국가 GIS구축 및 활용을 위한 국제세미나

INTERNATIONAL SEMINAR ON STRATEGIES FOR NATIONAL GIS DEVELOPMENT

April 18～19, 1996
Seoul Education and Culture Center / KRIHS
Seoul, KOREA

Organized by
Korea Research Institute for Human Settlements (KRIHS)

Sponsored by
Ministry of Construction and Transportation (MOCT)
REPUBLIC OF KOREA

KOREA RESEARCH INSTITUTE
FOR HUMAN SETTLEMENTS

INTERNATIONAL SEMINAR ON STRATEGIES FOR NATIONAL GIS DEVELOPMENT

SEMINAR SCHEDULE

April 18, 1996 (Thursday) : Seoul Education and Culture Center

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08:30～09:20 Registration09:20～09:35 Opening Address

Lee, Gun-Young (President, KRIHS)

Congratulatory Address

Ryoo, Sang-Yol (Vice Minister, MOCT*)

09:35～09:50 Keynote Speech

Kim, Kuen-Ho (Chairman, NGIS Administrative Subcommittee)

09:50～10:00 Coffee Break

Session 1 : Strategies for National GIS Development

Moderator : Kim, Tschang-Ho (Chairman, NGIS Advisory Board)

Discussants : Mosaad Allam (Director, Geomatics Canada)

Nick Land (Manager, Ordnance Survey)

Min, Tae-Jung (Director, Land Use Planning Division, MOCT)

Yu, Keun-Bae (Professor, Seoul National University)

10:00～10:20 A Strategic Perspective of Geographical Information Systems in the United States

K. Eric Anderson (Chief Scientist, USGS)

10:20～10:40 National Geographic Information Strategy in Britain

Ian Masser (Professor, University of Sheffield)

10:40～11:00 Japan Strategies for National GIS Development – Preparation of GIS Data Sets and Related Activities by GSI**

Kunio Nonomura (Deputy Director General, GSI)

11:00～11:20 Korea Strategies for National GIS Development
Kim, Young-Pyo (Director, LIC***, KRIHS)

11:20～12:00 Discussion

12:00～14:00 Luncheon
(Hosted by the Chairman, NGIS Administrative Subcommittee)

Session 2 : Strategies for Spatial Data Clearinghouse

Moderator : Ian Masser (Professor, University of Sheffield)

Discussants : K. Eric Anderson (Chief Scientist, USGS)
Park, Chong-Hwa (Professor, Seoul National University)
Kim, Eun-Hyung (Professor, Kyung Won University)
Kim, Sungryoung (Managing Director, Korea Telecom)

14:00～14:20 Australia's Plans for a National Land and Geographic Data infrastructure
Graham Baker (Secretary, ANZLIC****)

14:20～14:40 A Canadian Solution for Spatial Data Clearinghouse : Federated Multi-Database Infrastructure for GIS Interoperability
Mosaad Allam (Director, Geomatics Canada)

14:40～15:00 UK Strategies for a Spatial Database Clearing house – The Role of a National Mapping Agency
Nick Land (Manager, Ordnance Survey)

15:00～15:20 National Mapping Agencies : Looking to the 21st Century
J. Hugh O'Donnell (Managing Director, VISION Solutions)

15:20～16:00 Discussion

16:00～16:20 Coffee Break

MOCT* Ministry of Construction and Transportation
GSI** Geographical Survey Institute
LIC*** Land Information Center
ANZLIC**** Australia New Zealand Land Information Council

Comprehensive Discussion

Moderator :	Lee, Kyu-Bang	(Vice President, KRIHS)
Discussants :	Ian Masser	(Professor, University of Sheffield)
	Kunio Nonomura	(Deputy Director General, GSI)
	Chai, Dok-Sok	(Director General, NDPB*, MOCT)
	Kim, Won-Ik	(Director General, NGI**)
	Kim, Tschang-Ho	(Chairman, NGIS Advisory Board)
	Yoo, Bock-Mo	(Professor, Yonsei University)
	Yoon, Jay-Joon	(President, CADLAND, Inc.)

