

AUSTRALIA'S DEVELOPING GIS INFRASTRUCTURE - ACHIEVEMENTS AND CHALLENGES FROM A FEDERAL PERSPECTIVE.

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ABSTRACT

Australia has a relatively advanced GIS infrastructure with well developed policies, data and technology. Over recent years this infrastructure has been defined as the Australian Spatial Data Infrastructure (ASDI) which conforms to a large degree to other National Spatial Data Infrastructures. The Australia New Zealand Land Information Council (ANZLIC) released its discussion paper on the ASDI in 1996. Since then, there has been considerable discussion of the nature of the ASDI and how it should be implemented. There has also been a substantial amount of work done to implement various components of the ASDI.

Australia's federal system of government places a large responsibility for land management issues on state levels of government. Local government, the third tier of government in Australia also has some responsibility in this area, especially in relation to planning of land use and provision of local services. The federal government is a large producer and user of geographic information for national applications and plays a leading role in the coordination of the national activities of the various governments through established coordinating bodies such as ANZLIC. Also there are a number of national projects undertaken by the federal government that rely on being able to access, integrate and analyse data from numerous data custodians at the federal, state and local government levels.

The ASDI initiative has delivered significant achievements in areas that will improve the ability of users to access and integrate geographic information from numerous agencies that produce it. This paper will cover these initiatives and also look at the challenges that remain in fully realising the vision of the ASDI "*To provide better access for all Australians to essential spatial data*".

Keywords: Australian Spatial Data Infrastructure, GIS, ANZLIC, AUSLIG

1. INTRODUCTION

1.1 Drivers for GIS Development

GIS information products have traditionally been used by decision makers to improve economic, social and environmental conditions in the real world. Increasingly GI is being incorporated into business systems and used within industry to improve efficiency and competitiveness.

Technology development is now providing tools to enable GIS to be brought into the mainstream of information management. High powered computers, better graphics, improved bandwidth and communications, ease of use and of course the Internet and interoperability are all factors contributing towards this trend. As economies rely more on knowledge management to be competitive this is becoming increasingly important. There is a growing use of geographic information and GIS amongst government departments and businesses that are increasingly incorporating GI into their corporate databases.

This improved technology and greater penetration of GIS into government and business is also driving the need for access to reliable and accurate geographic information.

Experience is showing us that it is no longer the technology that is the impediment for GIS industry growth but the availability of standards compliant, accurate data that meets user requirements. In Australia, where there are a large number of government agencies across the different jurisdictions controlling much of the geographic information, the issue of access arrangements, including pricing and licensing to this data is currently an obstacle.

From this it follows that, while the technological framework can be upgraded or replaced with new developments, the investment in developing standards compliant data and associated whole of government policies for ensuring access to these data is vitally important. The improving availability of GIS data is providing opportunities for industry to value add these data and become more involved with GIS.

1.2 The National Development Strategy for GIS in Australia

The overall objective of developing a national geographic data infrastructure is to achieve better outcomes for the nation through better economic, social and environmental decision-making. The availability of standards compliant fundamental geographic datasets is essential if the full potential of GIS technology is to be realised in supporting those decision making processes. Recognising that the cost, quality and longevity of geographic data are critical in the application of the technology, the specific objectives in developing a national geographic data infrastructure should be to:

- produce standardised fundamental geographic datasets;
- avoid unnecessary duplication of cost in developing and maintaining those data;
- facilitate access to and application of those data;
- enable integration of other application-specific data by all users (value-adding).

The underlying philosophy to this approach is that fundamental geographic data are a national resource, which must be managed in the national interest.

1.3 The Importance of Coordination of Activities

The division of responsibilities between the 3 levels of government in Australia, Federal, State and Local makes it important to coordinate geographic information activities to avoid duplication and to facilitate sharing of data across the jurisdictions. The peak coordinating council for geographic information in Australia is The Australia New Zealand Land Information Council, which has representatives from all levels of government. Industry is also represented through a standing committee on industry development.

Broadly speaking the responsibilities of the different levels of government are given in Table 1.

Federal Government	State Government	Local Government
Taxation	Law Enforcement	Town Planning
Defence	Education	Local Roads
Trade and Foreign Affairs including International Treaties	Transport	Rates
Social Security	Health Services	Local Environment
Astronomical Observations and Navigation	Land Management	Essential local infrastructure
Statistics	Agriculture	

Table 1 A broad overview of the responsibilities of the various levels of government in Australia

The level of autonomy of state and territory governments in Australia can sometimes cause difficulties at arriving at consistent national approaches to issues, however this autonomy has resulted in effective land management infrastructures in each jurisdiction. It is in effect a distributed as opposed to a centralised model. Also the relatively small number of state level governments (6 states and 2 territory governments) makes coordination achievable in Australia. This contrasts with the United States of America where the number of states makes meeting and agreeing on issues far more difficult.

