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The Role of Social Architecture in Information Infrastructure:

A report for the National Environmental Information Infrastructure (NEII)

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Executive summary

*"Interoperability seems to be about the integration of information.
What it's really about is the coordination of organizational behavior."*

David Schell, Founder and Chairman of the Open Geospatial Consortium.

This report presents an analysis of the social dimensions of Information Infrastructure (II), or systems of systems. It provides a synthesis of key elements and lessons learned from a number of II initiatives analysed through a 'landscape review'. It provides some guidance and recommendations that can be applied to II such as the National Environmental Information Infrastructure (NEII) using the concept of 'social architecture'.

Social architecture refers to the social aspects of infrastructure development and maintenance with a particular focus on governance, participation and the management of the agreements that together define how stakeholders collaborate to achieve collective goals.

The social architecture presented in this report is intended to inform the NEII programme in the implementation of effective governance and participation mechanisms, together with a framework of agreements that will enable stakeholders to drive and sustain the NEII. The social architecture complements the NEII Reference Architecture expanding the enterprise viewpoint - one of the five Reference Model for Open Distributed Computing (RM-ODP) viewpoints used to describe the NEII architecture.
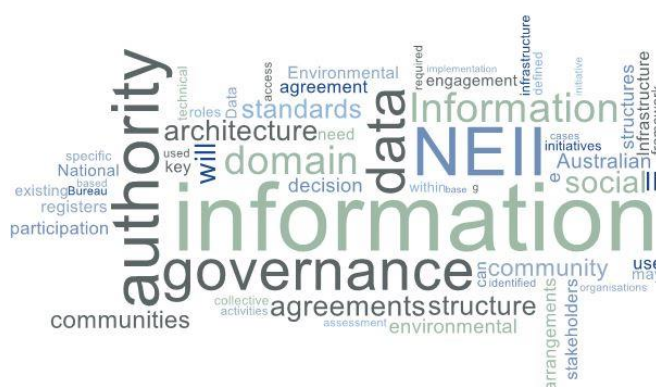
Information infrastructure

Information infrastructures (II) such as the NEII, comprise information systems that are connected through networks rather than being independent and disconnected. II evolve over a long period of time, building on and extending an 'installed base' of existing systems, standards, and arrangements. This "installed base" of evolving, open, heterogeneous components, inter-connected through standards, influences the design of new elements.

Developing and sustaining Information Infrastructure such as the NEII, is an interwoven socio-technical endeavor. The 'installed base' of the infrastructure comprises social phenomena such as work routines, organisational roles and culture, governance, informal collaboration, standards, policies and licensing arrangements, interwoven with the information and technology resources (data, information systems, and technologies) comprising the infrastructure.

Efforts to build on this installed base must be cognisant of and work with this installed base. Furthermore, as an II is socially constructed, it reflects the broader cultural, political, administrative and legal contexts in which it is embedded and this context also needs to be understood and addressed. Understanding, and leveraging these complex arrangements, relationships, personal and institutional drivers and blockers for collective action will be key to achieving successful outcomes in building II.

The environmental information landscape in Australia is complex. There exists a large installed base of environmental information infrastructure activities together with dynamic, overlapping environmental information governance arrangements that are poorly understood. Building and sustaining environmental information infrastructure such as the NEII will be a collective activity as the majority of resources (i.e. information, technology, human capital) from which it will be assembled, are owned, operated and managed

within numerous enterprises. Management based approaches which imply direct control over resources, cannot, therefore, be used. Thus, effective governance is critical to steer the initiative and to communicate collective goals that reconcile the different environmental policy and information supply perspectives, goals, drivers, and aspirations of community members.

However, governance alone is insufficient, as it is concerned only with direction and collective decision making ('steering'). Effort also needs to be focused on facilitating, encouraging, and stimulating the community participation ('rowing') necessary to move the initiative towards the achievement of a common agenda. As II is not implemented in *terra nullius* from a systems landscape perspective, stakeholder participation must account for, and leverage, existing organisational and information community initiatives that have delivered successful collaborative outcomes. To achieve collective impact, a broad range of existing and planned independent activities must be coordinated so that they become mutually reinforcing.

The NEII programme has recognised the need to explicitly address issues in the social domain and commissioned the work presented in this report.

Landscape review

A review of three Australian and three international II initiatives was undertaken to identify best practice and potentially applicable approaches that might inform development of a social architecture for NEII. The assessment looked at issues in the social domain rather than providing an assessment of II implementation more broadly.

The context of each of the initiatives examined possessed different legislative, policy, domain coverage, scale, maturity, and political characteristics. Context has significant impact on implementation of each II. Thus, to identify potentially relevant approaches, a basic characterisation and comparison of each initiative with the NEII was undertaken. Despite the differences in cases examined, a number of common themes related to governance, participation and agreements.

Governance

- The need for broad inclusive governance mechanisms including participation of state/territory governments (which hold significant environmental data), research, not-for-profits and industry;
- The need to improve alignment of II activities within thematic policies as well as crosscutting policies such as those related to eGovernment and Open Data;
- The need to link technical outcomes to high level government policy drivers and outcomes;
- The critical role of whole-of-government leadership and priority setting to provide top down drivers and coherence for collective activity; and
- The risk of lack of 'buy-in' if some stakeholders are not engaged early.

Participation

- The importance of key individuals, such as trusted leaders, who have built community trust based on strong track records within domains. Strong senior champions are needed to drive the initiative within participating organisations;
- Ensure recognition and support is given to participating individuals and organisations;
- The need for coordination, communication, and awareness at senior levels; and
- The critical role of networks and the need to tap into and leverage self-organising and formal communities that typically form around technical and domain issues and expertise.

Agreements

- Agreed, standard data licensing frameworks are key for effective data sharing. The recommendation to use the Australian Governments Open Access and Licensing Framework (AusGOAL)[1] to support and guide NEII open access was strongly expressed;
- The major barriers to data access are policy, organisational, legal, and cultural. Open Data initiatives have helped overcome some organisational and legal barriers and should be leveraged wherever possible;
- Promoting the importance and adoption of common standards, particularly for system and data providers, is an important area of work;
- Designated central authority plays a key role in coordinating the specification and implementation of standards for collection, integration and dissemination of information; and
- Obtaining permission from and ensuring attribution of data rights holders is key to ensuring continued participation.

To assist in identifying, defining and guiding the implementation of mechanisms for effective governance, community participation and agreement setting based on these lessons learned, a social architecture model was developed.

The model is presented as three inter-related components that are used to separate the concerns of governance (steering), participation (rowing) and agreement management that bring cohesion, clarify direction and drive collective efforts. The governance and participation components address the concerns of collective decision making and collective action. These describe the way in which stakeholders have 'skin in the game'. The agreement component provides a consistent approach to governing agreements that are produced through governance mechanism and implemented through participation mechanisms. The agreement framework is thus concerned with 'rules of the game'.

Key concepts within each of the three component of the model are described, with several critical aspects articulated in detail. These include the following. Firstly, a federated governance pattern comprising centralised, broadly inclusive decision making authority structures for cross cutting concerns and delegation to identified domain authorities for domain specific decision making. This aims to authorise, empower and effectively engage stakeholders across an extensive, evolving installed base of highly fragmented environmental information infrastructure activities. Secondly, a process for governing agreements based on an ISO standard governance model. This provides a consistent mechanism which enables agreements of many different types such as policy, legislation, standards, information models and vocabularies, adopted or developed by authority structures to be governed and made accessible to stakeholders. Finally, to achieve the participation of diverse, independent organisations and information communities to achieve collective goals, a defined approach 'collective impact' is proposed. This approach to achieving social change articulates key inter-related concepts that bring coherence to independent activities through setting a common agenda and metrics for success, steering independent activity to become mutually reinforcing, continuous communication and learning, and a 'backbone organisation' that plays a number of key roles.

Although funding is a critical issue in II development and maintenance, financial arrangements are not specifically addressed in any detail in this report. However, the social architecture model is designed so that it can be applied to a wide range of implementation contexts.

The report concludes with a summary of recommendations and activities to apply the social architecture model and the lessons learned from the landscape review. These are presented primarily to inform NEII programme design[2]. However, as the recommendations are considered to be of benefit to II practice more broadly, they are presented in a generic manner to illustrate potential management actions to support infrastructure implementation.

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[1] http://www.ausgoal.gov.au/

[2] Detailed recommendation have been provided in an internal report to the NEII Programme team.

1 Introduction

1.1 Document purpose

This report provides a synthesis of key elements of Information Infrastructure (II) initiatives identified through a 'landscape review'. It also provides recommendations to support the implementation of the National Environmental Information Infrastructure (NEII) using the concept of 'social architecture'.

For the purposes of this report, the term 'social architecture' is defined as '*the conscious design of an environment that encourages a desired range of social behaviours leading towards some goal or set of goals*' *(Wikipedia 2014).*

The social architecture aims to guide the NEII programme implementation of effective governance and participation mechanisms, together with a framework of agreements that will enable stakeholders to drive and sustain the NEII. However, the landscape review and the social architecture approach described in this report are applicable to and can be used to inform II practice more broadly.

The social architecture presented in this report complements the NEII Reference Architecture (Bureau of Meteorology 2014). This describes the proposed technical infrastructure for the NEII using the five viewpoints of the Reference Model for Open Distributed Processing (RM-ODP)[3]. The social architecture maps to and expands the Enterprise Viewpoint of RM-ODP.

1.2 Document scope and structure

The social architecture has been described at the same level of specificity as the NEII Reference Architecture and will need to be elaborated in synchronisation with that document.

Specifically, this report comprises a:

- Description of the background to and status of the NEII together with a rationale for the development of a social architecture (section 2);
- Summary of a review of selected domestic and international Spatial Data Infrastructure (SDI) and environmental information initiatives to explore lessons learned and to identify patterns, tools, and methods that could be applied to the social dimensions of NEII implementation (section 3);
- Description of the social architecture model (section 4); and
- Discussion on the application of the social architecture together with some high level recommendations (section 5). Detailed recommendations for applying the social architecture to the NEII are contained in a separate report.

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http://www.rm-odp.net/

2 Background

2.1 National Plan for Environmental Information (NPEI)

The National Plan for Environmental Information (NPEI) is an Australian government programme intended to improve the quality and accessibility of environmental information for decision making. The NPEI initiative commenced in July 2010 and in the first four years aimed to:

- Establish the Bureau of Meteorology (BoM) as the Australian Government central coordinating authority for environmental information;
- Formalise arrangements to coordinate priorities and activities across governments;
- Review existing information resources and environmental information activity; and
- Begin building priority national environmental datasets and the infrastructure to deliver them.

The following sections describe specific activities undertaken to address these goals.

2.2 Review of Australian Government environmental information activity

Under the auspices of NPEI, a review of the environmental information landscape was conducted in 2012 (Morton and Tinney 2012). The review identified key challenges and provided recommendations related to cultural, structural, funding, technical and legal arrangements. Key recommendations from the review are summarised below as these inform key aspects of the NEII framework.

Cultural issues

- Improved communication and coordination between policy agencies and [information] provider agencies; and
- New governance arrangements to ensure; policy priorities and strategic directions are set at the whole-of-government level and that roles and responsibilities are clear.

Specific recommendations include:

- The creation of a high level body – a Policy Advisory Group on Environment – to set the environmental information policy agenda; and
- Re-tuning of the existing Australian Government Environmental Information Advisory Group to assist in translating the environmental policy agenda into tangible information activity including input to development of standards and datasets by central coordinating authority (BoM).

Structural issues – the need for improved whole-of-government coordination of environmental information.

Specific recommendations included:

- BoM as central coordinating authority should maintain fundamental authoritative datasets for the Australian government or endorse as authoritative those held by other custodians;
- BoM should develop operating arrangements to provide effective access to these datasets wherever they are held, and maintain a catalogue of information held across government;
- Improving coordination within agencies through stronger senior executive leadership; and
- Agencies use an enterprise architecture approach to understand information.

Funding arrangements – the need to reform funding arrangements to address the mismatch between policy and budgetary time scales, and duplicative investment in environmental information.

Specific recommendations included:

- Increasing transparency of investment by auditing the current expenditure on environmental information in priority areas; and
- Ensure new funding investments are collaborative and meet priority needs.

Technical issues – the need to reconcile multiple content and metadata standards in use.

Specific recommendations included:

- Harmonisation, resolution and maintenance of authoritative standards; and promotion of the use of machine readable information and supporting technical systems, including developing an enterprise architecture capability within agencies and across government to allow the capture of information for reuse.

Legal issues – the need to address various issues (primarily licensing) that act as legal barriers to information exchange and reuse.

Specific recommendations included:

- Producing a guide to implementing the Australian Governments Open Access and Licensing (AusGOAL) framework for users and providers of environmental information;
- Agencies audit their own information licences to resolve legacy licensing issues; and
- Purchased data licences be whole-of-government and allow ongoing use, as well as release under a Creative Commons Attribution licence.

