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PROJECT SOLUTIONS

CRC-SI – Alignment Study of Spatial Data Supply Chains

Phase 1: Quick Scan of Relevant Initiatives

24 February 2012

Version 2.0

Document Approval:

Project Manager	Executive Sponsor
Signed Date	Signed Date

Document Control

Version	Primary Author(s)	Description	Date Completed
0.1	Maurits van der Vlugt	Initial Draft	7 Sept. 2011
0.2	Maurits van der Vlugt	Draft for RG discussion	11 Sept. 2011
0.3	Maurits van der Vlugt	Final Draft for RG sign-off	04 Oct 2011
1.0	Maurits van der Vlugt	Final after Reference Group Sign-off	20 Oct 2011
1.1	David Mc Meekin, Maurits van der Vlugt	Added QLD and NSW analysis	23 Jan. 12

Document Location

C:\Users\Maurits\Documents\My Dropbox\MV work_shared\Projects\CRC Alignment Study Ph1\Deliverables\CRC-SI -Alignment Study-Report_v1.6.docx

Distribution

Copy No	Holder or Location	Purpose
1		

Reviewed

Version	Reviewed	Status
2.0	Program 3 Board	Approved
2.0	CRCSI CEO	Approved

Contents

Executive Summary

One of the key technology enablers of Spatial Data Infrastructures is the capability to maintain automated, flexible, and distributed **end-to-end spatial data supply chain (SDSC) management**. End-to-end supply chain management will also support an emerging Australian and New Zealand Spatial Marketplace (ANZSM) by allowing providers to publish and market a wide range of data products, enabling frictionless user-access.

Currently in Australia and New Zealand, a great many organisations collect, maintain and share spatial data, and consequently there are a multitude of SDSC initiatives being pursued at all jurisdictional levels.

Many CRCSI participants agree that there is little to no co-ordination of these developments and very little understanding of what components have already been built, leading to duplication of effort, wasted investment and missed opportunities to define a world leading research agenda. To address this issue of lack of coordination and to identify R&D and collaboration opportunities, the “Alignment Study” project is conducted. The project consists of three phases, as described later in this document.

The present project is restricted to Phase 1, a ‘quick scan’ of relevant initiatives.

This study surveyed 34, almost exclusively government driven, SDSC projects in Australia and New Zealand. The projects reviewed show a wide variety in levels of implementation and automation of the supply chain components. Only a minority of steps in the reviewed supply chains are fully automated and only 9 projects (semi-) automate the entire supply chain.

The survey clearly supports the project’s premise that SDSCs are still in their infancy: half the initiatives are in pre-production stages, and only 6 out of 34 admitted to having a full, long term sustainable governance framework in place.

Within the group of reviewed projects, we can identify a number of possible areas of capability gaps, overlaps and potential for collaboration. These could be obvious areas for collaboration, knowledge sharing and co-investment, and would need to be more closely assessed in phase 2 of the alignment study.

Out of the 34 surveyed projects, nine are shortlisted for further review in the next stage:

1. LINZ Data Service
2. Maori Land Geographic Information System
3. PSMA Systems
4. QLD SDI
5. SISS - Spatial Information Services Stack
6. SLIP Enabler
7. Spatial Information Exchange (SIX) Clip n’ Ship
8. The Australian Hydrological Geospatial Fabric (Geofabric)
9. VSDL - Victorian Spatial Data Library

The next stage (phase 2) of the study will encompass development of a ‘Reference Architecture’, confirmation and detailed technical review of shortlisted projects, identification of challenges and technology options for the supply chain components, recommendations for collaboration and an R&D agenda, and finally a proposal for a collaborative demonstration project.

1 Introduction

1.1 Background

CRCSI Program 3 exists to deliver "projects that provide fundamental building blocks and expanded capability and relevance to existing and emerging spatial information infrastructure environments through development research, standards and software tools to manage digital rights, governance, federated data integration and distributed processing capabilities.", this includes the "removal of barriers to a fully functioning marketplace for spatial information – the Australian and New Zealand Spatial Marketplace (ANZSM)" (CRC-SI, 2010)[1].

Such a market place will facilitate discovery and access to a broad range of spatial information products and services from a variety of sources (from government owned to volunteered geographic information).

One of the core notions underpinning the development of Spatial Data Infrastructures is the idea that spatial information provides the common reference frame for domain information (Kuhn, 2005)[2]. One of key technology enablers for SDIs, is the capability to collect, maintain and distribute this common reference information in an automated, flexible and distributed manner. For the purpose of this study, we define this concept as **"end-to-end spatial data supply chains" (SDSC)**. The products of these supply chains provide the current, authoritative government data products that can be distributed through a marketplace.

End-to-end spatial data supply chain management allows spatial data managers to efficiently and effectively publish, maintain and market a wide range of data products, while enabling frictionless user-access. Formalisation and automation of the process means that data products will be consistent, have increased currency and can be traced back in time.

Currently in Australia and New Zealand, a great many organisations collect, maintain and share spatial data[3], and consequently here are a multitude of spatial data supply chain initiatives being pursued at all jurisdictional levels from federal (e.g. GA's MapConnect or LINZ's data service), to state (e.g. WA SLIP and VIC VSDL), to numerous initiatives in e.g. local governments and utilities.

Many CRCSI participants agree that there is little to no co-ordination of these developments and very little understanding of what components have already been built, leading to duplication of effort, wasted investment and missed opportunities to define a world leading research agenda. A 2007 report into the value of spatial information in Australia concluded: "[…] the first generation of spatial data infrastructure development in Australia has tended to be product based. While there have been attempts to break down silos and implement whole-of-government approaches, success has been at best partial." (ACIL Tasman, 2008)[4].

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[1] CRC-SI Program 3 Spatial Infrastructures, Program Boars Terms of Reference, version 2. Accessed online 3 October 2011: http://www.crcsi.com.au/getattachment/14b3c499-8f00-4b8d-9adf-31bf793006fc/.aspx

[2] Kuhn, W. (2005) Introduction to Spatial Data Infrastructures. Presentation held on March 14 2005 (http://www.docstoc.com/docs/2697206/Introduction-to-Spatial--Data-Infrastructures)

[3] For just one illustrative example in the Natural Resource Management domain, see: http://www.nrm.gov.au/publications/data/index.html

[4] ACIL Tasman (2008) the Value of Spatial Information. Report prepared for the CRC for Spatial Information & ANZLIC – the Spatial Information Council, March 2008.

To address this issue of lack of coordination and identifying R&D and collaboration opportunities, the "Alignment Study" project is conducted. The project consists of three phases, as described later in this document. The present project is restricted to Phase 1, a 'quick scan' of relevant initiatives.

1.2 Approach

As shown in Figure 1, the full Alignment Study will consist of three phases:

1. A "quick scan" of relevant SDI initiatives and a review of national and international research activities;
2. A detailed alignment study that identifies substantive and well supported research questions for Program 3;
3. A demonstrator project that will develop a working prototype (and associated standards & protocols) of a common Reference Architecture for SDSCs[5].

The scope of the current project is the completion of Phase 1 only.