16:20～17:40 Discussion

18:00～20:00 Dinner (Hosted by the President of KRIHS)

NDPB* National Development Planning Bureau
NGI** National Geography Institute

April 19, 1996 (Friday) : Korea Research Institute for Human Settlements

Session 3 : Current Status and Application of Digital Map

Moderator : K. Eric Anderson (Chief Scientist, USGS)

Discussants : Graham Baker (Secretary, ANZLIC)

J. Hugh O'Donnell (Managing Director, VISION Solutions)

Kim, Jae-Young (Research Fellow, KRIHS)

Kim, Chung-Pyung (Director, Hanjin GIS Co.)

09:30~09:50 Current Status of Digital Basemap in Korea

Kang, Il-Dong (Director, Geographic Information Division, NGI)

09:50~10:10 The New South Digital Cadastral Data Base and its application in an Integrated Land Information System

Tony Hart (Manager, GENASYS)

10:10~10:30 Detection of Underground Utilities – An Introduction to High Resolution Geophysical Techniques

John E. Scaife (General Manager, multiVIEW Geoservices)

10:30~10:50 Coffee Break

10:50~11:10 The Myriad Issues Confronting GIS Users

David Collison (Manager, INTERGRAPH Asia Pacific)

11:10~11:30 A National GIS – New Opportunities, Challenges, and Progress

Sheila Sullivan (Manager, ESRI - San Antonio)

11:30~12:00 Discussion

12:00~14:00 Luncheon (Hosted by the President, NGI)

Technical Discussion : Digital map production and Clearinghouse

Moderator	: Ryu, Joong-Seok	(Professor, Chung-Ang University)
Discussants	: 11 Invited Foreign Participants	
	5 Research Fellows from KRIHS	
	Han, Sang-Deuk	(Director, Geodesy Division, NGI)
	Kim, Myung-Ho	(Chief, Topographic Information Section, NGI)
	Goh, Il-Du	(Professor, Seoul National Polytechnic University)
	Kim, Kye-Hyun	(Professor, Inha University)
	Kim, Seung-Tae	(Professor, Anyang University)
	Kim, Yong-Il	(Professor, Seoul National University)
	Sung, Hyo-Hyun	(Professor, Ewha Womans University)

14:00～15:40	Digital Map Generation and Application
15:40～16:00	Coffee Break
16:00～17:40	Geographic Information Infrastructure and Clearinghouse
17:40～18:00	Comprehensive Technical Discussion

A Strategic Perspective of Geographic Information Systems in the United States

Dr. K. Eric Anderson

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ABSTRACT

The United States is a large country of more than 3 million square miles with 50 States and thousands of governmental units from towns, cities, counties, and water districts to State and Federal agencies. There is a great variety of geospatial data producers of cartographic, environmental, population, economic, remote sensing, and infrastructure data. Geographic information systems (GIS) provide a technology that enables the integration of geospatial data to support decision making for a wide range of applications including resource management, economic development, infrastructure management, and urban planning.

The United States has articulated a strategic vision of GIS through a National Spatial Data Infrastructure (NSDI) that links data producers and consumers via clearinghouses and standards that incorporates assigned

responsibility for data categories and a certification process for data to ensure the availability of geospatial data to users. This means that there is not a single national GIS, but many GIS centers using common standards and sharing data and techniques through networks that enable the maintenance of data categories by the appropriate responsible authorities.

The goal is to implement the NSDI across all levels of government in a partnership process that includes the private sector and universities. The U.S. Geological Survey and the Federal Geographic Data Committee will provide the leadership for standards development and coordination mechanisms. The result will be a distributed approach to meeting the needs for a national GIS that draws upon the strengths in all sectors of society.

요 지

미국은 3백만 제곱마일 이상의 면적과 50여개의 주, 그리고 수천개의 정부단위로 구성된 거대한 나라로 지도, 환경, 인구, 경제, 원격탐사, 사회기반시설에 대한 각종 지리공간자료를 생산하고 있다. GIS는 각종 지리정보자료를 통합하여 자원관리 경제개발, 사회하부시설관리 및 도시계획과 같은 광범위한 활용에 있어 의사결정을 지원하는 기술이다.