2.3 NEII governance and the Bureau's role

NEII programme governance has been defined in the NEII Governance Strategy (Bureau of Meteorology 2014). The structures defined within this document, shown in Figure 1 below, are a mix of programme governance and programme management, with the management functions being performed by internal Bureau structures and roles e.g. Senior Responsible Officer (SRO) and NEII project board.
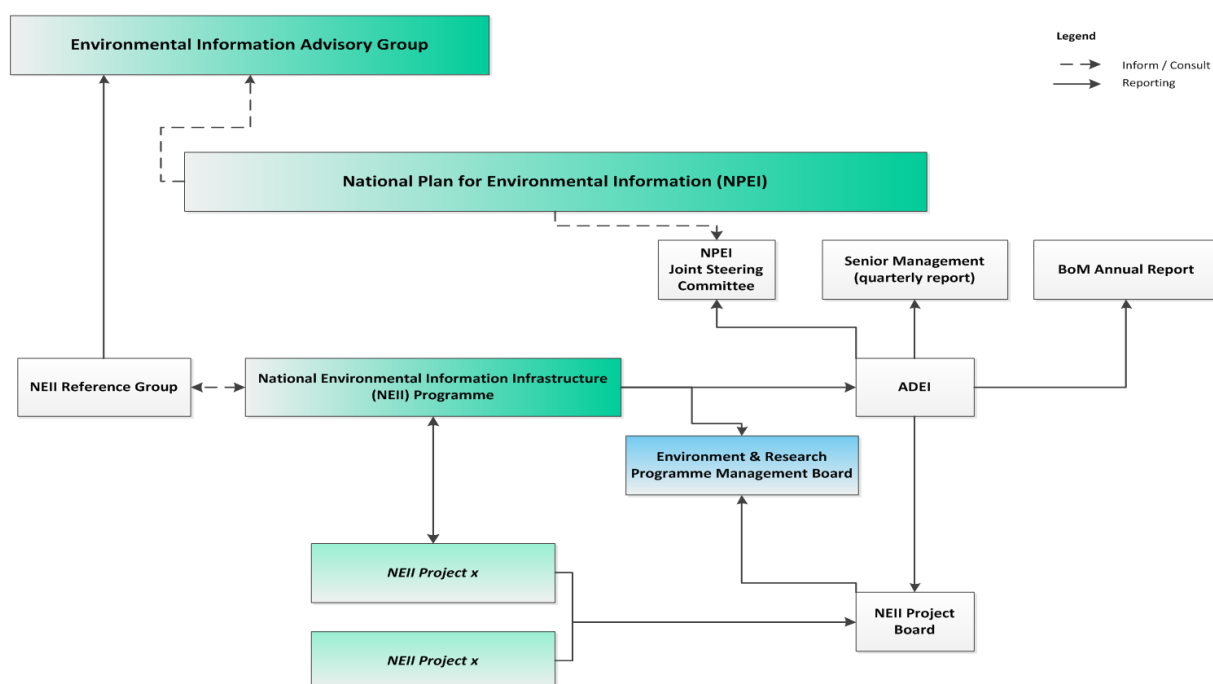
Figure 1 NEII programme governance (Bureau of Meteorology 2014)

Within this structure, the Bureau plays a number of distinct governance, functional and programme management roles. It is also identified as the central coordinating authority for the NEII, responsible for the development of common infrastructure for the NEII.

It is important to note that the current governance arrangements are a reflection of the maturity of the programme and the current emphasis on definition and execution of a work plan, rather than a fully mature and operational initiative. The NEII programme has been informed by several proof-of-concept projects that have been undertaken since the inception of the NPEI initiative. These have explored and demonstrated technical capabilities of an environmental information infrastructure. The lessons from these have shaped the NEII programme planning and current governance structure.

2.4 Environmental information priorities

In 2012, the Environmental Information Advisory Group (EIAG) produced the Australian Government Statement of Requirements for Environmental Information (Australian Government Environmental Information Advisory Group 2012). This statement provides an organising framework for whole-of-government collaboration on environmental information based on nine areas of interest:

- Biodiversity;
- Biosecurity;
- Climate change;
- Environmental reporting;
- Infrastructure and communities;
- Natural resources;
- Significant places;
- Waste and pollutants; and
- Water.

The statement identified the need for further engagement to develop a clear understanding of the long term, environmental information needs of government. It also noted that NPEI information interests overlap with those of the ANZLIC (Australia and New Zealand Land Information Council) Foundation Spatial Data Framework[4] (FSDF) programme in relation to elevation, hydrology and land cover information (p. 75 Australian Government Environmental Information Advisory Group 2012).

2.5 The National Environmental Information Infrastructure (NEII)

The NEII programme is a core NPEI activity. It has been conceived as a network of standards based IT components, supported by a network of collaborators working together to improve discovery and access to fundamental environmental data across Australia.

2.5.1 NEII REFERENCE ARCHITECTURE

An NEII Reference Architecture has been developed (Bureau of Meteorology 2014) to provide a technical specification of the NEII. It specifies the use of conventional SDI patterns which focus on enabling access to spatial information (Coleman and McLaughlin 1998, Rajabifard and Williamson 2001). Importantly, it extends this SDI focus to include environmental observations and measurements on or about the features that are typically represented in SDI data layers e.g. rivers, catchments, environmental reporting and management units. This has implications in terms of the scope of information that will be available through the NEII. This in turn has implications in terms of governance.

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[4] http://www.anzlic.gov.au/foundation_spatial_data_framework

The reference architecture is organised using the Reference Model for Open Distributed Processing (RM-ODP), a standardised framework for structuring specifications for large scale, distributed systems (ISO/IEC 1996). RM-ODP uses five inter-related 'viewpoints' to describe separate sets of concerns. These are: enterprise, information, computational, engineering and technology.

The reference architecture articulates key principles informing the long term development of NEII:

- **Feasible and sustainable** –federated where possible but centralised where necessary;
- **Standards based** – following existing SDI best practice to achieve virtual harmonisation [of provider data management infrastructure] through interoperability using 'conventional' SDI standards, together with standards regulated the Australian Government and the Bureau of Meteorology;
- **Data reusability and open licensing** – enabling users to assess fitness for purpose through traceable quality indicators for datasets; and effectively access data for reuse through common licensing frameworks;
- **Multi-purpose** – infrastructure to support government and a broad spectrum of the research community and public;
- **Agile** - enabling new ways of finding, accessing and integrating environmental information while minimising impost on providers to re-engineer their existing data infrastructures; and
- **Secure** – secure access for data providers and users.

It is worth noting that the first principle has some significant implications as it highlights the need for federation of environmental information, delivery of services and governance to relevant stakeholders.

2.5.2 THE NEII ENTERPRISE VIEWPOINT

The RM-ODP enterprise viewpoint describes the purpose, scope and policies governing the activities of the specified system. It documents the requirements for the system along with the roles and functions of system stakeholders and, by implication, the institutional arrangements that underpin the system. It is also where policy settings (broadly defined to include, legislation as well as jurisdictional and organisation policy and regulatory settings) for the system are described. As such, it is the viewpoint that provides the primary view into organisational and social aspects of the NEII.

The NEII Reference Architecture enterprise viewpoint specifies three policies that apply to the NEII:

- The National Plan for Environmental Information;
- Principles of Open Public Sector Information - Office of the Australian Information Commissioner; and
- NEII architectural principles.

Figure 2 below, depicts the key stakeholders in the system (actors) and the functions they perform in relation to the system (referred to as use cases).
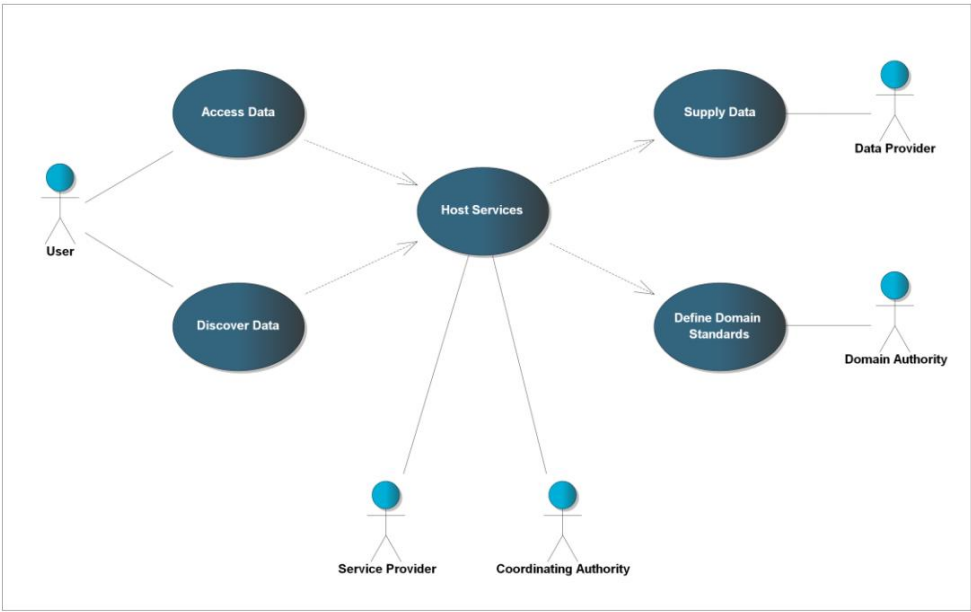
Figure 2 National Environmental Information Infrastructure high level use cases (Bureau of Meteorology 2014)

2.5.3 THE NEII INFORMATION VIEWPOINT

It is important to note that the information viewpoint of the architecture specifies the Observations and Measurement (O&M) (ISO 2011) standard as a conceptual foundation for the NEII architecture. In essence, O&M is used to inform the definition of key architectural components and the classification of information classes to extend the architecture beyond a conventional SDI. The information viewpoint specifies NEII 'broad information classes' mapped to O&M elements and NEII engineering components as shown in Table 1.

Table 1 NEII information classes and engineering components mapped to O&M (Bureau of Meteorology 2014)

O&M element	NEII engineering component	NEII broad information class
observed property	vocabulary service	environmental parameters
feature-of interest	monitoring sites register, information services	monitoring sites and networks, environmental geographies
procedure	observing methods register	observing methods
result	information services	information models

These broad information classes include geospatial data and environmental observation data as well as the information models and semantics such as species classification and observed parameters that describe the structure and meaning of the data. This has implications in terms of separating out the multiple roles that organisations may play in relation to specific datasets. For example, a data provider may be responsible for a hydrological data product while a domain authority may be responsible for the data model supporting the data. Many additional authorities may be responsible for the vocabularies used within the data set.

2.6 Information infrastructure and the 'installed base'

Information infrastructures (II), also known as systems of systems, comprise information systems that are connected through networks rather than being independent and disconnected. SDI are a type of II that are concerned primarily with geospatial data. In many respects, NEII can be characterised as an II.

II typically evolve over a long period of time, building on and extending existing infrastructure. The nature of the existing infrastructure or 'installed base' (i.e. the existing systems, standards, and arrangements) influences the design of new elements (Hanseth, Monteiro et al. 1996). II are characterised as being shared, evolving, open, composed of heterogeneous components that are inter-connected through standards.

Information Infrastructure – interconnected systems with interwoven social and-technical components including information supply chains, institutional arrangements, standards, and technology

Developing and sustaining an information infrastructure such as the NEII, is recognised, in both theory and practice, as being an interwoven socio-technical endeavor. Thus, the installed base includes social phenomena such as work routines, organisational roles and culture, governance, informal collaboration, standards, policies and licensing arrangements, interwoven with the information and technology resources comprising the infrastructure. Growing an II thus involves "enrolling actors through aligning their interests and practices" (Kok and van Loenen 2005 p. 15).

Understanding these complex relationships, personal and institutional drivers and blockers for participation is key. Furthermore, as an II is socially constructed, it reflects the broader cultural, political, administrative and legal contexts in which it is embedded and this context needs to be understood and addressed.

In the context of the environmental information landscape in Australia, the installed base is complex, dynamic, overlapping and poorly understood. Figure 3 provides an example of some of the major components of the environmental information installed base in Australia. Key points to note are the existence of multiple:

- IIs developed under National Collaborative Research Infrastructure Strategy (NCRIS) within specific environmental domains, comprising technology components, with attendant governance and participation arrangements; and
- Domain coordination and governance bodies (for example National Coordinating Committees) some of which have developed infrastructure (for example, Australian Soil Resource Information System[5] (ASRIS) under the National Committee for Soil and Terrain (NCST)).

It should also be noted that these are illustrative examples only, and there is likely to be many more domain specific II activities and governance mechanisms at federal and state and territory scales that comprise an operational installed base[6].

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[5] http://www.asris.csiro.au/
[6] In particular, it should be noted that a single initiative within New South Wales has been included in this figure. In reality there are likely to be numerous environmental II activities within each state and territory.
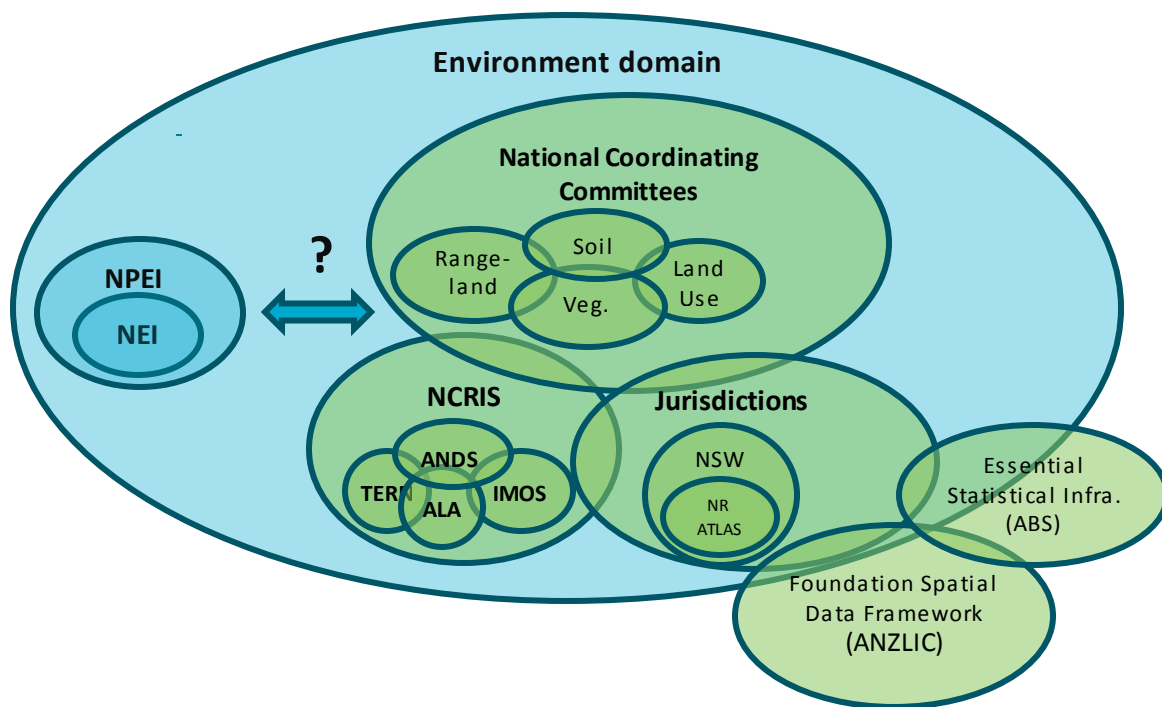
Figure 3 Installed base of the environmental information infrastructure

2.7 The need for social architecture

2.7.1 BEYOND GOVERNANCE

Institutional arrangements have long been recognised as a key enabler for II (Coleman and McLaughlin 1998, Masser 1999, Masser 2005, Lance, Georgiadou et al. 2009) enabling community efforts to build and maintain infrastructure. However, the social dimension of II covers a much broader scope of concerns than institutional arrangements, including approaches to coordination, motivation for collective action and participation, trust and governance. Given the large number and complexity of relationships between stakeholders in II implementation, addressing these concerns is a significant challenge.