The model for the Australian Spatial Data Infrastructure (ASDI) is in essence a combination of the jurisdictional level spatial data infrastructures whereby the ASDI provides the “glue” to enable these jurisdictional SDIs to interoperate. The national challenge is to ensure standards are developed and applied at both the technical and policy levels so that national datasets can be derived from jurisdictional data, although there will always remain reasons for federal agencies to produce

nationally consistent datasets where it is not feasible to simply “sew together” data available from states and territories.

The federal government coordinates its geographic information activities through the Commonwealth Spatial Data Committee (CSDC). This Committee consists of the major federal government spatial data users and producers. The Chair of CSDC represents the federal government on ANZLIC.

2. PROGRESS TOWARDS IMPLEMENTATION OF THE AUSTRALIAN SPATIAL DATA INFRASTRUCTURE

2.1 The Development of a Policy for Access and Pricing of Geographic Information

This is one of the most difficult areas for all governments to agree on.

ANZLIC convened a workshop in May 2000 to develop a common approach for access to fundamental geographic information. This workshop identified and prioritised a number of issues requiring further action. The top 8 issues are summarised below:

1. Institutional arrangements
2. Access to data
3. Custodianship
4. Engagement of the private sector
5. The need for a national information office to facilitate access to government data
6. Standards
7. Metadata
8. A common clearinghouse technology framework

Access to data and the administrative and licensing conditions, including the price of data charged by data custodians emerged as the main issue from the workshop. Private sector participants were particularly focussed on this area.

A comparison of the access and pricing policies in each jurisdiction reveals significant variations in both the prices and access conditions. In some jurisdictions, whole of government pricing and access policies apply while in other jurisdictions this is left up to individual agencies.

The New Zealand policy of access to government data is currently the least restrictive with low prices set for access and no royalty payments required for users wishing to value add and on sell the data. At the other end of the spectrum are agencies that charge a high price for data and require licences and royalties for users. Some jurisdictions have policies to provide data at minimal cost to other government agencies for internal use. An example of the variation in prices of the state/territory cadastral database across Australian jurisdictions is given in table 2.

State/Territory	Price
Northern Territory	\$2000
Victoria	\$5,500
South Australia	\$10,000
Australian Capital Territory	\$26,150

Queensland	\$87,500
Tasmania	\$189,000
Western Australia	\$200,000
New South Wales	\$4,725,000

Table 2. The price for cadastral database in Australia in November 1999
(These prices are possibly not current as jurisdictions continue to review prices)

In recognition of the importance for a consistent whole of government approach to access and pricing of geographic information, the federal government of Australia is currently developing a new policy that will apply to fundamental geographic information nominated in a schedule. This policy will be available towards the end of this year.

2.2 Development of Fundamental Data

The Commonwealth Spatial Data Committee has developed a list of fundamental and framework data that are considered important for national applications. **Framework** datasets describe those primary *fundamental* datasets that provide essential base information for multiple national requirements. They are the priority subset of *fundamental* datasets and provide the foundation on which organisations can create other datasets by overlaying their own thematic detail.

Information Needs	Requirements for Framework Datasets										
	Geodetic Control	Official Place Names	Populated Places	Elevation	Water Features	Transport	Administrative Boundaries	Property	Bathymetry	Land Cover, Use	Satellite Imagery
Major national responsibilities which require accurate spatial information products											
Defence, National Security, Disaster Management	√	√	√	√	√	√	√	√	√	√	√
Environmental Protection and Management, Sustainable Land Management.	√	√	√	√	√	√	√	√	√	√	√
Primary Industry; Natural Resources Management; Resource Industries Management	√	√	√	√	√	√	√	√	√	√	√
Land Management Policy, incl. Native Title	√	√	√	√	√	√	√	√		√	√
National Statistical Service, Community Services Policy (incl. health & education), Regional Infrastructure Development	√	√	√		√	√	√	√		√	√
Communications Infrastructure, Transport Infrastructure, Navigation	√	√	√	√	√	√	√	√	√	√	√
Weather Forecasting, Climate	√	√	√	√	√				√	√	

Modelling											
Commonwealth Asset Management/Utilisation	√	√	√	√	√	√	√	√		√	√
Electoral Boundary Determination	√	√	√		√	√	√	√			
International Treaties & Conventions, Offshore Territories	√	√	√				√		√	√	√

Table 3 Framework datasets required for national responsibilities

2.2.1 Ensuring the Quality of Data

The CSDC has embraced a process of “Compliance Auditing” of fundamental geographic information. This process is aimed at ensuring that fundamental geographic information meets a number of agreed compliance criteria that have been agreed. These criteria are given below.

