resource information. The evolution of



CANRI from program governance to operational governance and later transition to the Natural Resource Atlas (NRAtlas) were key aspects of this case study.

- Western Australia State SDI. This case focused on the Western Australia Land Information System (WALIS) – the state-wide geospatial coordination arrangements and a multi-agency program to develop the Shared Land Information Platform (SLIP), the service oriented infrastructure to support land administration, environment and emergency services business focus areas
- Victoria State SDI (VSDI) – this case focused on the evolving institutional arrangements for development of the Victoria SDI

Using semi-structured Interviews and workshops with stakeholders involved in the case study initiatives and informants from federal and state government agencies and the private sector, the conceptualization, function, scope, mechanisms, and challenges of SDI governance were explored.

#### 4.1 SDI Governance Lessons Learned

Table 1 presents some of the most pertinent governance lessons learned and extracted from the case studies. These have been grouped into institutional, business, data and service categories and ranked in order of the most frequently cited.

**Table 1 SDI Governance Lessons Learned**

<b>Institutional dimension</b>
Success of SDI initiatives are based on the trust & goodwill established in a community over years and based on personal relationships
Barriers between the geospatial and IT communities hamper efforts to build SDI
SDI governance arrangements and existing government (including Whole of Government) and domain governance arrangements need to be harmonised
Key agencies typically have multiple roles in SDI including lead agency, custodial, secretariat of governance body, coordinator, and operator of the infrastructure. These roles must be clearly understood and separated.
Governance operates through representational processes and the effectiveness of the process is dependent on the quality of the representation
For effective governance, agencies acting as community representative must subordinate the interests of their own organisation to those of constituency being represented
Current SDI approaches and governance models reflect a hierarchical structured government world view, which does not adequately accommodate network and market-oriented realities of the geospatial industry
SDI implementation requires leaders in individual agencies to champion initiative

With institutional changes (organisations, people and roles), business drivers, motivation, priorities and power balance changes. This results in a loss of momentum and a need to re-build partnerships and trust
Governance mechanism should encourage participation of and give voice to smaller agencies
Government to government business is hampered by weak contract arrangements and weak enforcement mechanisms with contract performance based on trust
<b>Business dimensions</b>
There is a need to understand the business drivers for SDI
There is a need to ensure alignment of business outcomes of individual agencies with collective interests
There is a need to convincingly answer the question “What’s in it for me?” for potential participants in an SDI initiative.
Selling SDI to participants using the benefit of increased efficiency alone is problematic, as this may be perceived as a threat – i.e. it represents loss of budget/staff/status/power
Justification for obtaining agency funding to participate in SDI is problematic as the benefits are realized by users outside of the organization (which maybe beyond the business goals of the funding organization).
Reticence of agencies to participate in SDI can be overcome by demonstrated positive benefits and results
<b>Data</b>
Complexity, lack of standards and guidance related to data licencing is cited as a key barrier to the sharing and publication of geospatial data
Liability concerns related to incorrect data or misuse of published data are cited as reason for non-publication of data
There is a need to adopt a transactional view towards data access, pricing and licencing. The current approach of accessing data sets based around physical data storage reality is out-dated
There is an accountability gap with regard to data custodianship. Custodial responsibility is mapped to an organizations. However in reality, geospatial data is typically managed in business units and with corporate IT governance focuses on corporate data.
<b>Services and technology</b>
Technical limitation (bandwidth, speed) are cited as barriers for low uptake of geospatial web services by GIS users
Entrenched business practices are cited as barriers for low uptake of geospatial web services by GIS users
Service quality limitation (e.g. availability) are cited as barriers for low uptake of geospatial web services by GIS users
to enable SDI stakeholders them to participate in the SDI adequate technical support and mutual learning opportunities are required

## 4.2. SDI Governance Recommendations

In addition to the lessons learned, some key recommendations regarding approaches to addressing SDI governance or aspects of SDI that have significant governance dimension, that are considered to be generic and thus broadly applicable, are presented below. They are offered as starting point for thinking about some of the key aspects of the governance.