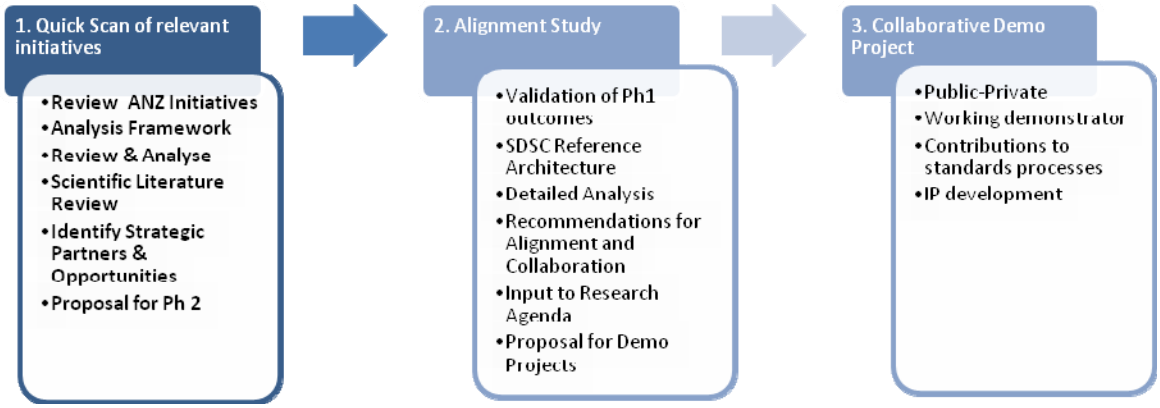

Figure 1 Three phases of the Alignment Study

Phase 1 of this project aimed to deliver the following:

- A list of the main SDSC systems currently in use or under development in Australia and New Zealand;
- A list of the principles and criteria that might characterise an optimal system ("best of breed");
- A report analysing and comparing the various systems evaluated, highlighting potential gaps and overlaps;
- A report documenting the current status and focus of international research initiatives in the SDSC/spatial data supply chain domain;[6]
- A proposal for Phase 2 of the alignment study. (see Appendix 3 - Phase 2 Proposal)

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[5] Purpose of this architecture is to be a framework model for comparing technical detail, solutions and R&D gaps of SDSCs: much like the Phase 1 Analysis Framework (refer relevant section), but with more detail and less abstraction. It is not an architecture in the software engineering sense of the word.

[6] Deferred to Phase 2

1.3 Spatial Data Supply Chains (SDSC)

One of the core notions underpinning the development of Spatial Data Infrastructures is the idea that spatial information provides the common reference frame for domain information. (Kuhn, 2005)[7]. That is, spatial information and in particular, real world features form the framework that supports the repurposing of other information. This notion is key to such activities as the Bureau of Meteorology's Australian Hydrological Geospatial Fabric (AHGF) where the vision is for the AHGF to

> *"... become the framework geospatial information upon which Australia's water information related activities are based and through which they are related" (Atkinson et al 2008)*[8]

For such a framework to be useful, users and contributors need to have confidence in the currency, quality and continuity of spatial information. In particular they need to:

- Be confident they are using the correct information and that there will be continuity of that information into the future (single point of truth);
- Be confident that the information will remain current (updated in an appropriate timeframe) but that previous versions remain accessible (appropriate version management);
- Be able to use the data with limited manipulation - support the supply of the same information in many different forms or "supply views" (format, structure and scale);
- Be able to access information as and when needed;
- Be confident that the framework will support new use cases as and when they appear – e.g. the rise of sensors and volunteered geographic information (VGI).

As such, the 'spatial data supply chain' to produce and maintain these framework data sets is of particular interest to the development of robust, evolvable SDIs and the ANZSM. Formalisation and automation of the process means that data products will be consistent, have increased currency and can be traced back in time.

We argue that to deliver the objectives above, SDSC systems

- will have a single point of truth where relevant data elements can be cached, or value added data can be maintained;
- are continuously updatable from multiple sources;
- support the supply of the same information in many different forms or "supply views" (format and structure) to support the many tools that are used,
- support multiple versions of these products to support traceability and transparency,
- have automated update and distribution, and

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[7] Kuhn, W. (2005) Introduction to Spatial Data Infrastructures. Presentation held on March 14 2005 (http://www.docstoc.com/docs/2697206/Introduction-to-Spatial--Data-Infrastructures)

[8] Atkinson, R.A., Power, R., Lemon, D., O'Hagan, R., Dee, D., and Kinny, D. (2008). The Australian Hydrological Geospatial Fabric - development methodology and conceptual architecture. CSIRO Water for a Healthy Country National Research Flagship report. Australia: CSIRO (http://www.clw.csiro.au/forms/publications/details.aspx?ID=1317)

- enable automated input from e.g. sensors or volunteered geographic information (VGI).

The existence of these features will enable automated, flexible, and distributed end-to-end spatial data supply chain management. An example of a system that plans to implement these capabilities is the Australian Hydrological Geospatial Fabric (AHGF), which is schematically shown in Figure 2.

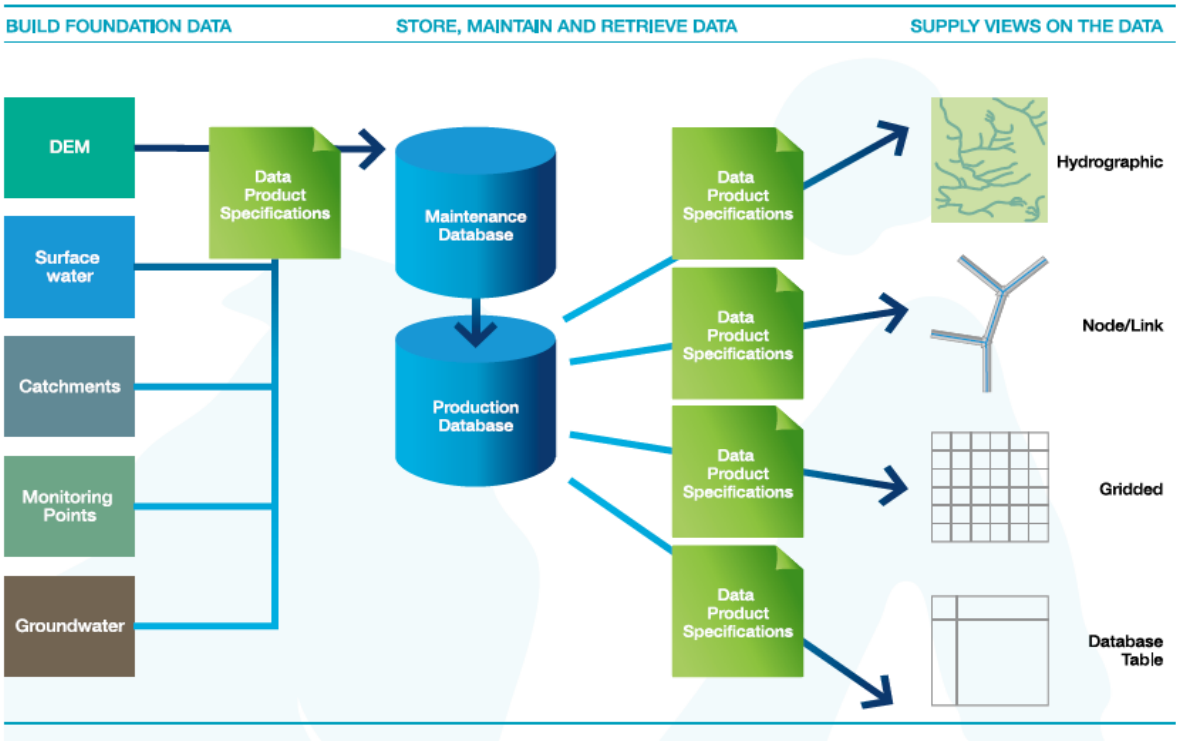

Figure 2 – Example AHGF Conceptual Architecture (from WIRADA 2009[9])

The premise of this study is that this capability represents the 'holy grail' in SDSC development and implementation, and poses a substantial challenge that is too big for any one organisation to overcome.