Governance is a central concern of an II as it provides an accountability framework that enables collaboration, and in particular the development and adoption of standards and the building of trust. Governance comprises: the rules, policies and mandates; institutional frameworks and arrangements; processes; and tools that enable a community to develop, manage and communicate agreements and their implementations in the form of information and systems which facilitate access to information resources (Box 2013). However, there are a range of broader 'social' issues that underpin successful II implementation, which are not addressed by governance. In the context of this document, the term social is taken to mean "of or relating to human society, the interaction of the individual and the group"(Merriam-Webster 2014).

Social Architecture - the conscious design of an environment that encourages a desired range of social behaviours leading towards some goal or set of goals

The NEII programme has recognised the need to explicitly address issues in the social domain. Broadly, these relate to governance and participation. Building and sustaining the NEII is a collective activity requiring collective action. As the majority of resources (i.e. information, technology, human capital) from which the NEII will be assembled, are owned and managed within numerous enterprises, management based approaches which imply direct control over resources, cannot be used. Thus, effective governance is critical to steer the initiative in the right direction and communicate NEII collective goals that reconcile the different environmental policy and information supply perspectives, goals, drivers, and aspirations of community members.

Furthermore, governance alone is insufficient, as it is concerned only with direction and collective decision making ('steering'). Efforts also need to focus on facilitating, encouraging, and stimulating the community participation ('rowing') necessary to steer the initiative towards the achievement of its goals through collective action. As II is not being implemented in *terra nullius* from a systems landscape perspective, NEII participation must account for, and leverage, existing community initiatives that have delivered successful collaborative outcomes.

2.7.2 PUBLIC GOOD

Government led information infrastructure development as part of open government efforts are public good i.e. they produce a good for the benefit of an entire community that is non-excludable, meaning that anyone can consume the good and non-rivalrous, meaning that consumption by one individual does not reduce the availability of the good for others[7]. Public good theory (Samuelson 1954) identifies several key challenges with developing public goods. From a public good perspective, one of the primary challenges in the development of II is the so called 'free rider' problem (Baumol 1952). The free rider problem is a situation in which resources, goods, or services produced through collective efforts of a group can be consumed by those who did not contribute to the collective effort, leading to either undersupply or over-consumption and depletion of the resource. It is posited that the free rider problem can be applied to aspects of public good II development. Stakeholders such as data providers or data users that benefit from common infrastructure such as a data catalogue service, but do not contribute to its development or maintenance, can be considered to be free-riders. The free rider problem and the implicit externalities i.e. costs being borne by one or more key participants and the benefits accruing to other participants and end users, may in some instances contribute to inertia in developing II.

2.7.3 THE COLLECTIVE ACTION PROBLEM

The collective action problem i.e. the disincentives that tend to discourage collective action by individuals in the pursuit of a common goal is typically encountered when building information infrastructure. The problem is that although individuals work collectively to achieve a common goal based on common interests individuals may also have conflicting interests which are a disincentive for collective action (Encyclopædia Britannica 2015). If there is a cost associated with contribution to collective action, individuals are likely to opt out of participation. This disincentive is reinforced if there is a possibility that the collective action may succeed without their participation i.e. they may be able to free ride. In response, other individuals within a community may reduce their effort based on the perception that others are not 'pulling their weight'. The perception or reality of a community member 'resting on their oars' and not rowing with the rest of the community, is a real challenge in achieving outcomes through collection action.

2.7.4 RULES OF THE GAME

Agreements are critical for defining how communities work together, providing a framework for collaboration. The role of standards in the development of II is well recognised and the NEII Reference Architecture defines a suite of standards around which the NEII will coalesce.

Standards are a form of agreement, but there are a range of other agreements that provide coherence to a collective activity. Examples include identified policies and legislation which are relevant to an initiative, data and software license frameworks, legal contracts, best practices, and service level agreements. This set of agreements provides a framework for participation, articulating the rules for participation in the initiative e.g. as a data provider, a service provider or a domain authority.

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[7] It should be noted that as some information and services provided by government and the private sector through II may be excludable due to restrictive commercial access arrangements, these aspects of II can be considered to be private good. In addition, private sector may participate in the delivery of public good e.g. Google.

Similarly, just as information and technology oriented agreements such as interface standards or agreed classification schemes, provide a critical information interoperability framework, other types of agreements provide for institutional, legal and policy interoperability.

2.7.5 A SOCIAL ARCHITECTURE

This report proposes a 'social architecture', which draws together the three dimensions of governance, participation and agreements to support the development and sustainability of the NEII. Social architecture is defined as "the conscious design of an environment that encourages a desired range of social behaviours leading towards some goal or set of goals" (Wikipedia 2014).

The term social architecture was originally used to refer to the blogosphere and the way in which people are connected and interact using social technologies (Boyd 2005). More recently, the term has been used to describe the way in which people are predisposed to interact within organisations (Day 2014). With the emergence of social technologies such as Facebook and Yammer, the role of social architecture to create effective 'social enterprises' has been highlighted (Gil 2013). There is a recognition that analysis of social networks both within and across organisational boundaries provides a new way of understanding and leveraging collaboration beyond the formal, hierarchical, organisational structures within which work is typically organised. Social architecture provides a means of understanding and attempting to leverage these important mechanisms to support II.

In the context of this report, the term social architecture refers to social aspects of infrastructure development with a particular focus on governance, participation and the management of the agreements that together define how II stakeholders collaborate to achieve collective goals.

3 Landscape review

3.1 Rationale

A review of information infrastructure initiatives was undertaken to identify best practice and potentially applicable approaches to inform development of a social architecture for NEII. For the purposes of the review, the assessment looked at issues in the social domain rather than providing an assessment of II implementation more broadly.

3.2 Methods

3.2.1 CASE IDENTIFICATION AND SELECTION

For this review, a case study methodology was used to assess relevant initiatives. This was considered the most appropriate approach given the breadth of topics to be covered, the variability of II in the existence and limited time available. An initial list of 25 candidate Australian and international initiatives was compiled (see Appendix 1 Candidate initiatives for landscape review).

In consultation with the NEII programme team, a subset of relevant initiatives was identified. In this process, an attempt was made to select initiatives that were as similar as possible to the NEII context. The following criteria were used to select cases for review:

- Implements a federated data sharing model;
- Has a need for agreements to exist between data custodians/providers and the coordinating body;
- Has a mature governance framework;
- Is actively delivering; and
- Has limited or no legislative backing.

Based on these criteria, the following initiatives were selected:

- Infrastructure for Spatial Information in the European Community (INSPIRE)[8] [9]
- New Zealand SDI (NZSDI)[10]
- Canadian Geospatial Data Initiative (CGDI)[11]
- Australian and New Zealand Foundation Spatial Data Framework (FSDF)[12]
- Australian National Data Service (ANDS) and Research Data Australia (RDA) [13]
- Atlas of Living Australia (ALA)[14]

3.2.2 INTERVIEWS AND ANALYSIS

Semi-structured interviews were held with ten individuals representing the six initiatives. Additional interviews were held with two other individuals related to NEII and the broader environmental information landscape. Analysis of key documentation was undertaken prior to these interviews in order to inform interviews and to identify potentially reusable concepts and approaches for NEII framework development.

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[8] http://inspire.ec.europa.eu/index.cfm
[9] Despite being legislatively driven, INSPIRE was considered to be of relevance for review
[10] http://www.linz.govt.nz/about-linz/our-location-strategy/sdi-and-open-government-data-programme
[11] http://geodiscover.cgdi.ca/
[12] http://www.anzlic.gov.au/foundation_spatial_data_framework
[13] http://www.ands.org.au/ http://researchdata.ands.org.au/
[14] http://www.ala.org.au/

A discussion guide (Table 2) was provided to interviewees prior to the interview. This guide was used as a framework to stimulate discussion about the nature of the initiative, key issues and lessons learned. Interviewees were provided considerable latitude to focus on key aspects of their initiatives. This approach enabled a good coverage of all issues.

Key topics of discussion, issues and lessons learned were documented for each initiative. This information was synthesised with salient points from the documentation analysis, organised and presented using the structure of the discussion guide. Summary of key findings are presented in Section 3.4[15].

Table 2 Semi-structured interview guide

Topic area	Discussion topic

Governance	Lead agency – its nature, mandate and facets of its role.
	Sticks and carrots - legislation and funding.
	Funding models used:
	    - centralised (centrally managed funding);
	    - coordinated (rationalizing whole-of-government information investment); or
	    - contributed (contributed best effort).
	Interaction with pre-existing governance arrangements/installed base.
	Interactions between policy and information provider organisations and networks.

Participation	Nature of existing information communities - community maturity, trust and collaboration, domain practices and culture. Connect into and leveraging of jurisdictional and domain networks with overlapping cross cutting concerns. Approaches to enabling bottom-up innovation – supporting and leveraging heterogeneous architectural patterns, information management and delivery approaches. Measuring/motivating implementation progress and increasing maturity for participants.
Agreements	Nature and role of agreements - legislation, policy, standards, vocabularies. Approach to defining and managing agreements.

3.3 Case study comparison

The context of each of the initiatives examined was different in terms of its legislative, policy, domain coverage, scale, maturity, and political environment. Context has significant impact on implementation of each II. Thus, to identify potentially relevant approaches, it is necessary to provide a basic characterisation of each initiative for comparison with the NEII.

Key dimensions of each initiative were assessed using an assessment framework developed by Land Information New Zealand (LINZ) to assess the 'state of play' of New Zealand's national level SDI (New Zealand Geospatial Office 2012)[16]. The assessment of case studies is presented in Table 3, below.

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[15] Detailed documentation of the review of each initiative was provided to the NEII programme team for internal use.

[16] This framework, in turn, was based on an assessment framework developed for INSPIRE.

Table 3 Assessment of case studies

Initiative	Information scope	Scale and participation	Federated data	Status	Legislation[17]	Central funding[18]	multiple roles[19]	Established to lead initiative[20]	Hosts / operates infrastructure[21]	Coordinates funding
							Lead Agency			
INSPIRE	Geospatial, environmental	Multi-national	Yes EU Member States	Build	Yes	No	Yes - EU JRC	No	Yes	No
CGDI	Geospatial, multiple themes	National	Yes Provinces + Federal	Operational	No	Yes	Yes – Natural Resources Canada (NRCan)	No	Yes	Yes
NZSDI	Geospatial, multiple themes	National	Yes - mix of data from central and local governments	Design	No	No	Yes – Land Information NZ (LINZ)	No	No	No
FSDF	Geospatial, multiple themes	National	Yes - Australian governments	Design	No	No	Yes – Dept. of Comms	No	No	No
ALA	Geospatial & observational, species	National	Yes Australian Governments, community, researchers	Operational	No	Yes	Yes – CSIRO	No	Yes	Yes
ANDS, RDA	Research data	National	Yes but not primarily engaged with state/territory governments	Operational	No	Yes	Yes – ANDS	Yes	Yes	Yes
NEII	Geospatial & observational, environmental	National	Yes	Design	No	No	Yes – Bureau of Meteorology	No	Yes	No

The cases examined varied greatly in terms of organisation, geography, thematic scope and implementation context. The majority of the initiatives have a geospatial data focus (with the exception being ANDS/RDA). Of the geospatial initiatives, most are national scale efforts that focus on meeting a wide range of use cases. INSPIRE is one exception which is driven by an environmental monitoring and reporting use case (at supra-national scale) but which aims to deliver data for a wider range of use cases.

One initiative focuses on a defined theme of data and undertakes significant processing of that data (ALA) while ANDS/RDA is oriented around research data. All initiatives are led by a lead agency which plays multiple roles. In one case (ANDS) the lead agency is dedicated to the initiative. Only one initiative has a legislated mandate (INSPIRE) while two are implemented using funds managed by the lead agency (CGDI and ALA). The initiatives also exhibit a range of maturity from being designed through to fully operational.

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[17] Is the initiative backed by/driven by dedicated legislation?
[18] Is dedicated funding for the initiative available through a specific funding mechanism?
[19] What is the lead agency and does it play multiple roles in the initiative?
[20] Has the lead agency been established specifically to lead/coordinate the initiative?
[21] Does/will the lead agency host or operate common infrastructure components?