**Leadership, mandate and neutrality** - The need for clearly defined leadership, a sustained formal mandate including a policy framework, and the neutrality and community-oriented action of organizations playing key governance roles are all critical requirements for SDI governance. It is recommended that:

- - A high-level policy framework to provide sustained formal mandate and mechanism for collaboration between individual agencies be established
- A lead agency be identified and provided with a clear mandate to lead, a role that must be exercised with neutrality
- A rotating chair for governance bodies be established to aid neutrality and enhance participation and buy-in from smaller agencies
- An independent chair for peak governance body be selected

**From project to operational governance** - Sound project governance and a clear transition plan to move from temporary project governance to operational governance in a multi agency context is a major governance challenge. It is recommended that:

- Since SDI capabilities are typically implemented as a series of inter-dependent projects, a project management approach/framework such as PRINCE2<sup>1</sup> be used to ensure effective project governance
- Project governance should focus on the meeting the business case, project, design and delivery while operational governance should focus on the ongoing operation and sustainability of the SDI
- Effective links and interfaces are established between project governance mechanisms and enclosing and related governance frameworks (e.g. geospatial community, political, administrative and regulatory system and corporate governance)
- A clear transition plan to move from project to operational governance be developed

**Licencing and data sharing** - Addressing the concerns of data custodians will assist in removing barriers to publication. It is recommended that:

- Legal concerns (such as licencing and liability) that act as barriers to geospatial data sharing be addressed

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<sup>1</sup> Projects in a Controlled Environment - <http://www.prince2.com/>

- The operational cost of the infrastructure be funded from the sale/licensing of data and information

**Business, institutional and technical architecture** - Developing separate institutional and technical frameworks that are business neutral and will greatly enhance prospects for growing an SDI. It is recommended that:

- Long-term sustained, institutionally independent, business drivers for the SDI be identified
- The financial investment in SDI using cost benefit analysis or return on investment in at least one business area be justified. Other business areas where investment is harder to justify can leverage the established infrastructure
- The institutional and technical frameworks that comprise SDI be separated
- The technical infrastructure be developed as a 'business-neutral' enabler
- Self-identified business areas e.g. environment, emergency response, marine be enabled to develop business cases and exploit/grow the infrastructure
- A mix of part-planned and part evolving approaches to infrastructure development that encourages innovation and heterogeneity be adopted

The case study research provided insights into SDI governance realities and responses and offers potential for informing how other initiatives approach challenges of SDI governance. The research has been used to abstract common elements and elements of SDI governance to inform the development of a conceptual model of SDI governance presented in the next section.

## **5. GOVERNANCE MODEL**

The following sections provide an overview of an initial governance model; positions governance in relation to coordination and describes an approach to handling agreement which is a central element of the model.

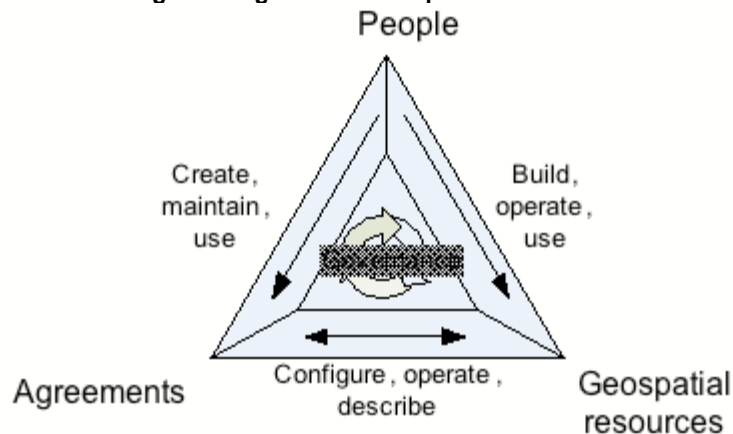
### **5.1 A Conceptual View of Governance**

At a conceptual level, the governance model comprises three interrelated dimension; 'who' – who is involved in the decision-making processes, 'how' – how is governance implemented (processes and mechanisms) and 'what' – what is the scope of decision-making and is based on the identification of the key role of agreements and registers in SDI governance (Atkinson & Box 2007).

The high level conceptual model of governance comprises SDI components identified by Rajabifard and Williamson (2001) conceptually recast to emphasise the role of governance in binding the components together. As shown in Figure 2,

the model comprises three core SDI components: people situated within organizations (who), agreements and geospatial resources (what), linked together through governance mechanisms (how).

**Figure 2 High-level Conceptual Model of Governance**



Agreements (which represent the output of the governance process) comprise policies, memoranda of understanding between organizations, standards, data models and other agreements that define the means and ends for community collaboration. Geospatial resources (the 'what') include geospatial data and technology components. People (the 'who') create maintain and use agreements and build, configure and operate geospatial resources on behalf of the community. As the agreements describe resources that are developed in accordance with them, they are a form of metadata and as such provide a description of the SDI and its component parts as well as of the how stakeholders agree to work together.