Governments in Australia and New Zealand are currently spending 10's of millions of dollars developing SDSC initiatives with similar and often overlapping capabilities[10]. Many of the CRCSI participants as well as others (e.g. in the eResearch community) see a huge opportunity to secure significant savings by reducing duplication of effort and finding opportunities to fully develop some of the existing components for production use or commercial exploitation.

1.4 Timeframe

The project kicked off in June 2011 and was concluded in January 2012.

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[9] Water Information Research and Development Alliance (WIRADA), Annual Report 2008-09.

[10] For just one illustrative example in the Natural Resource Management domain, see: http://www.nrm.gov.au/publications/data/index.html

2 Project Methodology

2.1 Project Identification & Response

Data Supply Chain Projects that were approached for this study were identified through a combination of methods:

- Existing awareness in CRC-SI networks
- Promotion through the CRC-SI New Zealand and subsequent NZ workshop
- Targeted approaches to jurisdictional representatives

A total of 38 organisations, projects and jurisdictions were approached, of which 34 provided complete responses (89%).

The responses include jurisdictional projects in NZ, the Australian Commonwealth, Victoria, Western Australia, New South Wales and Queensland. Several unsuccessful approaches were made to Tasmania[11].

See also: Appendix 1 – Full List of Projects

2.2 Analysis Framework

The project developed an "Analysis Framework" - a conceptual, generic workflow model that provides a baseline against which the supply chain initiatives can be mapped and evaluated. By defining a workflow and consistent terminology, it will be easier to compare apples with apples.

Respondents were presented with the Analysis Framework before entering project details. The Analysis Framework is listed in section 3, and is also available as part of the Project Summary online[12].

2.3 Project Survey

The Project Survey consisted of a combination of multiple choice and open questions, aimed primarily at identifying how projects implement the supply chain. All the questions are listed in Appendix 2 – Survey Questions.

Respondents could enter the survey responses in a spread sheet, or through an online form.

The survey responses are analysed in section 4.

2.4 Scientific Literature Review

Note that the Scientific Literature Review, as defined in section 1.2, has been deferred to Phase 2. This is the result of the unexpected withdrawal of the University of Melbourne, who were tasked with this review, as a project participant.

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[11] In addition an expression of interest call was sent to the ANZLIC national office for distribution to the jurisdictions, but this was not passed on to the ANZLIC jurisdictional officers in time for the survey.

[12] http://www.crcsi.com.au/getattachment/746fa7e2-774c-4852-a757-643ef45a6296/.aspx

3 Analysis Framework

The Analysis Framework is a conceptual, generic workflow model that provides a baseline against which the supply chain initiatives can be mapped and evaluated. By defining a workflow and consistent terminology, it will be easier to compare apples with apples.

Furthermore, by defining workflow components, it will assist in identifying challenges, current (better) practice solutions and R&D gaps on a component-by-component basis.

3.1 Terminology

From a quick review of published supply chain systems, it is apparent that there is little consistency in defined processes, components and associated terminology. The table below illustrates that by comparing the terminology used by VIC-DSE (for the VSDL), PSMA (Lynx) and BoM/CSIRO (Australian Hydrological Geospatial Fabric). The last two columns in the table list the adopted terminology for the Alignment Study, as well as some alternative terms used in the industry for similar process steps.

Table 1 Terminologies

DSE (VSDL)	PSMA (Lynx)	BoM/CSIRO (AHGF)	Alignment Study	*Alternative Terms*
Collect	Collect		**Collect**	
Publish		Build Foundation Data	**Publish**	*Ingest*
Aggregate & transform	Standardise	Data Product Specifications	**Standardise**	*Transform, Ingest*
Maintain	Integrate	Store, Maintain, Retrieve	**Integrate**	*Harmonise*
	Extract	Data Product Specifications	**Maintain**	*Replicate*
Product Generation		Supply Views of the Data	**Extract**	*ETL, Supply views*
Supply	Deliver		**Deliver**	*Supply, Ship, Serve*
			Use	*Consume*

Note that for the purposes of the Analysis Framework, ‘Collect’ and ‘Use’ are considered outside of the core supply-chain, as these are typically controlled by 3rd parties. Also, when we speak about ‘data’, we include both the data and its description (i.e. metadata).

Where data is passed-on unaltered from the collecting agent, they remain the custodian, and are often referred to as ‘point of truth'. Ideally, data requests from the user end should be fulfilled from custodial point of truth. However, there are many cases in SDSCs where this is either impractical (e.g. for

performance reasons) and the SDSC will maintain a so-called 'strong forward cache' (Atkinson, 2007)[13], or the SDSC process value-adds the original data in some way and will implement a maintenance & production database of value-added data.

3.2 Supply-Chain Model

Figure 3 below illustrates the steps defined in the previous section. A more detailed description and some examples are given in Table 2.

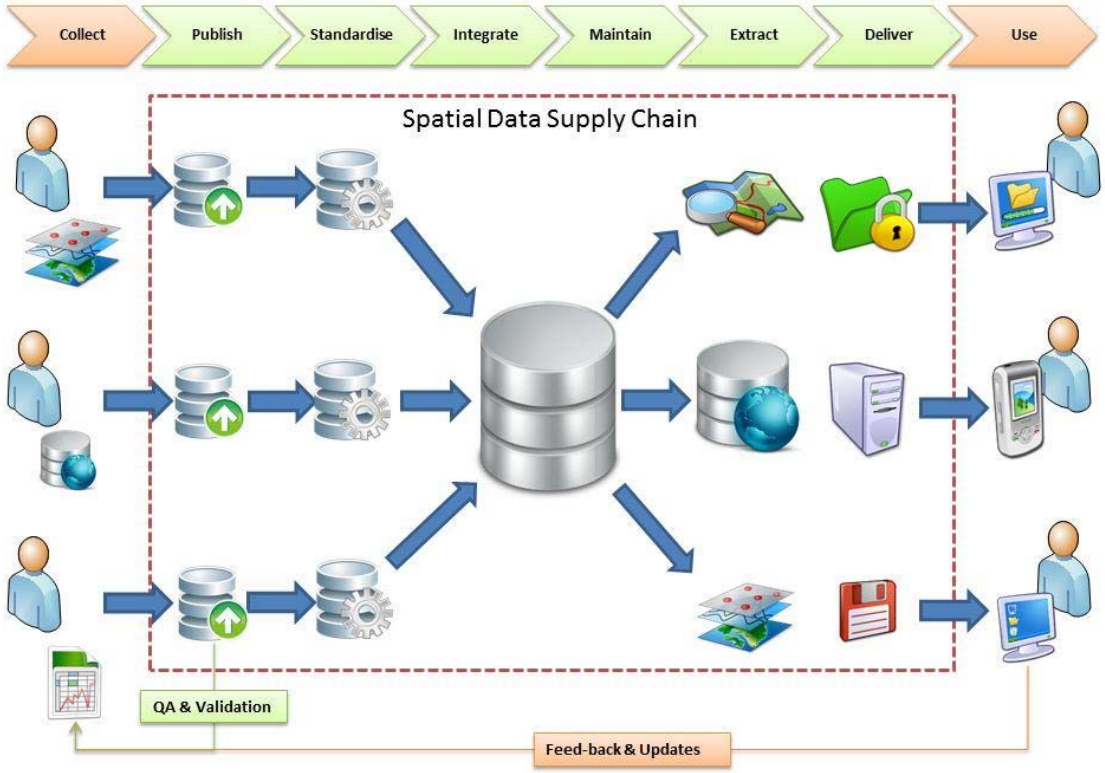


Figure 3 Conceptual Supply Chain Model

There are two key feed-back loops identified for the purposes of this study. At the Publishing stage, QA and validation processes (should) are performed, and any non-compliance is fed-back to the suppliers. Secondly, end-users will be feeding back requirements, updates and error reports.