3.4 Key findings

3.4.1 GOVERNANCE

Representation in governance mechanisms (CGDI, INSPIRE, NZSDI, FSDF). Broad inclusive governance mechanisms are required including participation of all levels of government (which may hold significant environmental data), research, industry and not-for-profits.

Alignment with thematic and cross cutting Information and communications technology (ICT) policy (INSPIRE, CGDI, NZSDI, FSDF, ANDS). Improved alignment of SDI activities within thematic policies as well as crosscutting policies on eGovernment and Open Data is required. Need to link technical outcomes of SDI initiatives to high level government policy drivers/outcomes. SDI activity needs to be aligned with, and provide support to, other information-related government policies and initiatives.

Leadership (CGDI, ALA, FSDF). High level whole-of-government leadership and priority setting provides top down drivers and coherence for collective activity.

Federal/State relationships (INSPIRE, CGDI, FSDF). Risk of lack of 'buy-in' if key stakeholders (e.g. States and Territories) are not engaged early.

Participation and engagement (INSPIRE, FSDF). Active stakeholder participation and deep engagement in setting the agenda can result in increased goodwill, trust and buy-in at implementation time.

Lead agency playing multiple roles (ALA). Lead agency with multiple roles was trusted to lead the initiative because of "neutrality", national coverage, and expertise in the domain and proven track record.

Funding and legislation (NZSDI, FSDF). Without a stick (legislation) or carrot (funding), a soft approach is required. This will typically result in slow progress and rely on 'coalitions of the willing'. Furthermore, legislation alone is not enough to ensure active participation. Lack of technical and financial resources for participants can significantly impact implementation timeframes. There are a number of intrinsic and extrinsic personal and organisational motivators other than funding for participation e.g. professional/organisational pride and community mindedness.

Formal accountability (NZSDI). The 'Coalition of the willing' approach lacks sufficient accountability to drive initiatives. Accountability at high levels within individual organisations is required.

Informal accountability (FSDF). Informal accountability mechanisms operate in parallel to formal ones and act as powerful motivators. For example reputational management and the desire to honour commitments.

Coordination monitoring and reporting (INSPIRE). Use of automated or semi-automated indicators to monitor and compare information provided by participants over time to measure progress is important. Coordination needs to promote concepts, raise awareness, build capacity and contribute to changes in organisational cultures.

Expectations about role of lead agency (NZSDI, FSDF)**.** For lead agency led infrastructure development, a clear plan for transition of capacity to the eventual custodian is required.

3.4.2 PARTICIPATION

Importance of key individuals (CGSDI, NZSDI, ALA, ANDS, FSDF). Trusted leaders are required. Trust is based on experience and track record in the domain. Strong senior champions are needed to drive the initiative within participating organisations.

Motivation (INSPIRE, ALA, ANDS, FSDF). Ensure recognition and support is given to participating individuals and organisations.

Communication (INSPIRE, CGDI, ANDS, FSDF). Need for coordination, communication, and awareness at senior levels.

Role of networks (INSPIRE, CGDI, ANDS, ALA, FSDF). Need to tap into and leverage self-organising and formal communities that typically form around technical and domain issues and expertise. Need to use lessons learned from successful communities to support less mature communities.

Capacity building and support for communities (INSPIRE, CGDI, FSDF). Need to assist information communities as they may lack technical capacity for implementation. Need to assist and guide less mature communities and leverage experiences/capabilities of the more mature ones.

Participation and stakeholder engagement (INSPIRE, ALA, FSDF). Participatory approaches to stakeholder engagement in the development phase help to build capacity and share best practices. This aids organisations to implement. Providers who do not engage are a challenge to work with. It is not practical to enforce data sharing even where an agreement exists and it may be necessary to withdraw from an engagement and focus on willing stakeholders.

3.4.3 AGREEMENTS

Licensing (INSPIRE, CGDI, NZSDI, ANDS, ALA, FSDF). Common (standard) licensing frameworks are key for effective data sharing. Accessibility and reuse of data is enabled through Open Data or comparable and directly accessible licence conditions, supporting machine licence interpretation. Dealing with multitudes of different licenses is a 'bureaucratic overload'. Australian initiatives recommended the use of Creative Commons[22] licences (as the preferred licence framework) with Attribution licence terms as the default position. The recommendation to use the Australian Governments Open Access and Licensing Framework (AusGOAL)[23] to support and guide NEII open access was also strongly expressed

Data access (INSPIRE, CGDI, ANDS, ALA, FSDF). The major barriers to access tend to be policy, organisational, legal, or cultural. Open Data initiatives have helped overcome some organisational and legal barriers and should be leveraged wherever possible.

Promoting standards (INSPIRE, CGDI, NZSDI, ALA) Promoting the importance and adoption of common standards, particularly for system and data providers, is important.

Role of central authority in standards (INSPIRE, ALA). The central authority has a key role in coordinating the specification and implementation of standards to collect, integrate and disseminate information. This was borne out in interviews and the ALA Biodiversity Profiling Report (Zerger, Williams et al. 2013). Cannot always mandate use of standard. May be necessary to take on the cost of transformation of data to common structure and/or mapping semantics to common vocabularies.

Rights in data (ALA). Permission and attribution from data rights holders is key to ensuring continued participation. Obtaining permission to share data from all the contributors to a dataset may be difficult in practice. Releasing work without permission can have negative effects on future participation. Legacy arrangements related to such things as data rights, structure and access may impact the ability to share data. These realities need to be factored into NEII agreements framework and in identifying stakeholders (potential data rights holders).

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[22] http://creativecommons.org.au/
[23] http://www.ausgoal.gov.au/

4 Social architecture model

4.1 Overview

4.1.1 RATIONALE AND SCOPE

Social aspects of information infrastructure are complex particularly given the distributed, overlapping nature of the installed base and the interwoven, continually shifting governance and social relations that underpin large scale systems of systems implementation. Added to this are the challenges associated with public good production and the free rider problem associated with collection action.

To assist in identifying, defining and guiding the implementation of mechanisms for effective governance, community participation and agreement setting, a model is considered to be essential. This section provides a description of the social architecture model that has been developed for this purpose.

The model is presented as three inter-related components. These components are used to separate the concerns of governance (steering), participation (rowing) and agreement management and bring cohesion, clarity, direction and drive to collective efforts. Key concepts within each component are described.

Several critical aspects of the social architecture are described in detail. These include a process for governing agreements (based on an ISO standard governance model) as well as a federated governance pattern with authority for decision making delegated to domain authorities. The latter enables effective engagement with and participation of stakeholders across an extensive, evolving installed base of highly fragmented environmental information infrastructure activities.

A brief discussion of application of the social architecture to information infrastructure practice is also provided here with section 5 providing more specific recommendations.

4.1.2 PRINCIPLES

The following principles have been used to guide the development of the social architecture model:

- **Feasible and sustainable** - federated where possible, but centralised where necessary[24];
- **Standards based** – approaches should, wherever possible, be based on standards[25];
- **Adopt, adapt, invent** – wherever practical, social architecture will leverage and reuse existing collaborative arrangements, governance modalities and community standards, adapt where necessary and invent only as a last resort;
- **Supportive** – the social architecture should encourage and support communities to participate and enable the behavioural change necessary to achieve outcomes;
- **Inclusive and representative** – all stakeholders included in decision making processes;
- **Adaptive and responsive** – social architecture will need to evolve as the community evolves and the information infrastructure matures; and
- **Accountable, transparent and independent** – the decision authority and decision making processes aim to minimise or avoid potential conflicts of interest with resultant agreements documented and readily accessible in order to guide and facilitate collective action.

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[24] principle articulated in the NEII Reference Architecture

[25] Ibid

4.1.3 COMPONENTS

The social architecture model, shown in Figure 4, comprises, three, inter-related components set within a real world context:
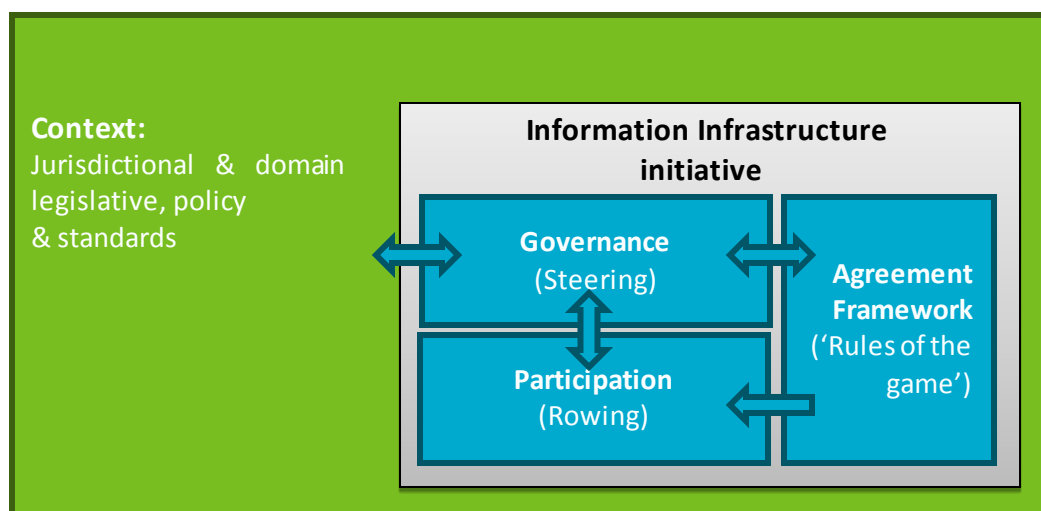

Context:
Jurisdictional & domain legislative, policy & standards

Information Infrastructure initiative

Governance (Steering)

Agreement Framework ('Rules of the game')

Participation (Rowing)

Figure 4 **NEII social architecture**

Governance – a framework of 'authority structures' and processes, by which communities manage their collective affairs through a continuous process of negotiation and decision making. The framework enables the creation and operation of mechanisms, processes and rules designed to reconcile the diverse needs and interests of a community and to steer individual and collective stakeholder initiatives to achieve agreed, collective goals (Box 2013).

Participation – is concerned with enabling and facilitating stakeholders to take part in the collective activity. Participation has a primary focus on implementation of community agreements created through governance processes, to enable collective action primarily in relation to improving access to coherent information.

Agreements - documented arrangements that have been defined by authorised decision makers through governance processes. Each agreement in the NEII agreement framework will have an authority associated with it, i.e. the body that decided to adopt the agreement as part of the NEII. The framework will include agreements that exist independent from the NEII (and have been adopted by it) and those that are developed specifically for it.

Context – II exists within a real world context and are developed on top of an installed base. This context provides drivers for change as well as a wide variety of potentially applicable agreements about how society and domains or 'information communities' behave. These include legislation, policies, regulations, standards and other agreements that relate to defined jurisdictions (such as state privacy legislation) as well thematically organised domains or '*information communities*' (such as soil or climatology information standards)[26]. A key goal of II governance is to determine which of these broader agreements will be used in the context of this initiative.

> *Information* **community** – A collection of people (government agency or group of agencies, a profession, a group of researchers in the same discipline, cooperating who share a common digital information language

Sections 4.2 (Governance), 4.3 (Agreements) and 4.4 (Participation) provide detailed descriptions of each of the three components of the NEII Social Architecture, their purpose, key concepts and important patterns in

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[26] It should be noted that standards have defined geographic scope, determined by the extent of the authority e.g. Standards Australia. However, as opposed to legislation and in most cases policy, which is typically mandated for a specific territories, standards adoption can be voluntary.

applying the component. Section 5 provides recommendation and identifies priority tasks to apply the social architecture model to II practice.

4.1.4 INTERACTIONS

The interactions between the three main components in the social architecture are as follows:

- **Governance - Participation** – governance and participation are related activities with governance providing the 'steering' and participation doing 'the rowing'. Governance sets the rules (defined through agreements) and provides oversight for participation. Participation is responsible for implementation of these agreements. In some cases, participation provides input to governance processes e.g. contributing to the development of a policy or a community standard for submission to a governance body. Measurement of the outcomes achieved through participation are fed into governance mechanisms to provide information for decision making.
- **Governance - Agreement** – Authority structures and decision making processes enable communities to create and manage a framework of agreements that define collective actions. Agreements are also used to define the governance rules e.g. terms of reference for an authority structure.
- **Agreement - Participation** – the framework of agreements defines the 'rules of the game' for participation. That is, it clarifies the specific requirements required to achieve collective outcomes.
- **Context - Governance -** the identification and adoption of legislation, policy and standards for II. Authority can be delegated to pre-existing authority structures, to create federated authority mechanism.

4.1.5 ISO 19135 – A GOVERNANCE MODEL

The governance and agreement components of the social architecture are inter-related. Governance is responsible for making decisions and the agreement component responsible for managing the agreements that are formed as the result of governance processes.

Both components are based upon ISO 19135 - Procedures for Registration of Geographic Items (ISO 2004). This standard articulates: the use of registers (or lists); registries (tools that manage these lists); defined roles to establish and manage registers; and a registration process to manage the registration of items[27].

A register contains metadata about registered items such as their status, approval date and authority together with a reference to the artefact that has been registered. This metadata enables the objects being described to be managed, discovered and used to achieve common goals. Repositories are typically used to store registered items.

The 'things' that a community cares about, and hence must manage to ensure the achievement of collective goals, can be conceptualised as a number of registers, or lists of things, that represent agreements about what a component is and how it behaves. These might include registers of; organisations and their roles, classification schemes and classification terms, or technology interface standards. Together these artefacts define and describe the collective activity.

ISO19135 is in widespread use within SDI initiatives and information communities, as a means to govern community agreed resources and is thus ideally suited to the needs of the NEII. Examples include: the INSPIRE registry[28] to govern INSPIRE themes, code-lists, application schemas; and the International Hydrographic Organisation (IHO) S-100 Geospatial Information Registry[29] which contains registers of hydrographic information together with registers of supplementary information owned by specialist domain experts.