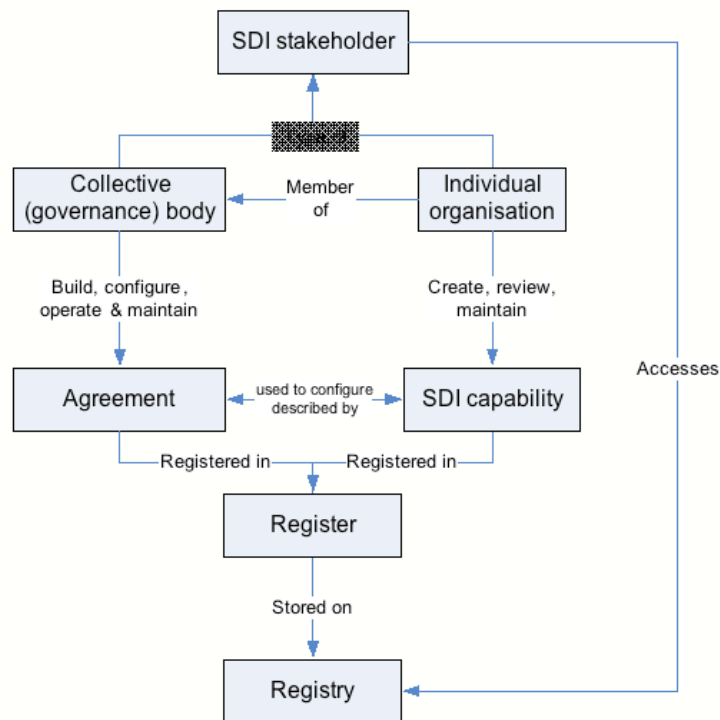
## **5.2 The Role of Registers in Governance**

So that SDI stakeholders are able to implement agreements and thus build, operate and use geospatial resources, community agreements need to be accessible. In addition, as agreements are reviewed, revised, and retired, to steer the SDI initiative they need to be managed throughout their lifecycle, a requirement in common with the geospatial resources that they describe.

To enable the publication, discovery, management and use of agreements, registers, essentially lists of descriptions and identifiers that reference items of interest (International Organization for Standardization 2005) organised using registries or catalogues, are required. Figure 3 below illustrates the critical role of a registers and registries as key governance mechanisms. In the figure, stakeholders working collectively in governance (decision-making) bodies create,

review and maintain agreements. Stakeholders within individual organizations build, maintain and operate SDI capabilities in accordance with agreements. Agreements are treated in the same way as the SDI capabilities that they describe and are published in registers, in the same way that metadata relating to spatial data and services are published in registers. Registers are stored on registries that facilitate their management and access to them by SDI stakeholders. Stakeholders wishing to participate in the SDI initiative in for example, a decision-input role or through the configuration and publication of a web map service, are able to find the agreements to enable them to understand the rules and mechanisms for participation.

**Figure 3 The Role of Registers and Registries as Governance Mechanisms**

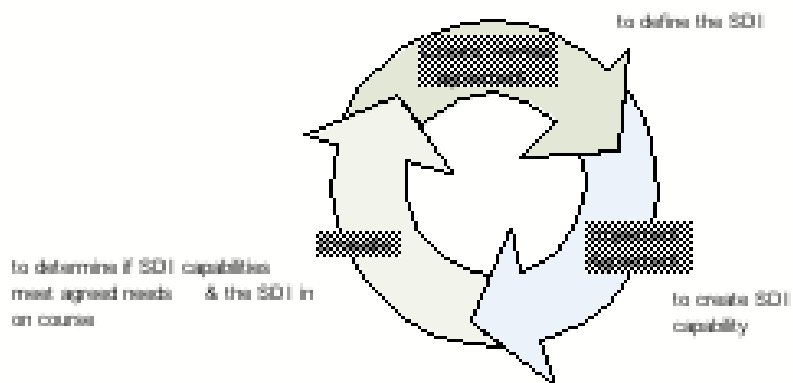


### 5.3. The Agreement Cycle

Although governance is concerned with decision making leading to agreements, an agreement is not an end in itself but simply describes how the community wishes to proceed with a specific aspect of the SDI. In the agreement cycle shown in Figure 4 agreements are created (through governance processes), implemented (by management and coordination processes),

monitored (through coordination) and evaluated (through governance) to ensure compliance and to track the overall progress and status of the initiative and its component parts. Finally, agreements need to be reviewed to ensure that they remain relevant and are steering the initiative in the desired direction.