Note that the Supply-Chain model as defined here is agnostic about data sets or data types. Especially for Phase 1 of the project which has a broad scope, there is no focus on specific data sets. However, datasets that have sufficient level of complexity in the supply chain (e.g. roads) should be included, and could be a good candidate for the (phase 3) demonstrator project.

The scope also includes governance arrangements, particularly around QA processes.

[13] Atkinson, Rob (2007), Technical Governance of Framework Data Services, White Paper prepared On behalf of UN Geographic Information Working Group.

Table 2 Supply Chain Components

	Supply Chain Components	Description	Examples
	Collect	Data collection (Sensors, Survey, UGC, etc.). Native storage & schemas. External (3rd party) custodianship	Jurisdictions collect & maintain road data
Supply Chain	Publish	Publishing collected data into supply chain. May (should?) involve metadata generation, validation and QA processes. Supply-chain custodian may prescribe discrete set of publishing standards	Submit updated road data set every 6 months to central custodian. With agreed metadata and attribute schemas, in GML format. Central Custodian validates compliance
Supply Chain	Standardise	Transformation of Data formats, schemas, semantics into a standard defined for the supply chain's central repository	Dataset and metadata converted into common schema and DB format for maintenance DB
Supply Chain	Integrate	Integrate standardised data from multiple providers into one repository (Single Point of Truth). May involve edge matching, semantic harmonisation, etc.	Data is integrated with national dataset, coordinate transformation and attribute harmonisation to ensure national consistency.
Supply Chain	Maintain	Maintenance of SPOT Production Database. May include versioning or replication (e.g. to to delivery DB)	Production DB (optimised for maintenance) is continually maintained, versioned and replicated to delivery DB (optimised for delivery, may be outside Firewall)
Supply Chain	Extract	The supply of the same information in many different forms or 'views', as data products or services. May involve extractions, transformation, semantic translations, rendering	'On demand' generation of regional roadmaps, road datasets with specific attributes for intelligent transport monitoring, and 4WD track maps
Supply Chain	Deliver	Delivery of data products to (end-) users. May involve e.g. (Clip) zip & ship, web services, incremental updates, and/or map production.	road datasets clipped for regions & converted to shapefiles. Downloadable via secure FTP. 4WD tracks published as Web Service.
	Use		Logistics company subscribes and regularly downloads national road dataset for route planning

4 Outcomes

This section presents the outcomes of the project survey.

4.1 Qualifications

- The analysis is based on the responses provided by the respective organisations, which is a self-assessment. No substantial validation of the responses has been undertaken;
- There are a relatively high number of responses from New Zealand. Our impression is that this reflects the promotional efforts of the NZ CRC-SI office; whereas no responses were received from some Australian jurisdictions.
- One respondent commented that in the Analysis Framework the 'Single Point of Truth', represented as a 'middle man' integrated database is not a reflection of how things are working in all such supply chains; especially across organisational boundaries where point of truth remains with the original (multiple) custodians.
- The projects and initiatives reviewed in this study are almost exclusively (semi-) government run, and thus excludes major private sector initiatives, which (we suspect) could provide valuable additional insights from e.g. Sensis, Google, PSMA VARs, or private sector imagery providers.

4.2 Summary Overview

	Does the Project/System:							Which Steps of the Supply Chain are Automated?						
Project Name	a. have a single point of truth ("Production Database")?	b. have continuous updates from multiple sources?	c. support the supply of the same information in many different forms and products ("supply views")?	d. support multiple versions of these products to support traceability and transparency?	e. have automated update and distribution?	f. enable automated input from e.g. sensors or volunteered geographic information (VGI)?	g. mandate the use of (open) standards for ingestion and delivery?	Publish	Standardise	Integrate	Maintain	Extract	Deliver	What is the maturity status of the project/system as a whole?
LINZ Data Service	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓	✓	✓	+
Maori Land Geographic Information System	✓	✓	✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓	+
PSMA Systems	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	++
SISS - Spatial Information Services Stack	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	+
SLIP Enabler	✓	✓	✓	×	✓	×	✓	✓	✓		✓	✓	✓	++
The Australian Hydrological Geospatial Fabric (Geofabric)	✓	✓	✓	✓	×	×	×	✓	✓	✓	✓	✓	✓	++
QLD SDI	✓	✓	✓	✓	×	✓	✓	✓			✓	✓	✓	+
Spatial Information Exchange (SIX) Clip n' Ship	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	+
VSDL - Victorian Spatial Data Library	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	+
LUCAS (Land Use and Carbon Analysis System)	✓	✓	✓	✓	×	×	✓	×	✓	×	✓	✓	✓	+/-
MapConnect	✓	×	✓	×	✓	×	×		✓	✓	✓	✓	✓	+
Petroleum and Minerals Permit Boundaries	✓	✓	✓	✓	✓	×	×			✓	✓	✓	✓	++
Petroleum and Minerals Technical Data	✓	✓	✓	✓	×	×	×				✓	✓	✓	++
QMAP Geology of New Zealand	✓	✓	✓	✓	×	×	✓	✓		✓				++
Road Asset Management Maintenance - RAMM	✓	✓	✓	✓	×	×	×	✓	✓			✓		+
WAMS - Walking Access Mapping System	✓	✓	×	×	✓	×	×	✓	✓	✓	✓	✓	✓	+
(eRUC) electronic Road User Charges	×	✓	✓		✓	✓		×	×	×	×		×	+/-
"LOC8WA" Points of Interest for Emergency Management	✓	✓	✓	✓	×	×	×		✓				✓	-
AURIN - The Australian Urban Research Infrastructure Network	×	✓	✓	✓	✓	✓	×		×		×			-
AusCover - remote sensing data facility within the Terrestrial Ecosystem Research Network (TERN)	✓	✓	✓	✓	✓		✓							+/-
Biosecurity Porthole	✓	✓	×	×	×	✓	✓	✓	✓	×	×	✓	✓	+/-
BOPLASS - Shared Geospatial Solutions	✓	✓	✓		✓	✓	✓		✓				✓	+/-
Centre for Environmental Information, NIWA	✓	✓	×	×	✓	✓	✓	✓	✓		✓		✓	-
Climate Change Information System	✓	✓	×	×	×	×	×	✓	✓	×	×	✓	✓	+
Farms On Line	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	+
FMO - Future mode of operation	✓	✓	✓	✓	✓	✓	✓							-
IMOS - Integrated Marine Observing System	✓	✓	✓	×	×	✓	✓							+/-
National Data Grid (NDG) Demonstrator, CRCSI	✓	×	✓	✓	✓	✓	✓			✓	✓	✓	✓	+/-
National Exposure Information System (NEXIS)	✓	×	✓	×	×	×	✓	✓	✓	✓	✓	✓	✓	-
NEII - National Environmental Information Infrastructure	×	✓					✓							-
New Zealand Defence Force - Spatial Data Infrastructure	×	✓	✓	✓	✓	×	✓	✓			✓	✓	✓	-
ROMAN II - WA road asset management software	✓	✓	✓		×	×	×		✓		×	✓	✓	+
UNSDI Gazetteer for Social Protection in Indonesia	×	✓	✓	✓	✓	×	✓							-
Database Replication	✓	✓	×	✓	✓		×				✓	✓	×	+/-