미국은 NSDI(National Spatial Data Infrastructure)를 통해 GIS에 대한 미래상을 보여주고 있다. NSDI는 정보유통기구의 네트워크와 표준화를 통해 정보생산자와 이용자를 연결시켜준다. 또한 정보분류 업무와 지리공간정보의 유용성을 확인하는 검수과정을 통합시키고 있다. 이것은 단 하나만의 국가 GIS가 존재하는 것이 아니라 네트워크를 통해 공통표준과 정보와 기술을 공유하는 다수의 GIS 센터가 존재함을 의미한다.

민간부문과 대학을 포함한 범 정부부처의 협력을 통하여 NSDI를 수행하는 것이 목표이다. 미국지질조사국(USGS;U.S.Geological Survey)과 연방지리정보위원회(FGDC; Federal Geographic Data Committee)는 표준개발과 조정역할을 주도할 것이다. 그 결과로 국가 GIS에 대한 수요를 만족시킬 수 있는 분산형 접근방식이 구축될 것이다.

1. AN HISTORICAL LOOK AT GIS

Geographic information systems enable the integration of diverse types of geospatial data such that data may be analyzed and new information synthesized using the spatial character of the data. These systems have evolved over the past 20 years to become an effective decision-making tool for resource managers, regional planners, and urban planners at all levels of government and the private sector.

1970's

The 1970's saw the emergence of GIS. Its primary applications were for large natural resource managing agencies. The technology was mainframe-based with terminal access and most map products generated off-line with pen plotters. Data structures were simple grids or topologically structured line graphs. Data capture was primarily by manual digitizing and considerable effort was expended on improving editing and error detection. Applications were focused on large areas in a land inventory manner for forest or range management or land use mapping.

1980's

The 1980's saw the rapid adoption of GIS by Federal agencies and States and its spread into new applications. During this period, graphics workstations became common and better software began to emerge. Raster scanners became a common digitizing tool and databases began to grow. Most GIS users were also data producers to meet their own needs. More sophisticated data structures evolved that permitted more advanced applications. With the diversity of users, concerns for standards began to emerge and committees were formed to begin their development. Sharing and exchange of data was still a significant problem.

1990's

The 1990's saw a rapid growth in the adoption and use of GIS by many different industries and local counties and towns. Strong commercial acceptance resulted in many new systems available to address new uses. Many of these new systems were much easier to use. Powerful, desktop computers helped the spread of the technology and the rapid growth of the Internet increased concerns about data exchange and the need for standards. Significant standards, such as SDTS, began to emerge that helped promote the sharing of data. The existence of significant data bases that had been developed through this time created a new group of data consumers that were not interested in digitizing but only in applications.

2. A STRATEGIC APPROACH TO GIS

This historical development helps to understand the strategic view of GIS that has emerged in the United States. In the early stages, the emphasis was to development coordination mechanisms to minimize the duplication of effort and to ensure the best use of limited budgets. These efforts helped to share technology, understand the benefits of applications of different groups, and to introduce new users to GIS. These efforts were focused on Federal agencies in the beginning because those were the users with larger programs who could benefit from even limited applications of the technology.

As these coordination groups evolved, they were the early promoters of standards and helped to promote various conferences that encouraged technology sharing and helped to bring new users into the community.

The coordination groups grew in responsibility and spread across all levels of government and included academia and the private sector. As the use of networks began to emerge, the potential of rapid and easy access to data in many places became apparent. The concept of a National Spatial Data Infrastructure was formed that would enable the rapid transmission of data among users. As this concept unfolded, it became obvious that one, giant national database for geospatial data was an unworkable concept. This has resulted in the idea of geospatial data clearinghouses which are servers on the Internet which serve as catalogues of spatial data and help direct users to the holders of data they can use.

At the same time, it was recognized that there were certain data themes that were required by many users, such as elevation or transportation. These are known as Framework data categories that specific agencies accept responsibility for maintaining and that others can build upon.