Content/extent

The data are nationally consistent.

The data are nationally significant (A small geographic coverage could still be nationally significant).

Sponsorship

A sponsor has been identified for the data.

The sponsor complies with ANZLIC guidelines:

- Liaises and cooperates with ANZLIC and other sponsors to ensure that data are assembled, maintained and delivered in a nationally consistent way
- Consults with users to disseminate information about the data
- Fosters efficient use of the data
- Coordinates data collection to minimise duplication
- Provides leadership in developing standards for content, quality and transfer

Custodianship

Data custodians have been identified. For each ASDI data layer, there may be many data custodians.

Custodians comply with ANZLIC custodianship guidelines:

- Ensures the spatial information under their custodianship is accessible.
- Consults with the national sponsor and user community to determine data needs and priorities before developing or defining collection or maintenance programs.
- Avoids duplication of capture, by ensuring, in conjunction with the national sponsor, that data to be captured is not already held.
- Develops, with the national sponsor and users, appropriate standards for the management and use of the fundamental data in their care.
- Ensures that the data under their custodianship conform to appropriate national, international or agreed standards.
- Provides full and frank quality statements regarding source, reliability, accuracy, completeness and currency.
- Maintains the quality of the data.
- Ensures appropriate storage, maintenance, security and archival procedures for their spatial information.

- Safeguards the Government's interest in the use of its information through licensing agreements or letters of understanding to protect privacy and confidentiality and interpretation of the information.
- Provides a single point of contact for inquiries about the fundamental data under their care.

Access Arrangements

Data are available "off the shelf" - accessible and readily available.

Conditions of use are documented and pricing/licensing arrangements are available.

Format

Data are available in well recognised / supported digital format suitable for interchange of the data.

Metadata (data documentation)

Metadata meet ANZLIC guidelines, are complete & meaningful for all ANZLIC essential metadata elements.

Information about scale/resolution, georeferencing information (datum, map projection type and parameters) are supplied with the data.

Metadata are available on the Australian Spatial Data Directory.

Metadata are always supplied with the data.

Standards

The data meets relevant international / national standards or guidelines.

The data model is documented and available.

Data dictionary describing the data is up-to-date and available.

The data are GDA94 compliant (ie available on the Geodetic Datum of Australia).

Quality Assurance

Satisfactory quality assurance procedures are in place to ensure that the data quality is correct as documented in metadata. In particular, mechanisms are in place to evaluate spatial accuracy, attribute accuracy, and logical consistency.

Quality assurance procedures are documented and available.

The status of audits undertaken to date is given below.

Data set	Custodian	Compliance	Date
LANDSAT Thematic Mapper	AUSLIG	Yes	17 Sept 98
LANDSAT MultiSpectral Scanner	AUSLIG	Yes	17 Sept 98
Ocean Thermal Data	AODC	Yes	9 Oct 98
Geology of Australia	AGSO	Yes	24 Jan 2000
Aust Statistical Boundaries	ABS	Yes	11 Nov 98
Register of the National Estate	Environment Australia	Not yet (more info on standards used required)	11 Nov 98
Digital Atlas of Aust. Soils	BRS	Not yet (Metadata and QA)	2 Feb 99

National Vegetation Information System	NLWRA	Not yet	1 June 2000
Aust Land Use	NLWRA	Not yet	6 June 2000

Table 4. Status of CSDC compliance audits.

This audit process is continuing to be refined and will extend to all framework datasets.

2.2.2 The Creation of a National Topographic Data Base from Multi Jurisdictional Data

In 1993 the public sector mapping agencies in Australia formed a consortium to supply topographic and cadastral data to the Australian Bureau of Statistics for the purposes of the provision of mapping for the 1996 census of population and housing. The data set is a multi-resolution data set sourced from the Federal government, the States and the Territories, with extremely detailed topographic feature representation in cities and urban areas, augmented by a national spatial representation of legal land parcels (the cadastral framework) provided by the States and Territories.