Legend	
✓	Pass
×	Fail
	Neutral/Unknown

4.3 Response Summaries

This section summarises the responses to the material survey questions. For the full list of questions, please refer to Appendix 2 – Survey Questions.

4.3.1 What is the Business Driver for your Project?

This was an open question. The responses fell roughly into 7 categories, with some projects giving multiple business drivers for their project.

Business Driver	No of Projects
Maintain a consistent, authoritative dataset to support evidence based decision making	11
Meet statutory obligations	9
Improve data access & sharing across organisations	8
Improve efficiency & reduce duplication	6
Publish data for scientific research	4
Improve value & service to stakeholders	4
Improve data quality	1

It is noteworthy that the primary business drivers seem internal or institutional drivers, while a 'pull' driver such as improving value to stakeholders comes second last.

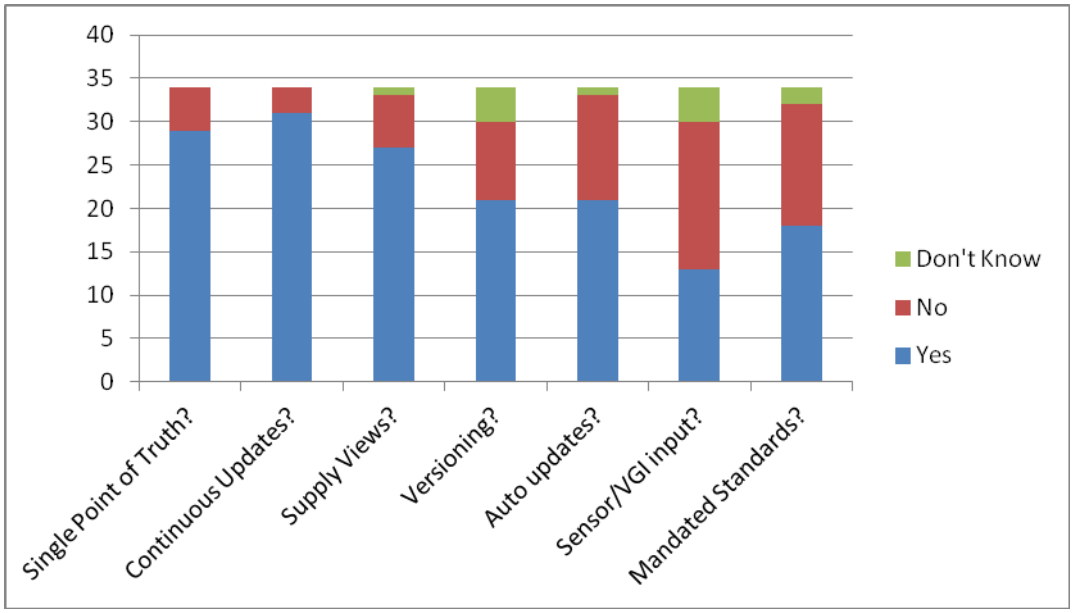
4.3.2 Who is the Audience/User Community?

This was an open question. The responses fell roughly into 4 categories, with some projects giving multiple audiences for their project.

Audience	No of Projects
Government agencies	27
Public organisations and business groups	16
Scientific Community	10
General Public	8

The strong focus on a government audience (27 of 34 projects) is consistent with the identified business drivers.

4.3.3 Does the Project/System have:



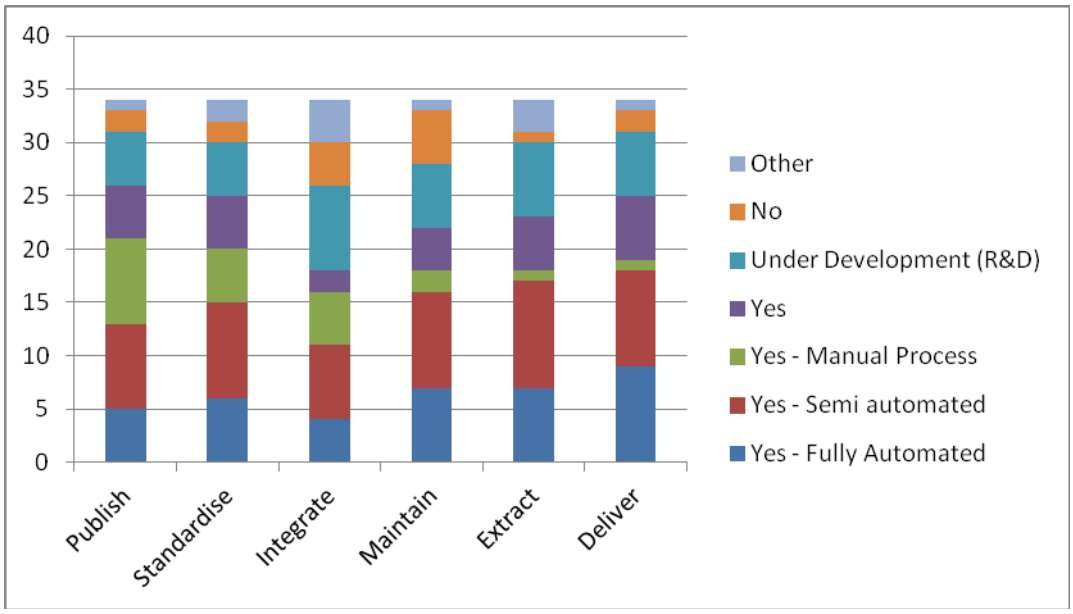
This question addresses the key technical capabilities underpinning SDSCs, as listed in section 3.2.

Not entirely surprisingly, almost all projects have a Single Point of Truth data store, and facilitate Continuous Updates. Other key ingredients of spatial data supply chains are less frequently present, while sensor- and VGI input capabilities exist in only one third of the projects.

4.3.4 Which Steps of the Supply Chain are implemented?

This question captures which elements of the Supply Chain as defined in the Analysis Framework (see 3.2) are implemented by the projects in questions, and how, i.e. are they manual, automated or still under development?[14]

[14] Note that due to an error in some of the surveys, six (New Zealand) projects only had yes/no response categories available here.