3. THE FEDERAL GEOGRAPHIC DATA COMMITTEE (FGDC)

The FGDC was established through the Office of Management and Budget (OMB) Circular A16 and charged with the responsibility to coordinate various surveying, mapping, and spatial data activities of federal agencies to meet the needs of the Nation. The committee is composed of representatives from 14 Cabinet level and independent Federal agencies and promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. Major objectives of Circular A16 are to avoid duplication and minimize costs in mapping and spatial data activities, which involves establishing standards and providing wider access to geospatial data. The FGDC also has been charged with coordi*nating geospatial data related activities with other levels of government and with public, private, and academic sectors.

4. ROLE OF SPATIAL DATA STANDARDS

Effective spatial data standards are necessary for any efforts in collaborative data production. Standards will increase the ability to share spatial data and preserve its original meaning, to create more complex applications, and to stimulate the commerce associated with GIS technology and spatial data. Several areas require standardization. These include data models, data content, feature delineation, data collection, georeferencing, indirect positioning, data quality, metadata, and data transfer and exchange. Achieving agreement on standards in all of these areas is a significant undertaking.

The most effective standards are those that are widely used. How best to obtain this status, through de facto or de jure standards, is the subject of much discussion (Guptill, 1994). The standards process needs to balance the involvement of a broad community with the need to implement standards in an effective fashion.

5. THE CONCEPT OF A NATIONAL SPATIAL DATA INFRASTRUCTURE

In the early decades of using geographic information systems, individual groups in separate divisions of an organization implemented the technology to solve different problems. This approach resulted in unique combinations of hardware, software, and data, each of which supported a unique application. Upon examination, most organizations realized that this "stovepipe" approach was very inefficient because of the nature of spatial data and the integrating capability of geographic information systems. Increasingly, agencies have come to recognize the value of developing a more open approach in which groups can share information that are commonly needed, as well as the ability to exchange information with groups outside the organization. For example, instead of a planning department, highway department, and tax office each maintaining separate street center-line data bases, one street file can be developed and shared across the departments. Responsibility for updates and maintenance are defined clearly among the three offices. This approach places more emphasis on the development of standards that enable data sharing, and developing working relationships among the participants.

This approach takes advantage of the fact that aspects of geographic space are common to many government and non-government applications and that efficiencies in data development can be achieved by sharing responsibility for the data. Additionally, the approach responds to other changes taking place in organizations, including downsizing, increased distribution of authority and responsibility in "flatter" organizations, and enhanced interest in partnerships. Finally, the approach encourages the development of multifaceted collections of knowledge needed to cooperatively tackle complex issues such as transportation planning or community sustainability.

The NSDI extends this approach to a national scale. The concept recognizes that many government agencies, at all levels, as well as private sector and non-profit organizations, share interests in and are developing data related to common pieces of geography. The major goals of the NSDI are to establish simpler mechanisms to find data and to build partnerships to share data over geographic areas that are of mutual interest. The approach will result in reduced duplication in data collection efforts (to minimize expenditures while expanding the data available), and development of a common view of shared places. The NSDI effort anticipates that the ability to integrate and examine data nationally can be accomplished at less cost through data sharing, and that the availability of data valuable for local-decision making will be improved.

The initial steps to implement the NSDI recommendations were carried out through the issuance of Executive Order 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," by President Clinton in April 1994. Executive orders are the means by which the President directs Federal agencies to implement various actions or policies. The order directed Federal agencies and the interagency Federal Geographic Data Committee (FGDC) to carry out tasks to improve access to federally-held data and, to plan better means of creating and maintaining data that are commonly needed, to develop and improve standards, and other actions to implement the NSDI (Executive Office of the President, 1994).

The Executive Order also had a significant effect in increasing the level of awareness about the value, use, and management of geospatial data among Federal agencies. It raised the political visibility of geospatial data collection, management, and use, both nationally and internationally. The Executive Order created an environment within which new partnerships among levels of government and organizations are not only encouraged, but required.