This data set has been updated and improved and is licensed to a number of value added resellers that have incorporated it into their products. It forms one of the most widely used GIS base data sets currently in use in Australia.

2.2.3 Important Private Sector GIS Datasets.

The most widely used digital data sets produced by the private sector relevant to the Australian Spatial Data Infrastructure are the digital versions of street directories. This is large scale data used increasingly by businesses over the Internet. The market in Australia is dominated by one or two large companies. One of these Companies, Telstra, provides an Internet based mapping service to other companies wanting to use maps on their own web sites. For example a company selling real estate over the Internet may want to show the location of the property on a street directory type of map. Telstra provide this service based on an annual fee plus a usage figure. The digital maps are also provided to the invehicle navigation market.

A geocoded street address database marketed by MapInfo is another private sector dataset gaining increased use within business. This particular dataset is a value added product derived from the base topographic data described in Section 2.2.2.

2.3 Access to Data

2.3.1 The Australian Spatial Data Directory

The Australian Spatial Data Directory is a national initiative supported by all governments under the auspices of ANZLIC. The Directory is a tool to improve data discovery for spatial data for industry, government, education and the general community through effective documentation, advertisement and distribution. The directory links government and commercial nodes in each State/Territory and spatial data agencies within the Federal Government.

The Directory is an essential component of the ASDI and incorporates information about datasets (metadata) from all jurisdictions.

The Directory was launched in 1998 and has since steadily grown in content to become the key source of spatial information in Australia. Currently there are 19 separate nodes, or individual databases connected to the directory with over 40,000 individual metadata entries.

The technology being used for the ASDD is the Z39.50 search and retrieval protocol which when combined with the World Wide Web provides a simple method of searching, discovery and retrieval of spatial data. The Directory is also compatible with the US Clearinghouse Network and notes are searchable through this network.

The Directory is maintained and developed by the Federal Government on behalf of ANZLIC through a National Coordination Group. This group is comprised of a consortium of Federal Government agencies, namely the Australian Surveying and Land Information Group (AUSLIG), the Environmental Resources Information Network (ERIN) within Environment Australia and the Bureau of Rural Sciences (BRS).

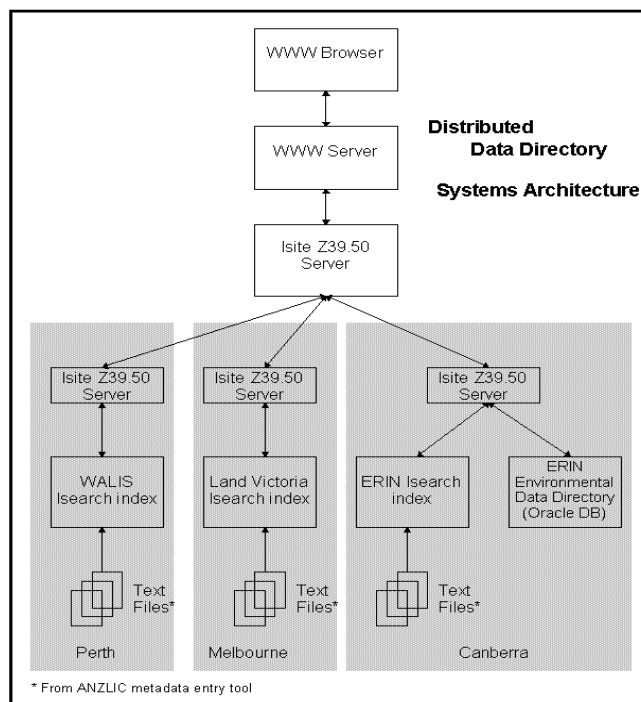


Figure 1. Architecture of the Directory

2.3.2 On Line Atlases

On line atlases are becoming a more accepted way of presenting and distributing geographical information. The Federal Government has initiated two significant on line atlas projects for specific purposes. The first initiative is known as the Coastal Atlas and is an initiative of the Environment Department. The other atlas product is a product to display the results of a national audit of land and water resources currently being finalised. It is known as the Australian Natural Resources Atlas.

The Australian Coastal Atlas

In May 1995 the Commonwealth Coastal Policy defined a need to establish an Australian Coastal Atlas (ACA) to help increase knowledge about Australia's coastal zone, and thus provide a sound information base to support decision making for coastal zone management.