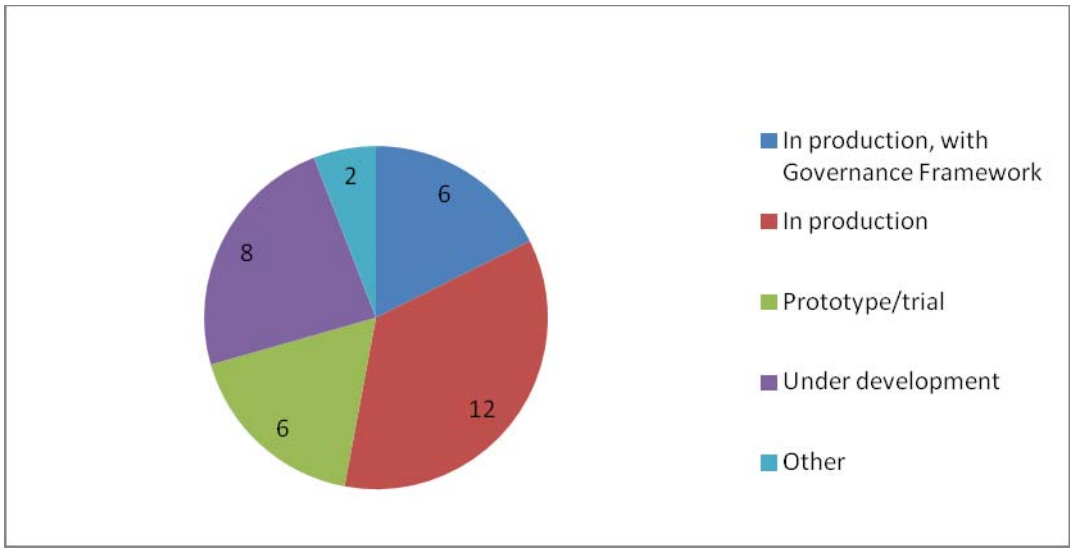


Observations:

- Most projects implement Publish, Standardise, Extract and Deliver;
- Most implementations are either manual or semi-automated;
- Maintenance, Extraction and Delivery are the most fully-automated steps;
- A significant number of projects have key steps still under development.
- The biggest challenges for implementing fully automated steps seem to lie with the Publish, Standardise, Integration and Maintenance steps.

4.3.5 What is the maturity status of the project/system as a whole?

This question determines the maturity status of a project, whether it's under development, in prototype or production, and if there are sustainable governance arrangements in place.



It turns out that just over half of the surveyed projects are in production, and only six of these admit having a long-term governance framework in place. The remainder are either in development or running a trial or prototype.

This result supports the assumption underlying the Alignment Study that mature, automated spatial data supply chains are still in their infancy, and could benefit from co-ordination of these developments, avoiding duplication of effort, wasted investment and missed opportunities.

4.3.6 What, if any, standards are applied in the Supply Chain?

This was an open question, which 25/29 respondents answered. The responses fell roughly into 6 categories, with most projects applying multiple types of standards.

Standards	No of Projects
Open APIs (e.g. OGC standards, REST, SOAP, SDMX)	11
Open Metadata standards (incl. ISO 19115, ANZLIC)	10
Open data model/schema standards (e.g. POSC)	8
Internal/Proprietary standards	8
Business Process/Quality Control	3
National Standards Frameworks (NZ e-GIF)	2

Though OGC, ISO and ANZLIC standards are well known and generally understood to be 'best practice', only about a third of the respondents specifically indicated their projects currently implement them.

It is somewhat surprising that no projects made specific mention of the use of Data Access & Licensing standards such as Creative Commons.

4.4 Gaps, Overlaps and Opportunities

Within the group of reviewed projects, we can identify a number of possible areas of capability gaps, overlaps and potential for collaboration. Note that the information gathered in this phase of the alignment study can only identify such possible areas. More in-depth investigation in phase 2 would be required to assess this more definitively.

4.4.1 Capability Gaps

As noted before (Section 4.3.5), mature, automated spatial data supply chains are still in their infancy in Australia and New Zealand. Only a minority of steps in the reviewed supply chains are fully automated (10-20%), and only 9 projects (semi-) automate the entire supply chain.

Assuming the aspiration of each of the projects is to automate as much of the process as possible, there are still serious capability gaps, which cannot be explained by project maturity alone.

Among the reviewed projects, the capability for automated publishing and integration are the least developed, markedly less than the other supply chain steps.

Other gaps include the apparent lack of implementation of data access & licensing standards such as creative commons, though it is unclear whether this is a capability or an awareness gap.

4.4.2 Overlaps

A significant proportion of projects indicate they are doing developing and or researching the automation of supply chain steps.

Development activities take place in all stages of the supply chain, but most R&D seems to take place in the areas of automated integration (integration of data from multiple providers into one repository) and extraction (supply of the same information in many different forms or 'views', as data products or services).

These could be obvious areas for collaboration and co-investment, and would need to be more closely assessed in phase 2 of the alignment study, looking at the common challenges in these areas and how they are being addressed, aiming at avoiding duplication of effort.

4.4.3 Opportunities

Ample opportunities for knowledge sharing suggest themselves: any areas where one organisation does development, and another may have already automated it. Examples would include automated integration, which is already automated by PSMA and LINZ, but under development by others such as Landgate, NZ NIWA and the Bureau of Meteorology.

The viability of such knowledge sharing will of course depend on the technical details, as well as the ability of organisations to share their IP or that of their implementation partners. This will be assessed as part of Phase 2.

5 Shortlist for Further Review in Phase 2

5.1 Guiding Principles

- The objective of this phase is to perform an inventory of relevant projects and create a shortlist for further exploration;
- Projects are shortlisted based on relevance and merit for phase 2 alignment analysis;
- The shortlisting process does not imply any judgment about the quality, success or business relevance of the individual projects;
- Projects will need to have automated several critical components in the Analysis Framework to be included.

5.2 'Best of Breed' Criteria

To qualify as 'best of breed', a project must be able to serve as a 'best practice' example, encompassing the research, development or implementation of SDSC components.

To serve as best practice (and thus be seen as best-of-breed), it need not have the full SDSC implemented and automated. Yet, it will need to have automated key critical elements of the supply chain, and have sufficient project maturity, and/or will have R&D outcomes and operational experience that can be shared with the community.

We define these critical elements as those that are the minimum requirement for a capability to collect, update, store and distribute spatial information, that is they will have:

- have continuous updates from multiple sources;
- have a single point of truth (or 'production database');
- support the supply of the same information in many different forms and products ("supply views");

Thus, in terms of our Analysis Framework, best-of-breed projects automate or semi-automate at least the 'publish', 'maintain' and 'extract' SDSC components.

Finally, best-of-breed projects will be fully matured, that is they are currently in production, preferably with a long-term, sustainable governance framework in place.

5.3 Shortlist for Phase 2

Projects that meet the selection criteria above are (in alphabetical order):

10. LINZ Data Service
11. Maori Land Geographic Information System
12. PSMA Systems
13. QLD SDI
14. SISS - Spatial Information Services Stack
15. SLIP Enabler
16. Spatial Information Exchange (SIX) Clip n' Ship
17. The Australian Hydrological Geospatial Fabric (Geofabric)
18. VSDL - Victorian Spatial Data Library

19.

While most projects (aim to) implement an SDSC, two (SLIP and SISS) provide a suite of tools specifically tailored for SDI and SDSC implementation.