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[27] Although ISO 19135 refers to registration of geographic item it can and has been used as model for registering a range of different resources.
[28] http://inspire.ec.europa.eu/registry/
[29] http://registry.iho.int/s100_gi_registry/home.php

The governance component describes the governance roles around the registration process and the authority structures that exercise governance and the agreement component provides more details on the typology of agreements and the use of registers.

4.1.6 THE AUSTRALIAN GOVERNMENT INFORMATION INTEROPERABILITY FRAMEWORK

An Australian Government Information Interoperability Framework (Figure 5) has been developed to assist Australian government agency capacity for information management and exchange (Australian Government Information Management Office (AGIMO) 2006). The framework provides principles that underpin information management and establishes the concepts, practices and tools to drive successful sharing of information across organisational boundaries. It details key interoperability enablers such as; partnerships, authoritative information sources, common standards, governance, legal and policy frameworks together with technical tools. These components enable effective exchange of government information held in a distributed information management environment.
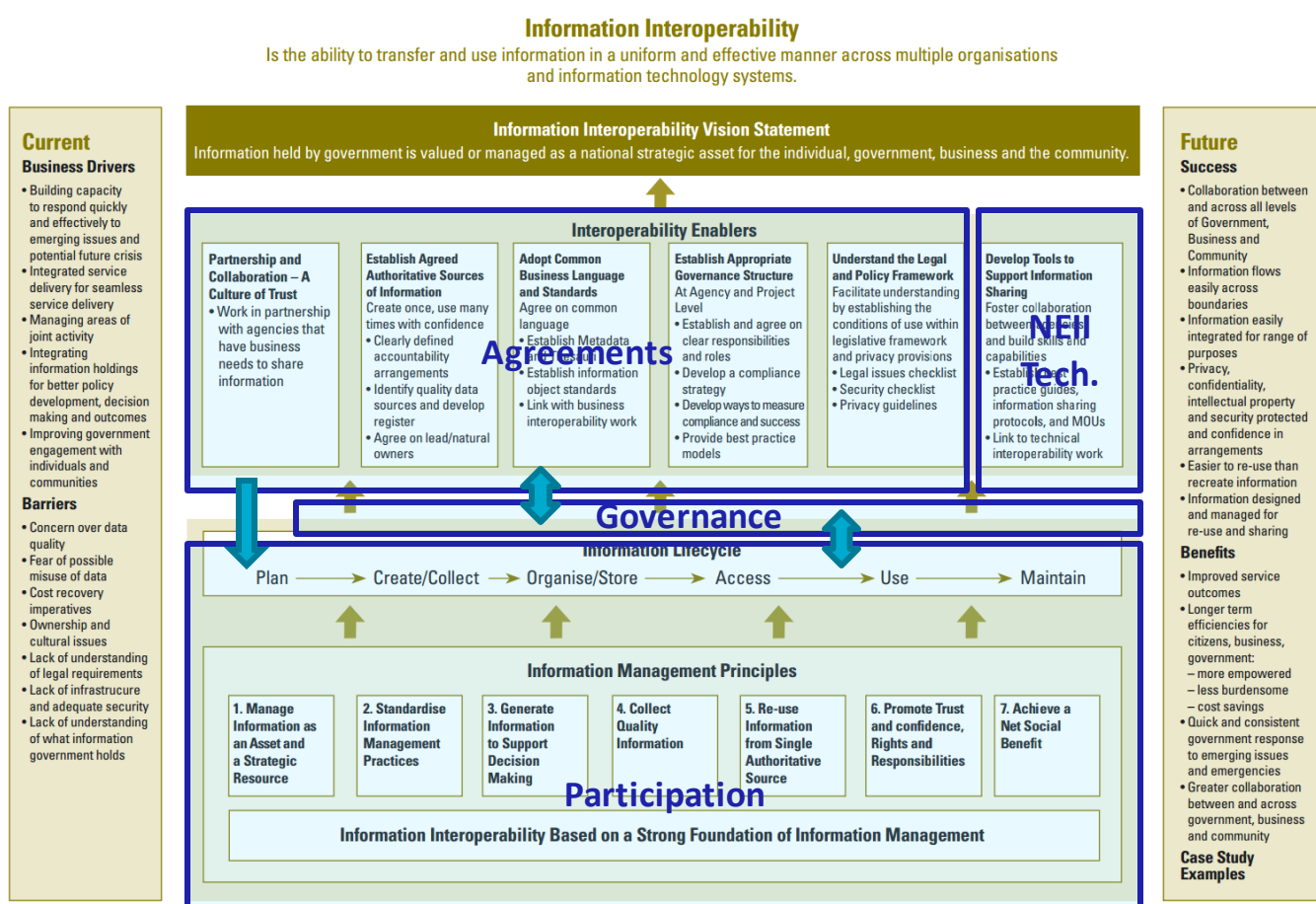

Figure 5 The Australian Government Information Interoperability Framework and the social architecture model (Australian Government Information Management Office (AGIMO) 2006)

As shown in Figure 5, social architecture components together with the NEII technical infrastructure component (NEII Tech.) can be mapped onto the Australian Government Information Interoperability Framework.

4.2 Governance

4.2.1 PURPOSE

The governance component of the social architecture is responsible for decision making, to steer the initiative and to oversee its implementation to achieve collective action. It is also responsible for creating and operating collective decision making processes for the NEII.

It is proposed that NEII adopt an approach to governance that enables and stimulates inclusive and active participation of relevant stakeholders in decision making. This will lead to deep engagement and improved outcomes in terms of environmental information availability.

It should be noted that governance is distinct from management. Governance is key to ensuring coherence in II development, which occurs through planned and coordinated projects as well as through independent uncoordinated streams of activity. Programme management, which includes coordination, stakeholder engagement, secretariat functions, and resourcing, ensures delivery and coherence of discrete activities. These activities are planned and resourced to developed specific aspects of the NEII. However, II is developed not only through coordinated and planned projects, but also through streams of activity (in the installed base) independent of centralised

Governance – the rules, policies and mandates; institutional frameworks and arrangements; processes; and tools that enable a community to develop, manage and communicate agreements and their implementations

control. Although these streams of activity may be leveraged and co-opted they cannot be directly managed and thus governance is required.

Despite its importance, programme management is not explicitly addressed in this report as it is a well understood function and adequately addressed through management practices. However, aspects of coordination of cross agency activity are touched upon and the relationship between governance and management is highlighted.

4.2.2 KEY CONCEPTS

The following sections describe key concepts that underpin governance. These concepts are depicted in Figure 6.

Authority structure – an organisational structure that has the power or right to control, judge, or prohibit actions of others. Power or right can be derived from a formal *de jure* source (e.g. legislation) or can be consensus based, *de facto* authority granted by a community. Authority structures comprise individuals (who may represent multiple organisations) who collectively make decisions. Authority structures are typically 'virtual organisations' such as committees, but can also be organisational structures such as a business units within a single enterprise. In the context of NEII, there a two types of authority structure:

- **Central authority structure** – created in the context of and under the mandate of the II being implemented and responsible for cross cutting concerns.
- **Domain authority structure** - authority structure that exists independently of the II and has agreed to work in conjunction with the central authority structure to exercise authority on its behalf. Domain authority structures have their own mandate and source of authority in the context of the domain (i.e. sphere of activity, discipline, or community) that they govern e.g. the Department of the Environment for National Air Quality Standards.
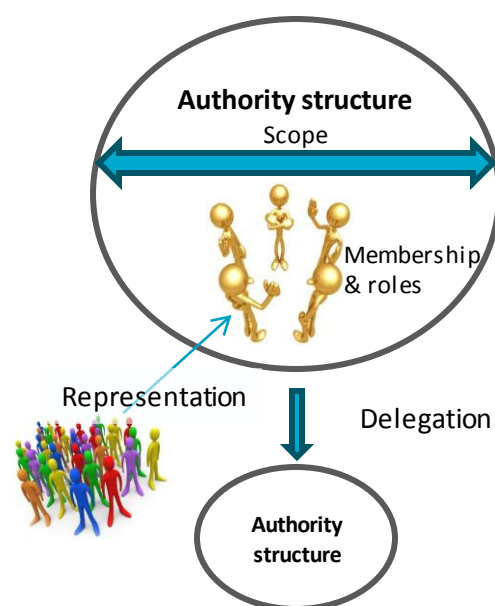

Figure 6 Key governance concepts

Governance scope - Each authority structure will have a defined governance scope i.e. the scope of decisions it is authorised to make. This scope will be defined in its terms of reference (TOR) – an agreement. The TOR will also define procedures for making decisions. This might include, for example, majority decision, quorum rules and final arbitration in the case of disputed or inconclusive decisions. Options for this latter case include decision escalation to a higher authority or decision making by the authority structure lead.

Authority structure membership and participant roles – the composition of an authority structure will be determined by its function and scope. Composition should aim to ensure effective representation of relevant stakeholder interests. Organisations will be invited to become members of an authority structure. Organisations will appoint individuals or organisational roles to represent them. The following roles should be assigned to participants:

- **Lead** – the role of leading a particular activity – e.g. chair of an authority structure. Lead may have voting rights and/or be the final arbiter of a decision. This role could be rotated on a pre-determined basis, based on election by voting members.
- **Voting member** – entitled to participate in decision making in an authority structure i.e. voting rights.
- **Observer** – entitled to observe the decision making process but not participate i.e. no voting rights.

Governance process and roles[30] – The governance process comprises identification of a need for an agreement, nominating responsibility for developing an agreement, submission of an agreement for review and providing a decision to accept, reject or modify a proposed agreement. Two mandatory and one optional role are involved in the process of submitting, recommending and final approval of decisions:

> *Domain authority – an organisational structure that has the power or right to control, judge, or prohibit actions within an identified domain*

- **Submitter**: gathers and assesses the relevant facts, obtains input from appropriate parties, and then creates and submits an agreement to a register owned by a 'decision authority'. The decision authority nominates submitters. The submitter role can be assigned to an authority structure or an individual organisation.
- **Decision authority**[31]: has authority to make a decision. Can review and approve the adoption of a submission. This role can be assigned to an authority structure or an individual organisation.
- **Control body**: an optional role that can be appointed by the decision authority to review and advise the decision authority on whether to approve or reject a submission. A control body could be an organisation, an ad hoc group specifically formulated for a specific decision or an existing authority structure.

These roles, together with a register used to support the agreement governance process, are shown in Figure 7, below. The role of registers and registries in agreement governance in covered in more detail in section 4.3.

Federated decision making - Federated decision making aims to respect and utilise existing domain authority governance and maximise the opportunity for input into decisions. There are two main patterns for federated decision making:

- **Authority** delegation - the assignment of authority from one body to another, to perform a governance function. An authority structure can delegate a portion of its governance scope to another authority structure. For example, an overall technical reference group responsible for all information and technology standards, could delegate authority for domain information standards to a specific domain authority. Conversely, domain authorities by virtue of joining a federation, cede authority to the central authority structure in relation to agreed, typically cross cutting concerns such as common interface standards.

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[30] These roles are defined in ISO19135
[31] Referred to as 'register owner' in ISO19135

- **Control body** appointment – the appointment by one authority of another authority structure to act as review body in respect of certain submissions. For example, a proposal may have been developed and submitted to a technical reference group of the decision authority for a standard. In order to engage with a broader community it may form an ad hoc control body to review the standard.

4.2.3 KEY PATTERNS

In II implementation, which typically cross multiple domains, much of the governance of information resources is likely to be distributed to existing domain authority structures. These structures will have their own terms of reference and operating procedures and thus it may not be possible to apply some of the concepts articulated above. However, well designed authority structures should encompass most of these concepts.

Together, the central authority structures for an II initiative and the domain authority structures create a federated governance system. This domain oriented federation operates alongside and may be interwoven with government federation such as an alliance of state and territory governments to form a federal government.

The delegation pattern is the most important mechanism to enable federated information governance in multi-domain II activities such as the NEII. It is therefore critical that the delegation process be clearly defined and the resultant delegated authority be documented and communicated to all stakeholders. It is anticipated that delegation of responsibility to act as a domain authority for data standards (content models and semantics) will be a common pattern. Information priorities should inform engagement strategies and drive priorities for authority delegation.

Identifier governance is a key concern across a wide diversity of information types within II, to enable unambiguous identification and referencing of objects such as reporting units or monitoring sites, information models (application schemas) and controlled vocabularies. Identifier governance encompasses both identifier patterns (e.g. domain names policies and identifier paths) as well as governance of identifier allocation rights. That is, defining which agencies are authorised to create (or 'mint') identifiers and who governs specific sets of identifiers. The Australian Linked Data Working Group (ALDWG), a practitioner network is developing recommended identifier patterns for use within government. Domain identifier governance is being addressed within some information communities c.f. ANDS persistent identifier service 'Identify My Data'[32].

4.3 Agreements

4.3.1 PURPOSE

The agreement component of the social architecture is concerned with the process of managing a range of different types of agreements under heterogeneous governance arrangements that collectively define the II and how it is implemented. It is concerned with the entire lifecycle of agreements from needs identification, through creation, submission adoption and finally deprecation.

The primary focus of this component is on the agreements that underpin information provision, access and interoperability. These include the information and technology standards, data access and licensing arrangements, service level agreements and overarching legislative and policy settings.

There are a range of other important agreements that will support NEII implementation. This includes such things as common goals, information priorities, work plans, contracts and other interagency collaboration agreements. These can be treated in a similar fashion to the core agreements and managed within the agreement framework, provided sufficient drivers for their governance exist.