In the longer term, the success of the NSDI is based on a complex web of partnerships among public and private organizations. These partnerships will vary across the nation, based on organizations' interests in data over any specific location. Participation by different levels of government and different sectors is something of a self-selecting process. The Federal Government has promoted the concept of the NSDI on a national basis, but as the NSDI evolves, the roles of local and state governments are becoming more pronounced.

Many state agencies have taken on the task of assimilating and integrating Federal data sets with local data to create useful statewide data bases. Local agencies increasingly are collecting very accurate and current spatial data. The NSDI is an excellent example of the adage, "think globally, act locally".

6. NATIONAL GEOSPATIAL DATA CLEARINGHOUSE

The National Geospatial Data Clearinghouse is a distributed, electronically connected network of geospatial data producers, managers, and users. The clearinghouse will allow its users to determine what geospatial data exist, find the data they need, evaluate the usefulness of the data for their applications, and obtain or order the data as economically as possible.

Like the information-based economy of which it is a part, the geospatial data community is in the midst of change. Decreasing costs and the increasing capabilities of hardware and software are lowering the initial investment needed for technology and are increasing demands for geospatial data. But even with billions of dollars going into geospatial data production, few users can answer the basic question, "Where are the data?"

The result is that agencies and the public spend money collecting data that may already exist.

Electronic networking capabilities increasingly assist communication within the geospatial data community. There is still much work to be done to move from traditional means of communicating about geospatial data to using the emerging information infrastructure. The clearinghouse provides a means to inventory, document, and share geospatial data. For data users, the clearinghouse makes data easier to find and access. As part of their participation in the National Spatial Data Infrastructure (NSDI), Federal agencies are beginning to provide data and use the clearinghouse.

As the clearinghouse evolves additional functions will be supported, such as the capability for producers to publicize data that are being prepared or are planned and for users to advertise their data needs. These capabilities will foster communication between the users and producers, which will encourage dialogue on new product needs and developments, will help to form partnerships for data production, and will minimize duplication in data collection. This communication is vital to ensuring that the NSDI continues to be responsive to the needs of the community.

The National Geospatial Data Clearinghouse is intended to be a distributed, electronically connected network of geospatial data producers, managers, and users. The Clearinghouse will allow its users to determine what geospatial data exist, find the data they need, evaluate the usefulness of the data for their applications, and obtain or order the data as economically as possible.

Geospatial data that are created, collected, processed, disseminated, and stored by the Federal Government are a valuable national resource. The Federal Government serves as a steward of this resource, shall exercise information resource management with special emphasis on the information life cycle, and shall ensure the effective and economical development of the Nation's spatial data infrastructure.

Agencies shall commit to the maintenance, validation, description, accessibility, and distribution of geospatial data. Agencies shall manage geospatial data in a way that facilitates data sharing and use by other agencies and the general public. Geospatial data shall be maintained consistently among agencies. Data sharing maximizes the net return on the investment of public resources.

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NATIONAL GEOGRAPHIC INFORMATION STRATEGY IN BRITAIN

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INTRODUCTION

This paper presents a broad overview of recent developments in Britain relating to the evolution of the national geographic information strategy. It describes the activities of the key players in government, considers the institutional context within which they operate, and then examines some of the main elements of the national geographic information strategy in terms of co-ordination, the creation of core data sets and the development of metadata services. The discussion is limited to the public sector because the government plays a critical role with respect to all the main elements of the national geographic information strategy not only through its direct actions concerning the availability and supply of geographic information but also through the institutional context that it provides for such actions.

The paper forms part of a larger research project that is being undertaken by the author on the evolution of national and transnational geographic information strategies. As part of this project a parallel study is being undertaken of the Netherlands using the same format used for this study. The research will also draw upon recent experience in Australia and the United States and consider developments at the transnational level in the European Commission. The broader context for these studies will be provided by an evaluation of the concept of geographic information from a number of different theoretical perspectives.