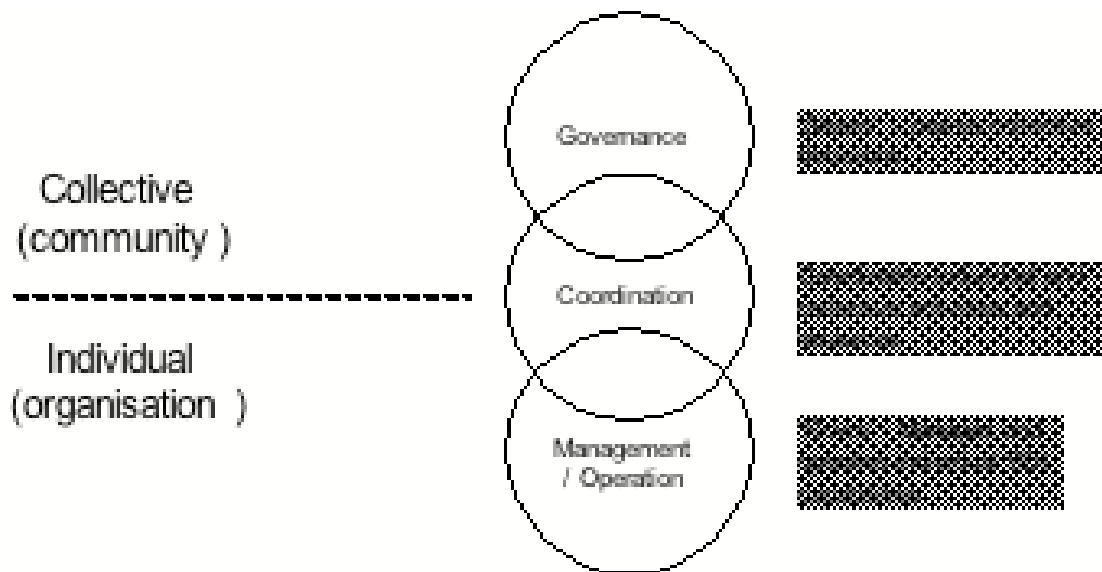
**Figure 4 The Agreement Cycle**



#### **5.4 Governance and Coordination**

As can be seen from the agreement cycle, governance and coordination are inter-dependent. The primary challenge of governance is reconciling collective and individual needs and interests to achieve common goals through collective decision making. In this regard, coordination provides a critical link between the 'steering' processes of governance and the 'rowing' activities of individual actors that move the community in the required direction. This is especially true of infrastructure such as SDI, that comprise distributed capabilities under different ownership which are developed and operated independently.

**Figure 5 Governance, Coordination and Operations**



## 6. CONCLUSIONS

The research presented in this paper aims to contribute to an improved understanding of governance through the development of an SDI governance model. A review of the meanings of governance in a number of contexts has been used as the basis for clarifying the meaning of governance in relation to SDI and to conceptually frame the SDI model. A brief exploration of the emergence of governance and approaches to SDI governance in literature together with the findings from research into SDI governance in four Australian case studies were presented to provide a context for the governance model.

The governance model presented describes three related dimensions of governance, the 'who', the 'how' and the 'what'. It places governance mechanisms at the nexus of people and geospatial resources and identifies agreements, created through an agreement cycle, as key governance outcomes that bind together SDI initiatives. The model also identifies the key role of registers and registries as key governance mechanisms to support publication, management and discovery of agreements. Coordination has been identified as important function to ensure that actions of numerous stakeholders, implementing agreements produce a coherent whole. Implementation. However, in reality coordination represents a significant challenge, as the informal nature and often limited enforceability of agreements, particularly in the context of government to government business, means that agreement implementation relies on cooperation and collaboration underpinned by trust.



The publication, and management of agreements which facilitates their discovery and use, offers potential for their re-use between SDIs and the potential to leverage intellectual efforts of other initiatives and increase the potential for interoperability of resources between initiatives. However the re-use of agreements across SDIs introduces dependencies between initiatives and an implied requirement for meta-governance.

In conclusion, although the model developed to-date assists in clarifying our understanding of SDI governance, it requires further elaboration in several key areas. These include: abstracting common patterns from implemented SDI governance authority structures; defining key governance roles including that of leadership, a critical steering mechanism, and research into the role of registries as a key governance tools. Of particular note in this regard is the International Standard "Procedures for Registration of Geographic Items" (International Organization for Standardization 2005) that provides a conceptual model for the governance of registers and registries.

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