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[32] http://ands.org.au/services/identify-my-data.html

4.3.2 KEY CONCEPTS

ISO 19135 – a Registration model - The agreement framework is based upon ISO 19135 as it provides a mechanism for agreement governance. Typically, it is applied to the governance of geographic information concepts such as feature types, themes of geospatial information or controlled vocabularies. The social architecture proposes a consistent approach to the governance of all kinds of agreements, using registers as articulated in ISO 19135. Section 4.2, of this document describes the application of ISO 19135 roles to support governance. Section 5.3 describes the application of ISO 19135 to manage the registration of agreements that are created through governance processes, using agreement registers.
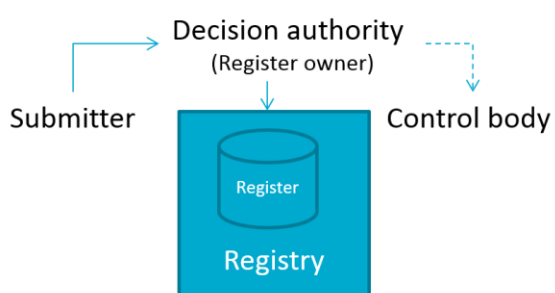

Figure 7 Agreement governance roles

Register - 'a set of files containing identifiers assigned to items with descriptions of the associated items' (ISO 2004). A register provides standardised metadata for registered items enabling their governance. In the context of social architecture, the typical use of registers (for concepts such as application schemas, or controlled vocabularies) is extended to enable governance of any type of agreement that is adopted by an II authority structure.

Registry – an information system in which a register is maintained (ISO 2004). A single registry may be used to maintain several registers.

II agreement – an agreement that specifies an aspect of the II with respect to what it is or how it should behave. For example, an endorsed: data exchange standard for a theme of data; controlled vocabulary; or Open Data policy, can all be regarded as agreements. Every agreement whether developed specifically for an II or adopted by it, should have a clearly defined owner i.e. the authority structure that authorised its adoption.

Domain – a specified sphere of activity or knowledge (Oxford University Press 2014). For the purposes of this document, the environment is considered to comprise a series of domains that deal with different aspects of the environment such as hydrology, ecology or soils. A definitive specification of these domains is beyond the scope of this document. However these domains will emerge as community engagement increases and data priorities are set.

Domain authority - an authority structure that governs a specific domain. A domain authority may be a body that is informally appointed by an information community to control information standards within the domain e.g. the Australian Collaborative Land Evaluation Program (ACLEP)[33] for the development of ANZSoilML[34] or a formal body that is legislated or constituted by a jurisdiction e.g. the Secretaries' ICT Governance Board (SIGB)[35]. Domain authorities may be delegated to act as an authority structure for an II.

4.3.3 KEY PATTERNS

Multi-domain II implementations, such as the NEII, are based on a combination of cross cutting and domain specific agreements. Therefore federated governance will need to be reflected in both authority structure and register design.

A key pattern within the agreement framework is the referencing of authoritative sources of adopted agreements. In the majority of cases, the agreement framework will comprise pre-existing agreements such as jurisdictional legislation and policy, international and national standards and domain standards defined by stakeholders. Thus, registers will need to be able to reference authoritative sources of adopted standards. These sources may be registers or web accessible resources (such as a document accessible at a specific URL).

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[33] http://www.clw.csiro.au/aclep/
[34] http://anzsoil.org/anzsoilml/
[35] http://www.finance.gov.au/governance-awards-data/sigb/

Register implementation patterns will need to reflect governance reality (scope of authority structures and the relationships between them). ISO 19135 specifies three structures that can be used for registers:

- Simple register – contains registered items of the same class e.g. agreements of the same type;
- Multi-part register – contains registered items of different classes organised in sections based on the type of information required for each agreement type e.g. agreements of different types governed by the same authority structure; and
- Hierarchical register – a structured set of registers composed of a principal register and one or more sub-registers e.g. a central vocabulary register that contains a list of the domain vocabulary registers.

A combination of all three structures is likely to be required. However, it is anticipated that the hierarchical register pattern will be commonly used, as this enables federated and partitioned governance of a particular type of registered item such as data exchange models. A hierarchical register of application schemas could for example be created with a principle register articulating the domains (e.g. hydrology, geology) and linked to domain specific sub-registers, each of which contains application schema for a specific domain.

Cross-referencing registered items between registers will be an important pattern as this will bring navigability and coherence to the agreement space. For example, a registered application schema can be cross-referenced to registered code-lists used with the application schema.

A range of agreement types are required to set the rules of the game for II efforts. These include:

- Overarching jurisdictional legislation and policy;
- Initiative steering agreements – agreements that define the direction of an initiative including the articulation of shared goals and agreed metrics for measuring progress;
- Technology standards that define how technology components behave;
- Information standards – that define the structure, semantics and delivery formats for information; and
- Data access agreements - data sharing agreements and data licensing.

4.4 Participation

4.4.1 PURPOSE

This component aims to address aspects of the 'collective action problem' and mitigate disincentives for participation in the development of II. It also recognises that participants in any new II initiative are typically already engaged in a number of pre-existing collective initiatives. Specifically, the component is concerned with engaging with stakeholders and enabling them to effectively take part in and contribute to the II through:

- sharing information;
- building common infrastructure components;
- nominating and/or developing information standards (application schema and code-lists) as required; and/or
- collaborating and exchanging knowledge to address common and domain specific issues to achieve collective goals.

In addition the component aims to: encourage, facilitate and guide participants to implement agreements; leverage, align, mediate and bridge existing capability; and minimise the cost to participants, while maximising collective benefits. The participation component recognises the:

- distributed, federated and fragmented nature of drivers, resources, mandate and capability;
- existence of installed base, comprising pre-existing institutional arrangements, standards, services and common infrastructure; and
- heterogeneity of participant motivations, drivers, timeframes, mandate and capacity to participate.

Participation and governance components are inter-related. Governance is concerned with collaborative decision making to identify and adopt NEII agreements such as policies, standards, authoritative data sets, common models and vocabularies. Participation is also concerned with collaboration but is focussed on engaging stakeholders to achieve 'buy-in' to the initiative and enabling communities, providing them with support and guidance to develop and/or nominate domain standards (common models and semantics) and implement these to realise II goals.

4.4.2 KEY CONCEPTS

The participation component of the social architecture is based on 'collective impact', an approach to achieving commitment of a group of actors from different sectors to a common agenda to achieve social change, using a structured form of collaboration (Kania and Kramer 2011). Designed to address complex challenges in social service delivery, the collective impact approach provides a useful framework that can be applied to II practice. This is because there are some striking similarities between social service delivery and II implementation in terms of the challenges faced. Broadly, this is the challenge of motivating, and aligning multiple participating organisations and communities engaged in a range of independent activities from policy to service delivery, embedded within complex policy, legislative and operational settings, to achieve agreed outcomes for the benefit of a set of stakeholders. The collective impact approach is based on five key concepts.

Common agenda: participating organisations and information communities have a shared vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed upon actions. The development of a common agenda is the most important task in both governance and participation spheres of the social architecture. Participation is required from all stakeholders to document and understand participants' existing goals, activities, and constraints and develop a common understanding of the implementation context and the problem space. Governance enables collective decision making and the development of agreements about, the collective agenda, key aspects of the problem space to be addressed, and the priority actions that will steer the initiative in the agreed direction.

Shared measurement system: development of an agreed approach to measuring success and reporting progress. This includes the identification of key indicators for all participating organisations. The development of a shared measurement system is critically important, as this provides the basis by which governance authority structures can determine if the initiative is on track. It also provides a means by which participating organisations are able to assess their own efforts. In the context of II, shared measurements may include, indicators related to information availability and quality, conformance to standards, and information usage metrics.

Mutually reinforcing activities: engaging with a diverse set of stakeholders, typically across multiple domains and information communities, to coordinate activities through a mutually reinforcing plan of action. This recognises the independence of each individual activity and a conscious decision to leverage, harmonise and where possible align them to a coherent plan of action.

Continuous communication: the need for frequent communications over a long period of time between key stakeholders within and across organisations, to build trust and inform ongoing learning and adaptation of strategy. This concept recognises the timeframes for change may be significant and that there is a need to build trust between participants. It also recognises the importance of communication to ensure rapid feedback from implementation efforts so that learnings from independent but mutually reinforcing activities can be factored into strategic decision making.

Backbone organisation: the critical role of ongoing support provided by independent staff dedicated to the initiative working within a 'backbone organisation'. Backbone organisations play a pivotal role in collective impact performing six key roles: guiding vision and strategy; supporting aligned activities; establishing shared measurement practices; building public will; advancing policy; and mobilising funding. It is worth noting that in the context of II development, the role of 'building public will' focuses on engagement with stakeholders including providers and user of information and others, to build understanding of and support for the initiative. The II implementation context and in particular funding arrangements will obviously determine the scope of and manner in which the backbone organisation mobilises funding. At one end of the spectrum it

may be coordinating funding allocation to participants in the case of a centrally funded initiative or at the other end of the spectrum it may be attempting to align investments of individual participants in independent activity and advocate for funding on behalf of the collective effort.

4.4.3 KEY PATTERNS

To develop a common agenda, which reconciles and aligns the activities and interests of individual organisations, so that they are more mutually reinforcing, requires deep engagement with identified stakeholders, to understand their goals and interests. Engagement with stakeholders to understand requirements for information is also critical. Generic use cases are useful to articulate high level functions of infrastructure such as 'discover data'. However, explicit, detailed use cases need to be developed as a framework for engagement. Documentation of specific use cases enables the framing of the value proposition for stakeholders, and clarifies data priorities. In turn data prioritisation enables relevant information communities and stakeholders to be identified and engaged. Using a use case and data driven approach, proposed governance and engagement mechanisms together with the emerging technical infrastructure can be tested end to end, using priority use cases and associated data.

When building on an installed base across multiple information communities, as is the case in the NEII, engagement represents a significant challenge that can be time consuming and costly. Investment in engagement is critical to achieving success in this type of collective initiative and thus the benefits of deep engagement far outweighs the costs.

It is recognised that II is built through planned activities executed within a programmatic context and as well as through streams of independent activity across discrete information communities that coalesce to achieve collective outcomes. Steering both programme and independent activity towards a coherent suite of mutually reinforcing activities requires pragmatic, flexible responses from all stakeholders to adjust and re-align efforts and exploit 'windows of opportunity'. Good communication and responsive management action is needed to identify and exploit 'windows of opportunity' that open (and may rapidly close) when independent domain activities and collective goals and priorities can be aligned.

There are several patterns that may assist in coordinating independent activities so that they are mutually reinforcing. One is to allow an organisations to lead collective efforts where there is alignment between a collective goal and pre-existing activities being implemented by the organisation. Another is that inclusive stakeholder representation together with adequate authority to make decisions, will facilitate alignment of II strategy and plans to exploit emerging windows of opportunity.

However, it must be recognised that there are often significant constraints around conflicting interests that militate against achieving this alignment. The kind of social change required for collective impact in II contexts, typically occurs over long periods of time. Trust between participants needs to be built over time so that participants feel comfortable enough to build dependencies between activities and thus take on increased risk.

Development of shared metrics to guide and assist stakeholder to move towards increase levels of conformance with II agreements are critical. Of particular importance are information and technology standards as II building is effectively about agreeing and adopting standards to achieve increasing levels of interoperability between systems. Given that the installed base is likely to comprise information communities that have developed II for their own community (e.g. IMOS for the marine community or ALA for bio diversity data) that will need to be leveraged as part of a new II initiative, the ability to measure individual organisations and information communities will be required. Measurement systems must also reflect the variable maturity of participants and recognise the differing drivers and targeted end state for communities.

Certain technical skills necessary to develop and deliver conformant information for II may be in short supply. For example, lack of spatial information modelling expertise has been identified as an issue through FSDF information modelling activities. Existing mechanisms that support development of key skills and technical capacity and exchange of knowledge and skills, should be supported and strengthened. Collective approaches to addressing skills shortage are not only more cost effective than fragmented individual approaches but they also contribute towards more coherent technical outcomes.

It is worth noting that in II practice, the identified backbone organisation may also play several stakeholder roles. These include, an information provider and or a domain authority responsible for information standards for one or more domains. This is the case for the Bureau of Meteorology in the NEII. It is important that there is a clear separation of the core backbone organisation roles from the other II participation roles.

5 Applying the social architecture model

5.1 Overview

This section of the report provides a summary of recommendations for applying the social architecture model and the lessons learned from the landscape review to inform the NEII programme design[36]. Key recommendations presented in this section are also of potential benefit to other initiatives as they illustrate potential management actions to support infrastructure implementation.

The recommendations are based on the structured landscape review process that included interviews and document review. The lessons from the review have been framed using the social architecture model. Key recommendations for applying the social architecture model to II practice are based on a recognition of the following:

- **Reuse of the installed base** – The social architecture must respect where a significant installed base exists and ensure that, wherever possible, the existing social and technical mechanism can be leveraged and reused. This will require recognition and leveraging of multiple hierarchical (top down) and self-organised (bottom-up) network governance models and relationships between stakeholders.
- **Heterogeneity** – the social architecture must be able to reconcile and operate in the context of heterogeneous architecture, governance, standards and licensing arrangements that exist across diverse information communities with variable cohesion and maturity. Aggregating data from multiple providers will demand flexible information architectures that accommodate both centralised and distributed approaches to data management and reuse. (Zerger, Williams et al. 2013).
- **Flexibility** – Information infrastructures evolve through planned activities but also exhibit emergent unplanned behaviour due to the interaction of multiple streams of independent activity. The social architecture should enable adaptive responses that support the initiative to utilise these 'windows of opportunity'.
- **Variable maturity and evolution** - information infrastructure initiatives and their component systems and information communities are of variable and continually changing maturity. Governance and participation arrangements need to evolve to accommodate this and be re-calibrated based on the phase of the initiative e.g. moving from start-up phase with a focus on programme governance to more inclusive participatory community governance.
- **Lightweight** – a lightweight framework that can be scaled as an initiative grows. The framework must, wherever possible, leverage existing mechanisms to minimise the burden and allow the community to participate in governance, ensuring that governance and participatory overheads are commensurate with scale and maturity of the initiative.
- **Learning and Innovation** – enable continuous assessment and review of stakeholder innovation for potential adoption.