Other projects close to meeting these criteria are:

- "LOC8WA" Points of Interest for Emergency Management (still under development)
- Farms On Line (doesn't support multiple supply views)
- MapConnect (no continuous updates from multiple sources)
- WAMS - Walking Access Mapping System (doesn't support multiple supply views)
- LUCAS - Land Use and Carbon Analysis System (doesn't implement 'publish' step)
- Petroleum and Minerals Permit Boundaries (doesn't automate 'publish' step)
- Petroleum and Minerals Technical Data (doesn't automate 'publish' step)
- QMAP Geology of New Zealand (doesn't automate 'maintain' and 'extract' steps)
- RAMM - Road Asset Management Maintenance (doesn't automate 'maintain' step)

Table 3 Description of Shortlisted Projects

Project	Organisation	Description
LINZ Data Service	Land Information New Zealand	SDI provider node for LINZ data
Maori Land Geographic Information System	Ministry of Justice, New Zealand	In order to improve services to public Maori land owners and internal staff the Maori Land Court initiated a project to geospatially enable its www.maorilandonline.govt.
PSMA Systems	PSMA Australia Limited	PSMA Systems is the overarching product/project name to the capabilities PSMA Australia has built, and has in the pipeline to be built, to achieve the following key requirements: a. greater levels of quality (coverage, accuracy, completeness); b. flexibility of delivery (both the method of delivery and the form of the data to be delivered); c. greater range of data and the harmonisation of that data to aid analysis and new product development; and d. support for infrastructure and environments that enable rich blending of spatial products and services in near real-time.
SISS - Spatial Information Services Stack	CSIRO	The Spatial Information Services Stack (SISS) is a suite of tools for spatial data interoperability. SISS uses OGC standards, GML application schema, modelling tools, vocabulary support services and registries. AuScope is deploying the SISS in multiple Australian Government agencies and research organisations. SISS is not single SDSC, but as a suite of tools an enabler for SDSC implementation.

Project	Organisation	Description
SLIP Enabler	Landgate	The Shared Land Information Platform (SLIP Enabler) is a Government program aimed at increasing agency participation and collaboration by sharing information through a common platform. As a technology enabler, it's not a single SDSC per-se, but provides a suite of tools as a platform to enable SDSC implementation.
The Australian Hydrological Geospatial Fabric (Geofabric)	Bureau of Meteorology	The Australian Hydrological Geospatial Fabric (Geofabric) is a specialised Geographic Information System (GIS). It identifies the spatial relationships of important hydrological features such as rivers, lakes, water storages and catchments. By detailing the spatial dimensions of these features, their connections and spatial relationships, models can be developed to show how water is stored, transported and used through the landscape.
Spatial Information Exchange (SIX) Clip n' Ship	NSW Land and Property Information (LPI)	Provide vector and raster data discovery and extract
QLD SDI	QLD Department of Environment and Resource Management (DERM)	QLD SDI around DERM Framework.
VSDL - Victorian Spatial Data Library	Department of Sustainability and Environment	Store of Victorian Government's authoritative spatial information

6 Conclusions

Though there are many initiatives under way, mature, automated SDSCs seem to be still in their infancy in Australia and New Zealand.

The projects reviewed in this study are almost exclusively (semi-) government initiatives, with a strong technical/data focus and internal or statutory business cases. This study has not looked at what supply chains exist in the private sector.

The study used the concept of an Analysis Framework to model the different projects against. This was generally well received by the respondents, and helped assess the different projects in relation to each other.

The projects reviewed show a wide variety in levels of implementation and automation of the supply chain components defined in the Analysis framework. Only a minority of steps in the reviewed supply chains are fully automated (10-20%), and only 9 projects (semi-) automate the entire supply chain.

Half the initiatives are in pre-production stages, and only 6 out of 34 admitted to having a full, long term sustainable governance framework in place.

Within the group of reviewed projects, we can identify a number of possible areas of capability gaps, overlaps and potential for collaboration. Note that the information gathered in this phase of the alignment study can only identify such possible areas. More in-depth investigation in phase 2 will be required to assess this more definitively.

A significant proportion of projects indicate they are doing developing and or researching the automation of supply chain steps. These could be obvious areas for collaboration and co-investment, and would need to be more closely assessed in phase 2 of the alignment study, looking at the common challenges in these areas and how they are being addressed, aiming at avoiding duplication of effort.

Ample of opportunities for knowledge sharing suggest themselves: any areas where one organisation does development, and another may have already automated it. The viability of such knowledge sharing will of course depend on the technical details, as well as the ability of organisations to share their IP or that of their implementation partners. This should be an important part of the scope of the next stage of the Alignment Study.

Out of the 34 surveyed projects, nine are shortlisted for further review in the next stage:

1. LINZ Data Service
2. Maori Land Geographic Information System
3. PSMA Systems
4. QLD SDI
5. SISS - Spatial Information Services Stack
6. SLIP Enabler
7. Spatial Information Exchange (SIX) Clip n' Ship
8. The Australian Hydrological Geospatial Fabric (Geofabric)
9. VSDL - Victorian Spatial Data Library

The next stage (phase 2) of the study should encompass:

- International Scientific Review (deferred from phase 1);
- Validation of Phase 1 outcomes and project shortlist

- Further refinement and validation of the Analysis Framework;
- Confirmation and detailed technical review of shortlisted projects;
- Development of a ‘Reference Architecture’;
- Identification of challenges and technology options for the supply chain components
- Recommendations for collaboration and an R&D agenda
- Proposal for a collaborative demonstration project

Appendix 1 – Full List of Projects

Status	Project	Lead organisation	Name
Survey Completed	ROMAN 2	Main Roads WA & WALGA	Graham Lantzke
Survey Completed	AURIN (Australian Urban Research Infrastructure Network)	University of Melbourne	Martin Tomko
Survey Completed	National Map (NatMap) / MapConnect	GA	Dmitar Butrovski, Russel Hay
Survey Completed	Data Hosting and Direct Editing	Landgate and Dept Environment and Conservation	Marty Stamatis
Survey Completed	VSDL	VIC DSE	Cathy Crooks
Survey Completed	National Data Grid Demonstrator (NDG)	VIC DSE	Cathy Crooks
Survey Completed	Centre for Environmental Information	NZ NIWA (National Institute of Water and Atmosphere)	Jochem Schmidt
Survey Completed	Auscope SISS (Spatial Information Services Stack)	CSIRO	Robert Woodcock
Survey Completed	Maori Land Geographic Information System	Minsitry of Justice / Maori Land Court	James Collier
Survey Completed	NEII (National Environmental Information Infrastructure)	BoM	Andrew Woolf
Survey received 1/8	LUCAS	Ministry for the Environment	Deborah Burgess
Survey received 1/8	Petroleum and Minerals Permit Boundaries	New Zealand Petroleum & Minerals	Rebecca Schulz
Survey received 1/8	Petroleum and Minerals Permit Boundaries	New Zealand Petroleum & Minerals	Rebecca Schulz
Survey received 1/8	New Zealand Defence Force - Spatial Data Infrastructure	Geospatial Intelligence Organisation, NZDF	Steve Pyatt / Richard Wells
Survey Received 29/7	Climate Change Information System (CCIS)	MAF/Fisheries	Grant Johnson
Survey Received 29/7	Farms On Line	MAF	Phillip Viviers
Survey Received 29/7	Biosecurity Porthole	MAF, NIWA	Hernando Acosta
Survey received 3/8	electronic Road User Charges (eRUC)	NZ Transport Agency	Manu King
Survey Completed	NEXIS (National Exposure Information System)	GA	Krishna Nadimpalli