The ACA project involves:

- developing partnerships with marine and coastal agencies and working together to provide information to the wider public;
- improving management of marine and coastal data;
- filling some gaps in fundamental marine and coastal data;
- development of protocols and software to help make data available over the Internet;

The Australian Coastal Atlas (ACA) is a national network of marine and coastal agencies all working together to provide information to the public over the WWW. The ACA is made up of a network of agencies around Australia called "Nodes". All Nodes have now either been installed with the Australian Atlas software or have developed their own web mapping software. The use of Internet technology allows data from each node to be accessed both nationally and internationally by a broad base of users interested in coastal information. The primary objective of the ACA is to improve coastal management.

The development of an Australian Coastal Atlas was considered to be a partial solution to better coastal management by providing a foundation for:

- integrated decision making and the development of long term strategic responses to coastal problems; and
- improved data management and information exchange to enable managers to make informed decisions about the use and development of the coast.



Figure 2. Web Interface to Australian Coastal Atlas

The Australian Natural Resources Atlas

The Australian Natural Resources Atlas is a vehicle for presenting the information products of the National Land and Water Resources Audit.

The information is organised by subject and by geography

by subject:

- area of interest eg water, soil, vegetation and
- topic of interest eg surface water, soil quality

by geography:

- whole of Australia
- State / Territory eg Victoria
- regionalisation eg surface water basins, interim biogeographical regions

The information presented may take the form of maps, photographs, text descriptions, numerical information, charts, graphs which are managed in a database. Additionally, some of the maps are linked to an interactive map which allows the user to explore the information using state-of-the-art web mapping techniques.

The presentation of the information is dynamically generated by retrieval of appropriate information from the database and insertion of the retrieved information into layout templates. The Atlas is therefore a growing system which is intended to serve the needs of the resource management community well into the future.

Further extensions to the atlases are planned to provide data download capabilities, subject to the licensing requirements of the data custodians.

2.3.3 Federal Government Interoperability Trial

The Australian Surveying and Land Information Group led a consortium of government, industry and research agencies, known as the Australian Web Mapping Consortium to participate in the OpenGIS Consortium Web Mapping Testbed project. This consortium developed an Australian testbed that was demonstrated in the USA in December 1999.

Internet based on line delivery of services is a rapidly developing area. Many services delivered by government agencies rely on sharing information maintained by other custodian agencies at the federal and state levels. The demand for interoperable solutions is clear and standards are emerging that will improve the ability to achieve this.

The Commonwealth Spatial Data Committee is conducting a trial amongst 6 federal agencies to test the interoperability standards being developed. The trial will build on the work done by the Australian Web Mapping Consortium to allow agencies to gain first hand experience in the emerging technologies and enable them to make future decisions to improve their service delivery.

The trial will involve developing some applications that integrate data being served from the various participant agencies using different hardware and software into a single web interface.

Many of the theories and policies that have been developed by bodies such as ANZLIC and CSDC will be able to be tested through this process and shortcomings identified for future action.

2.4 Standards and Guidelines

The importance of standards for using and transferring geographic information as part of the Australian Spatial Data Infrastructure are well recognised. These standards are particularly important to achieve a degree of interoperability across jurisdictional borders.

A list of the standards being used and developed in Australia is provided below:

Standard	Purpose	Comment
ANZLIC Metadata Guidelines	Consistent description of metadata for geographic datasets. Forms foundation for the Australian Spatial Data Directory	Consistent with US FGDC Content Standard for Digital Geospatial Used extensively.
ANZLIC Custodianship guidelines	The guidelines provide advice on the principles of custodianship, the responsibilities of custodians and users and on the management of information products.	These principles are accepted and followed to a large degree by custodians.
AS 2482-1989 Geographic information systems - Geographic data - Interchange of feature-coded digital mapping data	This Standard specifies the format and coding of unstructured digital point and vector geographic data to be used when the information is being prepared for exchange purposes	This standard has been used extensively in the past but will be superseded soon by the ISO 19100 series on Geographic information/Geomatics.
AS/NZS 4270.1:1995 Part of a series of standards for geographic information systems - Spatial data transfer standard - Logical specifications	This standard specifies a structure and content for spatially referenced data in order to facilitate data transfer between dissimilar spatial data base systems.	This standard has not been widely used in Australia. Users view this standard as too complex.
AS/NZS 4584(Int):1999 Geographic information - Australian and New Zealand land use codes	The provides a hierarchical code for land usage in order to bring uniformity to the structure and categories under which the	Being progressively applied in Australia