5.2 Governance

This section describes key recommendations and priority tasks to implement the governance component of the social architecture model. These recognise the need for federated governance, the need to calibrate arrangements appropriately against the level of maturity of an initiative and the promotion of a high level of stakeholder authority and participation. To achieve collective impact, participating organisations and

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[36] Detailed recommendation have been provided in an internal report to the NEII Programme team.

information communities should be given responsibility, accountability and the opportunity to develop a common agenda to steer the initiative.

5.2.1 RECOMMENDATIONS

- Identify domains and domain authorities and ensure that these are adequately represented in authority structures. Domain clarity will also assist in engagement with represented communities.
- Define a process to assign and/or delegate authority and a means of documenting the nature of the delegation e.g. scope of decision authority. Authority for domain specific agreements, chiefly those related to domain information standards (such as data models and vocabularies), should be delegated to identified domain authorities.
- Clearly define terms of reference for federated domain authorities, including their: function; membership and chairing; operating procedures; scope of decision authority; and relationships and reporting lines to other authorities.

5.2.2 PRIORITY TASKS

Define and create core authority structures

Identify required authority structures to exercise governance over specific aspects of the initiative. Three inter-related levels of authority structure are recommended which address different decision domains:

- **Policy-information nexus** – this provides an interface between the information oriented concerns of the II and the broader policy context. Senior representatives of key stakeholders should be invited to participate in authority structures at this level. Wherever possible, existing domain authorities should be identified and used.
- **Strategic direction and oversight** – authority structures that are created specifically to govern or steer the initiative. There may be more than one authority structure at this level and if so, a peak authority should be identified. This level of decision making is responsible for setting information priorities, approving implementation plans, and, if centrally managed finances or other resources are available, for resource prioritisation decisions.
- **Technical** – a range of technical authority structures will be required to address cross cutting concerns as well as concerns related to specific domains. These are likely to comprise central and domain authority structures.
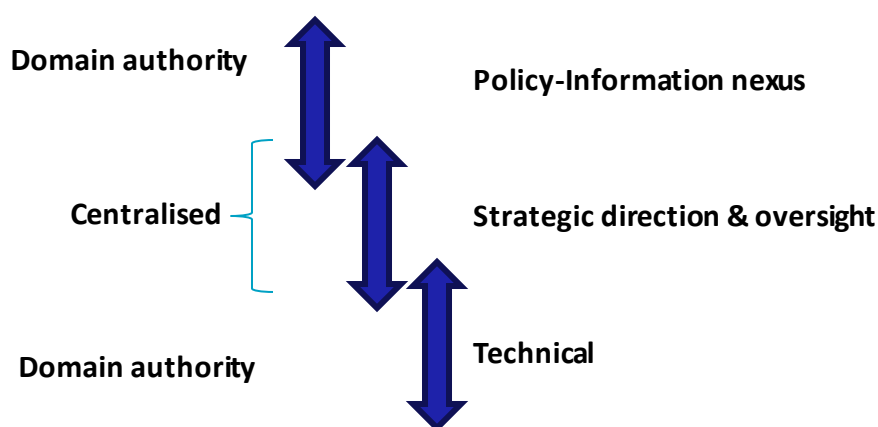
Figure 8 Type of authority structure and decision domains

Define function and relationships between authority structures. The purpose of each core authority structure should be defined through terms of reference (TOR). Relationships between authority structures (in terms of authority i.e. superior/sub-ordinate relationships and reporting) and also between authority and programme management structures should be defined and documented.

Define governance scope and decision processes in TOR. Governance scope should be defined in terms of the extent of decision authority i.e. what kinds of decisions the structure is authorised to make. Operating procedures should be defined to clarify decision making processes. The mechanisms for registering, providing access to and communicating agreements are described in the agreement component (see section 4.3).

Define membership and assign roles. Determine the required composition for each authority structure based on its function and governance scope. Selection of organisations and appointment of individuals should be informed by their ability to represent relevant communities and/or interests. Participant roles should be assigned for each participant.

Enact authority structure federation

Define delegation mechanisms. Define and approve a mechanism by which authority delegation can be enacted. This will be a decision for the peak centralised authority structure. It may, for example, delegate thematic information prioritisation to relevant domain authorities. It may also grant a core technical authority structure the ability to further delegate authority to federated structures.

> *Federation – an alliance or union of self governing authorities under a central authority, with each authority retaining control of its own internal affairs*

Determine data priorities and target information communities that are responsible for this data. A data priority driven and domain based approach to developing federated governance is recommended. This entails identifying priority data requirements, custodians for the identified data and the information communities in which they participate. Authority structures that are responsible for setting standards (information models and semantics) for the data also need to be identified. In some cases, a single agency may be responsible for setting standards for a community or for its own data e.g. the Bureau of Meteorology is responsible for water information. In other cases, a separate domain authority may exist e.g. ALA has developed a species classification standard for species data providers, although in this case it does not mandate its use by data providers. Rather, it provides a centralised transformation service.

Engage with identified communities. Engagement with identified organisations and authority structures that act in the capacity of a domain authority for identified data sets and/or information community will be required, so as to explore their potential to act in the proposed capacity. Understanding motivations and blockers for an existing domain authority structure to exercise authority as part of a federation with a central authority structure will be important. These may include such things as:

- Blockers:
  - Time and resource constraints to take on additional tasks;
  - Reluctance to be accountable to another authority structure; and
  - Lack of 'buy-in'.
- Motivators:
  - Connecting domain specific activities to broader information community activity;
  - Strengthening the mandate of the domain authority through a new connection;
  - Improved visibility for the information community and its activities; and
  - Ability to leverage other activities and outcomes.

Define the nature and scope of delegated authority. Delegation will most commonly be required to achieve federated governance of information resources. Multiple authority structures may be responsible for governing different aspects of information within a given domain. Relevant authority structures will need to be identified, and the scope of authority delegated to them agreed. In addition, certain information communities may have agreed specific data format standards and interface specifications. In practice there is likely to be fairly standard set of common format and interface standards (primarily OGC and W3C) that tend to be commonly used across II.

Document the delegation and interaction mechanisms. Having identified and secured agreement for delegation of authority to domain authority structures, delegations will need to be documented. In addition, agreed communication and reporting modalities will need to be agreed. Registers standardised lists of

agreements together with repositories that provide access to the agreed artefacts are the primary means of managing agreements. Please refer to Section 4.1.5 for a description of registers and repositories.

Monitor progress and steer the initiative. A key function of governance is to provide oversight. In order to perform this role, progress against agreed targets needs to be measured. This information will be fed into programme management processes and ultimately governance processes to enable strategic decision making. Section 4.4 on participation, describes the use of assessment frameworks to monitor stakeholder progress towards achievement of II goals.

5.3 Agreements

The following recommendations and tasks are based around a consistent approach to governing and managing a range of agreements that describe many different aspects of how II stakeholders agree to work together, through the use of agreement registers. The recommendations address the realities of working in environments with fragmented and overlapping information resource governance and complex enclosing legislative, policy and standards frameworks. Given the critical importance of data licensing and access arrangements to the success of II initiatives, some explicit recommendations addressing these issues are also provided.

5.3.1 RECOMMENDATIONS

- Establish registers for each authority structure to enable them to govern the agreements for which they are responsible. Wherever feasible existing mechanisms (including registers) implemented by domains to govern semantic resources should be reused. Register arrangements should be defined in parallel with authority structure definition, as registers need to reflect governance realities including federated governance. One or possibly more registers will be assigned to each authority structure.
- Working in parallel with a centralised and identified domain authority that has agreed to act as a federated domain authority, work through the process of establishing registers and populating them with content.
- Develop a machine readable standardised classification scheme for agreements that will facilitate consistent documentation of the enabling environment and the information resources.
- Identify and agree on a data licensing framework such as Creative Commons as the preferred licensing framework. If possible set the most open licence e.g. Creative commons attribution (CC BY) as the default licence type.
- In Australia, leverage and engage with AusGOAL community key data providers to determine appropriate approaches to data licensing that will fit with existing arrangements.

5.3.2 PRIORITY TASKS

Establish agreement Registers

Establish an agreement registry to manage agreement registers. The registry is a system to enable governance of agreements that are organised in a series of registers (or lists). A number of implementation options are possible, ranging from implementing a registry using spreadsheet software with one sheet per register, to high end commercial registry software or development of bespoke applications. Simple, multi-part and hierarchical registers are likely to be required. It is anticipated that the hierarchical register pattern will be commonly used, as this enables federated and partitioned governance of a particular type of registered item such as data exchange models.

Data access and licensing

Data licensing and access arrangements (including attribution, permissions) are likely to represent significant challenges that may impact on the ability to publish information. In some information communities these issues have been addressed and clear and open access arrangements are in place. However, in some cases

these issues have not yet been addressed. In these cases, significant effort may be required to negotiate and or clarify access and licensing arrangements.

Define agreement typology and priorities for governance

Identify key types of agreements that are required to enable access to and interoperability between information resources and determine which agreements will be formally governed as part of the social architecture. Agreements can be categorised in a number of different ways. The following is one possible categorisation:

- Overarching jurisdictional legislation and policy settings such as Open Data policies, privacy legislation, data archival requirements.
- Initiative steering agreements – agreements that define the direction of an initiative and enable the measurement of outcomes. This includes such things as shared goals and objectives that define a common agenda, information priorities, agreed metrics for measuring progress and work plans.
- Technology standards – standards that defined how technology components behave. Service interface standards (such as OGC Web Map Service) are a key type of technology standard. They tend to be technology focused and are likely to be governed through core authority structures. Note that some domains may have defined profiles of technical standards for their particular communities.
- Information standards – standards that define the structure, semantics and delivery formats for information. It is anticipated that these will be under federated governance to delegated domain authorities. They include: information models, information semantics (e.g. controlled vocabularies) and data format standards.
- Data access agreements - data sharing agreements and data licensing.
- Service agreements – agreements that define nature of information services provided e.g. service level agreements and operating level agreements.

Assign registers to authority structures

Define register structures in parallel with authority structures, as registers need to reflect existing governance realities as well as federated governance arrangements comprising centralised and domain authority structure. One or possibly more registers will be assigned to each authority structure.

As indicated in Section 4.2, roles will need to be defined in relation to each register. These are: the owner - the authority structure; submitters - those authorised to submit new items for consideration; and optionally, a control body responsible for advising the register owner on a decision to approve or reject a submission.

Identify and register priority agreements

Working in parallel with the core authority structure and selected domain authorities that have been delegated to act as a non-core authority structure, work through the process of adopting identified agreements and identifying additional agreements for adoption. The content of registers is typically dynamic with new items being proposed and accepted (or not), clarified, superseded, or retired. Therefore, registers must be maintained to support the management of items throughout their life. Individual registered items should be individually managed, moving through a set of well defined states. Information about the temporal history of each item should be maintained.

5.4 Participation

The recommendations in this section are focussed on stakeholder participation through the setting of a common agenda and the identification of clearly defined use cases and data priorities. The recommendations recognise: the planned and emergent nature of II development; the need to develop and maintain a common agenda; and the role of responsive programme governance and management actions to ensure that emerging 'windows of opportunity' can be exploited. Furthermore, the recommendations recognise the fact that collective action problems are encountered in II development and that the disincentives to actively participate must be directly addressed by both the participation and the governance component of the model.

5.4.1 RECOMMENDATIONS

- Engage with stakeholders to develop and build a common agenda.
- Engage with the stakeholder to develop user stories and use cases as exemplars to drive development from governance, technology and data content perspectives.
- Guided by use cases, define data priorities and develop engagement strategies for targeted organisations and information communities. Undertake an assessment of readiness of data and capability providers and willingness of data custodians or intermediaries[37] to participate. Prioritisation should be pragmatic exploiting 'windows of opportunity' with willing, capable partners, using existing infrastructure.
- Scan for potential collaborative activities and allow for responsive management actions to leverage windows of opportunity.
- Identify opportunities for stakeholders to lead specific projects or other well defined tasks.
- Engage with all levels of government to achieve national level integration of data that are fragmented across levels of government.

5.4.2 PRIORITY TASKS

Develop a common agenda

Develop and execute an engagement strategy that will enable the development of a common agenda and clearly articulated value proposition for participation. Develop a common agenda for the II that enables engagement with, and leads to buy-in from II stakeholders. A key aspect of this agenda is a clear articulation of the value proposition of the initiative as a whole, as well as the value for individual participants. The II value proposition can be expressed in relation to generic uses cases e.g. improved discovery of and access to information through a common metadata catalogue. However, more specific and detailed use cases provide valuable insights into system requirements as well as enabling the value proposition for stakeholders to be more explicitly framed. For example, a use case such as delivering a seamless national water feature reporting framework to underpin legislated water accounting, enables implicated data and service providers, domain authorities and users to compare current arrangements with the proposed end state and assess the cost/benefit of proposed actions to achieve this change. This type of analysis is increasingly important as part of the process of developing a business case for investment. Key aspects of stakeholder engagement are addressed in the following sections.

Identify data priorities and target information communities and organisations accordingly. Define data priorities and develop engagement strategies for targeted organisations and information communities. It is anticipated that different engagement strategies will be required depending on the nature (i.e. maturity, cohesion, size and governance mandate) of the community.