Status	Project	Lead organisation	Name
Survey Completed	SLIP Enabler	WA - Landgate	Darren Mottolini
Survey Completed	LOC8WA	WA Police, FESA and Landgate	Simon Abbott
Survey Completed	IMOS - Integrated Marine Observing System	University of Tasmania	Simon Allen
Survey Completed	LINZ Data Service	LINZ	Ron Munro
Survey Completed	RAMM	Critchlow	Russel Bowden
Survey completed	BOPLASS - Shared Geospatial Solutions	Bay of Plenty (BOPLASS)	Dave Withington
Survey completed	AHGF - Australian Hydrological GeoFabric	Bureau of Meteorology (BoM)	Matt Brooks Elizabeth McDonald
Survey completed	QMAP Geology of New Zealand	NZ Institute of Geological and Nuclear Sciences	David Heron
Survey completed	UN Spatial Data Infrastructure (UNSDI)	UN/CSIRO	Paul Box
Survey completed	Auscover / Terrestrial Ecosystem Research Network (TERN)	CSIRO Marine and Atmospheric Research in Canberra	Alex Held Matt Paget
Survey Completed	Offline/version maintenance of Hydro Data	Landgate/Dept of Water	Marty Stamatis Ford, Richard
Survey completed	Lynx	PSMA Australia	Gerry Stanley
Survey completed	FMO - Future mode of operation	Auckland Council	Ian Smith
Sent reminder	iSpatial	WA - Landgate	Marty Stamatis
Sent reminder	SDI initiatives?	Wellington City Council	Michael Brownie
Sent reminder	SDI initiatives?	NZ Fire Service	Stuart Waring
Sent reminder	SDI initiatives?	Department of Conservation (DoC)	James Reid
Survey completed	SiX	NSW LPMA/LPI	Pedro Harris, Des Mooney
Sent reminder	LIST	Tasmanian Government	Matthew Healey
Survey completed	Queensland Government Information Service	QLD Government	Steve Jacoby

Appendix 2 – Survey Questions

Please help us with the information gathering for the CRCSI Alignment Study.
If you have a project, system or initiative that (aims to) implement a spatial data supply chain, please let us know by filling out the short survey below, and returning this sheet to the Project Leader Maurits van der Vlugt maurits.vandervlugt@mercuryps.com.au.

Project Details

Name & Acronym	
Website	
Lead Organisation	
Contact : Name	
Contact : Role	
Contact : Phone	
Contact : eMail	

About the Project

Description	
What is the business driver for your project?	
Who is the audience/user community?	

General Criteria

Does the project/system:

a. have a single point of truth ("Production Database")?	*Yes, No, Don't know*
b. have continuous updates from multiple sources?	*Yes, No, Don't know*
c. support the supply of the same information in many different forms and products ("supply views")?	*Yes, No, Don't know*
d. support multiple versions of these products to support traceability and transparency?	*Yes, No, Don't know*
e. have automated update and distribution?	*Yes, No, Don't know*
f. enable automated input from e.g. sensors or volunteered geographic information (VGI)?	*Yes, No, Don't know*
g. mandate the use of (open) standards for ingestion and delivery?	*Yes, No, Don't know*

Analysis Framework (refer to diagram & table)

What components of the Analysis Framework does the project/system implement?

a. Publish	*Not implemented, Yes - Fully Automated, Yes -*

	Semi automated, Yes - Manual Process, Under Development (R&D), Other: …
If other, please describe:	
b. Standardise	*Not implemented, Yes - Fully Automated, Yes - Semi automated, Yes - Manual Process, Under Development (R&D), Other: …*
If other, please describe:	
c. Integrate	*Not implemented, Yes - Fully Automated, Yes - Semi automated, Yes - Manual Process, Under Development (R&D), Other: …*
If other, please describe:	
d. Maintain	*Not implemented, Yes - Fully Automated, Yes - Semi automated, Yes - Manual Process, Under Development (R&D), Other: …*
If other, please describe:	
e. Extract Products	*Not implemented, Yes - Fully Automated, Yes - Semi automated, Yes - Manual Process, Under Development (R&D), Other: …*
If other, please describe:	
f. Deliver	*Not implemented, Yes - Fully Automated, Yes - Semi automated, Yes - Manual Process, Under Development (R&D), Other: …*
If other, please describe:	

Project Maturity

What is the maturity status of the project/system as a whole?	*Under development, Prototype/trial, In production, In production with long-term, sustainable governance framework in place, Other: …*
If other, please describe:	

Standards

What standards are applied in the Supply-Chain (including publishing and delivery)?	

Appendix 3 - Phase 2 Proposal

Phase 2 will comprise a detailed alignment study that identifies substantive and well supported research questions for Program 3.

Objectives

- Substantive and well supported research agenda
- Specific collaboration and research opportunities
- Defining a collaborative demonstration project exhibiting capabilities and opportunities

Scope

The proposed scope is summarised in the table below.

Phase	In Scope	Out of Scope	Tasks	Deliverables
2 - Alignment Study Phase 2				
	International Scientific Literature Review[15]		Conduct review	'Current scientific status' report Research Paper(s)
	Validation of Ph1 outcomes	Open call for projects	Confirm findings with shortlisted projects Review and validate Analysis Framework with participants	Validated Analysis Framework and project shortlist
	Detailed review of shortlisted initiatives	Systems/Software Implementation	Workshop to identify current best practice, key workflow requirements and knowledge gaps Develop Reference Architecture	Reference Architecture: - Workflows & Business Processes - Modules - Interfaces - Standards - Implementing technologies - Gaps & Overlaps
	Selected site visits/interviews		Analyse shortlisted initiatives in relation to Reference Architecture	Detailed project assessment Identification of challenges and technology options for the supply chain

[15] Deferred from Ph 1

Phase	In Scope	Out of Scope	Tasks	Deliverables
				components
	Identification of synergies, gaps and overlaps		'Planning' workshop to determine alignment recommendations and R&D agenda	Recommendations for Alignment and Collaboration
				Barriers to implementation
				Input to Research Agenda
	Project Management		Develop proposal for Demonstration Project	Proposal for Demo Project
			Write project report	Project outcomes report
			Dissemination: - presentations to participants - major industry events	
			Project Management & Coordination	

After completion of Phase 1, the following considerations have been raised for inclusion in Phase 2:

- Try to include Local government, to ensure full end-to-end supply chain across 3 tiers of government is covered;
- The Reference Architecture will need to address integration of 'spatial' data that goes beyond geometric data, i.e. the separation of identity and representation of spatial features, and the integration of knowledge or attributes from multiple sources with common geometry (e.g. roads – as implemented in RAMM);
- The Ph 1 survey outcomes are based on self assessment. Ph 2 will need validation to confirm and validate shortlisted and 'almost' shortlisted projects;
- The term 'Reference Architecture' needs to be clarified that it is intended to be a framework model for comparing technical detail, solutions and R&D Gaps of data supply chains: much like the Ph. 1 Analysis Framework, but with much more detail and less abstraction;
- Some good opportunities may exist for collaboration for Ph. 2, including NEII (developing Reference Architecture) and the APS200 location project;
- Definition of the Reference Architecture will be critical, and there should be a joint workshopping day early in Phase 2.

Timeline

It is anticipated that Phase 2 can be conducted in a 6-8 month timeframe.