	information is collected.	
AS/NZS 4724:2000 Geographic information - Rural addressing	This Standard establishes requirements and provides guidelines for a comprehensive rural addressing system. It identifies the elements of the system and provides guidelines for the application of those elements to various road patterns and road classifications found in rural areas.	Being progressively applied in Australia
ICSM Draft Australian and New Zealand Rural and Urban Addressing Standard [version 1.10 (28 Aug 2000)]	This draft standard is an attempt to determine the best way to incorporate geocoding and complex addressing into a standard	Comments sought.
Geodetic Datum of Australia	A new geocentric geodetic datum of Australia has been implemented based on 1994 epoch	Being progressively implemented. Now is the official datum for Australia.
ICSM Draft National Topographic Data Model - Version 0.3	This data model has been designed to amalgamate the ideas of the jurisdictions which have separately contributed their own data models for topographic information.	Not in use yet.
ICSM National Cadastral Data Model Version 1.1 June 1999	This National Cadastral Data Model has been developed from a review of cadastral data models supplied by jurisdictions in Australia and New Zealand.	Not in use yet

3. INDUSTRY PARTICIPATION AND DEVELOPMENT

A study undertaken by Price Waterhouse in 1995 of the economic benefits arising from investment in spatial data infrastructure revealed that for every dollar invested in producing spatial data, \$4 of benefit was generated in the economy. In 1989 – 1994 these benefits were in the order of \$4.5 billion distributed across the broad spectrum of economic activities.

An ANZLIC discussion paper on industry development in Australia has recently been released. This paper defines the spatial information industry as that section of the economy engaged directly or indirectly in supplying spatial attributes information of all types. Currently, the public sector dominates the supply and demand aspects of this marketplace and accounts for a majority of expenditure in

products, services and data. The commercial industry consists of the participants in the various product supply chains that are formed in servicing this spatial information marketplace.

The paper also suggests that the spatial information industry appears to be emerging from a developmental phase and moving towards exploitation. Additionally some significant spatial databases are being developed in the private sector particularly in the remote sensing area. Some key indicators of the shift in industry dynamics are:

- supply side participants beginning to reach the end of long standing data acquisition programs;
- maturation and commercialisation of spatial information technology, in both hardware and software areas;
- convergence of spatial and main stream information management technologies and, perhaps more importantly;
- realisation of business benefits in traditional spatial information areas (land titles, natural resources, etc) has led to consideration and growing acceptance of low margin, high volume spatial information licencing, in direct contrast to the conventional very high margin/very low volume model.

The Federal Department of Industry Science and Resources has recognised the Spatial Information Industry as an industry with growth potential that is important in an information based economy. An Action Agenda has been established which will provide a mechanism for the Government and industry to work together to overcome barriers to growth and to ensure a whole-of government approach to the development of the industry. It will enable the industry to build on its existing strengths, generate new domestic and export marketing opportunities, enhance the development of Australia as a regional centre of excellence and encourage the creation of new technologies and products. The Action Agenda will also promote the capabilities of the industry, facilitate access to infrastructure, streamline technology diffusion between public institutions and the private sector, and encourage clustering to ensure effective competition for global market opportunities.

4. CONCLUSIONS

The increasing recognition of the importance of GIS data by government and industry is driving the development of a national GIS infrastructure known in Australia as the Australian Spatial Data Infrastructure. The focus has changed recent times from discussion on the theory and organisation of the ASDI to implementation of its components. This paper has discussed some of the progress made in this implementation to date.

Due to the division of responsibility between the various level of governments in Australia coordination activities are important. The national GIS infrastructure is in effect a combination of the infrastructures of the various jurisdictions involved.

The development of more consistent policies for access and pricing of geographic information remains a challenge for government but is seen as one of the most important issues to be resolved. The development of a more competitive and capable GIS industry depends to a significant degree on improved access to GIS data held by government agencies.

Progress has been made in the implementation of a national spatial data directory and the implementation of a number of national on line atlases. Additional work is being undertaken in trialing technology and standards to enable better sharing of data. Increased interoperability across federal and state government agencies is viewed as an important future development.

Standards are being developed through national committees that will provide a higher degree of national consistency with geographic information.

The identification and auditing of framework datasets will continue to deliver more reliable. The development of datasets comprised from data sourced from all jurisdictions in Australia is also providing better GIS data. This data availability is stimulating the GIS industry. Finally, the government has recognised the potential of the GIS industry and is actively encouraging its development through the identification and removal of obstacles to growth.

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