Mature communities, responsible for priority information, should be targeted initially. In this context, mature communities are those that have developed and adopted agreed information models, have agreed published semantics and have implemented services for data delivery. Architectural and standards conformance assessments can be used to assess community maturity against specified II conformance requirements (see shared measurement, below for more details).

Shared measurement of success

Develop agreed metrics to measure progress. To measure progress towards the achievement of collective goals, an agreed measurement systems should be defined. Key indicators should also be defined that enable participants to assess and report individual progress. These should be in a form that can be aggregated to measure the progress of the entire initiative. As II is fundamentally about standardisation of information, key metrics should be developed to measure the availability, quality and conformance of information to adopted standards. Conformance assessment methods with a number of increasing levels of conformance, enables

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[37] Those agencies that provide data on behalf of data custodians.

participants to assess information resources (e.g. data sets, information services, information models, or controlled vocabularies). Conformance targets are used primarily to enable participants to determine the level of conformance of existing capabilities and support progress towards achieving future targets. Engagement activities and communications need to ensure that this message is clearly articulated, otherwise conformance targets could be perceived as a performance measure rather than an incentive.

A number of options for the design of conformance assessment exist, including:

- Role base conformance assessment – assessment based on the nature of roles performed by the assessed capability e.g. data provider, service provider or domain authority; or
- Resource based conformance – conformance assessment that is tailored to the nature of resource being assessed. Resources could be characterised for assessment based on a technology perspective e.g. an assessment of the data access services, vocabulary service, and feature registers or an information perspective e.g. feature data set, or controlled vocabulary (for environmental properties or observing procedures) and information models.

Conformance assessment will need to assess a diverse range of situations, from a single organisation supplying a single information resource (e.g. a data set, a service or a code-list), to a large, mature information community that delivers a coherent set of data, services and underlying models and semantic resources. In developing the assessment methodology it is also worth noting that not all capability providers will have the same goals in terms of interoperability targets and therefore may be aiming for different levels of conformance. The conformance assessment should be developed in close cooperation with the stakeholder community and again represents an important engagement opportunity.

Wherever possible, automated indicators should be used (i.e. those that can be populated by querying II technical components such as service catalogues) to assess progress. Monitoring of the volume and conformance of information resources by type, and by domain will be required. The use of registers to govern agreements and the growth of resources under governance will be an important source of information for monitoring progress.

Perform initial assessment with targeted organisations or information communities. Working through authority structures (identified and engaged through the governance activities) for a targeted domain, an initial conformance assessment should be performed in association with identified community members. The assessment provides an important opportunity to engage with and communicate at a business and technical level with key community members.

Mutually reinforcing activities

Identification of data priorities The identification of stakeholder data priorities is a concrete way of trying to identify mutually reinforcing activities e.g. standardisation, harmonisation and delivery and exploitation of one or more data sets.

Provider oriented value proposition. The value proposition for participation is often oriented around the data user and based on generic use cases e.g. improved discovery of and access to information through a common metadata catalogue. Specific, detailed use cases provide valuable insights into system requirements, enabling the value proposition for stakeholders including data providers to be more explicitly framed.

Windows of opportunity. Efforts should be made to identify and where ever possible exploit 'windows of opportunity' that open when independent activities of stakeholders, potentially in the context of other initiatives, can be aligned with and leveraged to deliver towards the overarching goals and priorities of the NEII.

Conduct gap analysis and develop work plans, partnerships and other formal collaboration arrangements. Based on the assessment, a gap analysis can be undertaken to identify priority activities to achieve data supply. Work plans can be framed and progress monitored against the conformance target specified in the conformance assessment. Attempts should be made to leverage and, wherever possible, align with planned domain and organisational activities and work plans. As the II matures and trust is developed, it should be possible to influence the activities and work plans of information communities to deliver into the II. In some

instances, partnerships or other formal collaboration arrangements may be used to achieve required outcomes for priority activities.

Recognise stakeholders are engaged in pursuing individual and community goals using resources under their control. If buy-in can be achieved, the investment can be recognised as co-investment. Recognition of individual, organisational and community contributions to collective efforts are a motivator for participation. Conversely, if contributions are not adequately recognised, this can act as a significant de-motivator and disincentive to participate.

Develop a contributor recognition strategy. Recognition of individual, organisational and community contributions to collective efforts are a motivator for participation. This is particularly important when leveraging an installed base which has been developed by organisations participating in initiatives and communities, all of which have their own brand identity. If contributions are not adequately recognised, this can act as a significant de-motivator and disincentive to participate. Engagement strategies and the institutional arrangements that are defined should explicitly address the issue of participant recognition.

Clarify data access arrangement together with data licensing, attribution and acknowledgement. Data licensing and access arrangements (including attribution and permissions) are likely to represent challenges that may impact on the ability to publish information. In some information communities, these issues have been addressed and clear and open access arrangements are in place. However, in some communities these issues have yet to be addressed. In these cases, significant effort may be required to negotiate and or clarify access and licensing arrangements.

Continuous communication and learning

Use informal networks. In many cases exchange within information communities is addressed through existing affinity networks, domain conferences and standardisation and information infrastructure development activities. Cross community exchange could be facilitated through the development of technical working groups, domain case studies and the use of networking opportunities e.g. dedicated programmes and workshops within relevant conferences and other events.

Different types of stakeholders e.g. data providers and domain authority will require differing engagement strategies. Stakeholders performing key roles should be identified within targeted information communities and appropriate engagement modalities defined. Key users should be identified and engaged to ensure that use cases are captured and used to drive information and system requirements. In many cases data provider agencies are also significant users of data. Domain authorities will be engaged through governance discussions and in particular the design of federated information governance, described in Section 4.2. In addition, where domain authorities perform a coordination role for their information communities, engagement strategies for the information community should be developed collaboratively with the domain authority.

It should be noted that typically, organisations and individuals play multiple roles and that information communities may already have role based engagement mechanisms, for example a peer network of practitioners working on data provisioning issues. These realities should be factored into engagement strategies.

Learning and knowledge exchange. Domains will be at varying levels of technical maturity. Solutions to common problems are likely to emerge from specific domains. It is important that there are opportunities to share experiences between domains and amongst specialised technical practitioners. In many cases, knowledge exchange within information communities may be addressed through existing affinity networks, domain specific workshops and conferences and standardisation of II development activities. However, cross community exchange can be facilitated through the development of technical working groups, domain case studies and engineered networking opportunities e.g. dedicated programmes and workshops within relevant conferences other events.

Backbone organisation

Explicitly identify the backbone organisation and confirm its roles. It is important that a backbone organisation be explicitly identified. It is anticipated that in many cases the choice of backbone organisation

will be obvious. In those cases where an obvious candidate for backbone organisation does not exist, several organisations could share the backbone organisation role. The core functions of the backbone organisation should be confirmed and adequately resourced. These roles are: guiding vision and strategy; supporting aligned activities; establishing shared measurement practices; building public will; advancing policy; and mobilising funding. Where two or more organisations act as a federated backbone, these roles can be shared between them.

Clear separation between backbone and other roles. If the backbone organisation plays additional roles e.g. it is represented in authority structures or the organisation is a key information provider or domain authority, these roles should be clearly separated from the backbone organisation roles.

Appendix 1 Candidate initiatives for landscape review

International

- Infrastructure for Spatial Information in the European Community (INSPIRE) - http://inspire.ec.europa.eu/
- 1October
- The intergovernmental Group on Earth Observations (GEO) - leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) https://www.earthobservations.org/index.php#
- Eye on Earth http://www.eoesummit.org/
- Belmont Forum Data and E-Infrastructures http://www.bfe-inf.org/
- New Zealand SDI - http://www.linz.govt.nz/geospatial-office/about/projects-and-news/spatial-data-infrastructure
- Canadian Geospatial Data Infrastructure (CGDI)/ GeoConnections http://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/8906
- EarthCube http://earthcube.org/
- The Ocean Biogeographic information System (OBIS) http://www.iobis.org/home
- US Environment Protection Agency (EPA) http://www.epa.gov/
- NSDI (India) http://dst.gov.in/scientific-programme/s-t_nsdi.htm

Domestic

- NCRIS facilities
  a. Atlas of Living Australia http://www.ala.org.au/about-the-atlas/atlas-background/atlas-governance/
  b. AuScope – National Earth Science Infrastructure http://www.auscope.org.au/site/auscope.php
  c. IMOS http://imos.org.au/
  d. Terrestrial Ecosystem Research Network (TERN) http://www.tern.org.au/
  e. ANDS - Australian National Data Service (ANDS) http://ands.org.au/
- NEOS-IP (National Earth Observation from Space Infrastructure Plan (NEOS-IP) http://aeoccg.org.au/operational/14-aeogcg/47-01-aeogcg
- NRM Spatial Hub http://dev.effectalmedia.com/crc/edition-44/#featureStory
- Foundation Spatial Data Framework (FSDF) http://www.anzlic.gov.au/foundation_spatial_data_framework
- Australian National Statistical System Australian Bureau of Statistics(ABS) http://www.nss.gov.au/
- State/Territory SDIs
- WA – WALIS - Shared Location Information Platform (SLIP) www.walis.wa.gov.au/projects/slip
- NSW - NRAtlas http://nratlas.nsw.gov.au/wmc/custom/homepage/home.html and NSW Spatial Information Exchange https://six.nsw.gov.au/wps/portal/

Acronyms

ABS	Australian Bureau of Statistics
ACLEP	Australian Collaborative Land Evaluation Program
ALA	Atlas of Living Australia
ANDS	Australian National Data Service
ANZLIC	Australia and New Zealand Spatial Information Council
ASRIS	Australian Soil Resource Information System
AusGOAL	Australian Governments Open Access and Licensing
BoM	Bureau of Meteorology (the Bureau)
CGDI	Canadian Geospatial Data Infrastructure
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EIAG	Environmental Information Advisory Group
EPA	Environment Protection Agency
FSDF	Foundation Spatial Data Framework
GEOSS	Global Earth Observation System of Systems
IHO	International Hydrographic Organisation
ICSM	Intergovernmental Committee on Surveying and Mapping
ICT	Information and Communication Technology
IMOS	Integrated Marine Observing System
INSPIRE	Infrastructure for Spatial Information in the European Community
IT	Information Technology
LINZ	Land Information New Zealand
NCRIS	National Collaborative Research Infrastructure Strategy
NEII	National Environmental Information Infrastructure
NPEI	National Plan for Environmental Information
NSW	New South Wales
NZSDI	New Zealand Spatial Data Infrastructure
O&M	Observations and Measurement
OBIS	Ocean Biogeographic information System
OGC	Open Geospatial Consortium
RDA	Research Data Australia
SDI	Spatial Data Infrastructure
SLIP	Shared Location Information Platform
SRO	Senior Responsible Officer
TERN	Terrestrial Ecosystem Research Network
TOR	Terms of Reference
URI	Uniform Resource Identifier

Glossary

Agreement - documented arrangements that have been defined by authorised decision makers through governance processes.

Authority structure - an organisational structure that has the power or right to control, judge, or prohibit actions of others. Power or right can be derived from a formal *de jure* source (e.g. legislation) or can be consensus based, *de facto* authority granted by a community

Backbone organisation - an organisation dedicated to coordinating activities and stakeholder involved in a collective initiative. A backbone organisation may be a business unit within an organisation that is dedicated to an initiative rather than being a separate organisation. Backbone organisations perform six key roles: guiding vision and strategy; supporting aligned activities; establishing shared measurement practices; building public will; advancing policy; and mobilising funding. (see collective impact)

Collective action – action taken by a group to achieve a common objective.

Collective action problem - Despite the fact that individuals may be motivated to work collectively to achieve a common goal based on common interests, individuals may also have conflicting interests which are a disincentive for collective action (Encyclopædia Britannica 2015)

Collective impact - is the commitment of a group of actors from different sectors to a common agenda for solving a specific social problem, using a structured form of collaboration (Kania and Kramer 2011). The five main component of the collective impact framework are: common agenda, shared measurement system, mutually reinforcing activities, continuous communication and a backbone organisation.

Delegation - the assignment of authority from one authority structure to another.

Domain authority -- an organisational structure that has the power or right to make decisions about an information domain

Federation - an alliance or union of self-governing authorities under a central authority, with each authority retaining control of its own internal affairs with some portion of its control ceded to a central authority.

Governance – a framework of 'authority structures' and processes, by which communities manage their collective affairs through a continuous process of negotiation and decision making. The framework enables the creation and operation of mechanisms, processes and rules designed to reconcile the diverse needs and interests of a community, to steer individual and collective initiatives of stakeholders to achieve agreed, collective goals (Box 2013).

Information community - A collection of people (government agency or group of agencies, a profession, a group of researchers in the same discipline, cooperating who share a common digital information language and common features.

Information Infrastructure – inter-connected systems with interwoven social and technical components including information supply chains, institutional arrangements, standards, and technology.

Installed base - *existing,* shared, evolving, open, standards, and arrangements comprising heterogeneous components that are inter-connected through standards.

Participation – process and mechanisms through with enabling and facilitating stakeholders to take part in the collective activity. Participation has a primary focus on implementation of community agreements created through governance processes, to enable collective outcomes including improving access to information.

Register a set of files containing identifiers assigned to items with descriptions of the associated items. (ISO 2004)

Register owner - organization that establishes a register. (ISO 2004)

Registry- information system on which a register is maintained. (ISO 2004)

Social architecture - 'the conscious design of an environment that encourages a desired range of social behaviours leading towards some goal or set of goals'. (Wikipedia 2014)

Spatial Data infrastructure - Spatial Data Infrastructure – the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data. (The White House 2002)

Submitting organisation - organization authorised by a register owner to propose changes to the content of a register. (ISO 2004)

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