서 론

이 글에서는 영국의 국가지리정보 구축전략의 전개와 관련된 최근의 성과를 개괄적으로 소개하고자 한다. 우선 정부의 주요 관계자들의 활동과 제도적 상황을 고찰한 다음, 조정, 중요정보 구축 및 데이터에 대한 설명정보(Metadata) 개발이라는 측면에서 국가지리정보 구축전략의 주요사항을 살펴보기로 한다. 하지만 논의 전개는 공공분야에 국한시키며, 그 이유는 정부가 국가지리정보 구축전략의 주요부분에서 절대적 역할을 하기 때문이다. 정부가 주로 지리정보 구축전략의 유용성과 공급에 직접관련할뿐 아니라 그러한 활동을 하기 위한 제도적 장치를 주관하기 때문이다.

본 논문은 국가 및 초국가적 지리정보 구축전략의 전개에 따라 수행된 연구 프로젝트의 일부이다. 동일한 연구방법 틀 내에서 유사연구가 네덜란드를 대상으로 수행되고 있고, 오스트레일리아와 미국에 대해서도 최근 축적된 노하우를 이용해서 연구할 것이다. 또한 유럽위원회(European Commission)에서는 초국가적 수준의 지리정보 구축전략의 개발을 고려하고 있다. 다양한 이론적 접근을 통해 지리정보의 개념을 평가함으로써 이러한 연구들을 수행하기 위한 보다 폭넓은 맥락을 잡을 수 있을 것이다.

2. KEY PLAYERS

2.1 Introduction

The geographical coverage of government departments in the United Kingdom of Great Britain and Northern Ireland varies considerably and the key players in the geographic information field are no exception to this rule.

Many of these variations reflects not only regional circumstances but also differences in the legal systems of England, Wales, Scotland and Northern Ireland. For example, the main agency with responsibility for land and property in England and Wales is Her Majesty's Land Registry. Its counterpart in Scotland is Registers of Scotland. Similarly, the National Mapping Agency for Great Britain is the Ordnance Survey. Its counterpart in Northern Ireland is the Ordnance Survey of Northern Ireland. In the case of statistical responsibilities the position is further complicated by their decentralisation to all the main government departments in England and Wales as well as their counterparts in Scotland and Northern Ireland. Furthermore, in England and Wales the registers of vital events are maintained by the Office of Population Censuses and Surveys which is also responsible for the decennial Census of population and housing. Its counterparts in Scotland and Northern Ireland are the General Registry Office, Scotland and the Department of Health and Social Security in Northern Ireland. These variations are not confined to government departments. The nature and functions of local government also vary considerably between England and Wales, Scotland and Northern Ireland. Similarly, the status of the various public utility companies varies from one part of the UK to another. For example, water provision remains in public ownership in Scotland whereas it has been privatised in England and Wales.

It is not the intention of this paper to attempt to present a comprehensive account of the activities of all these important users of geographic information within the public sector. They will be dealt with primarily from an English perspective in the discussion that follows. Nevertheless, it is important to bear in mind not only that these variations exist but also that they often embody differences in powers and responsibilities. Furthermore, it must be emphasised that English practice is not necessarily the most advanced in the United Kingdom when it comes to particular geographic information activities. For example, Scotland's land registration system dates back several hundred years further than the equivalent system in England and Wales to the Register of Sasines that was set up by the Scottish Parliament in 1617. Similarly, there is no equivalent in mainland Britain to the Northern Ireland GIS centre which has been set up by the Ordnance Survey of Northern Ireland and it should be noted that the General Registry Office, Scotland used postcodes to organise both its 1981 and 1991 censuses whereas the spatial unit used by the Office of Population Censuses and Surveys for the equivalent censuses is the enumeration district which contains roughly 10 times the population.

With these limitations in mind this section provides a broad overview of the activities of the key players in geographic information in Britain from an English perspective. In the process a distinction is made between those agencies which are primarily data suppliers and those which are primarily data users. As a result the rest of this section is divided into two parts. In the first of these the activities of the three main spatial data suppliers and their geographic information products are outlined while the second contains a brief description of the main user interest groups within the public sector.

2.2 Main Suppliers of Geographic Information

2.2.1 Her Majesty's Land Registry

Her Majesty's Land Registry for England and Wales was set up in 1862 as a separate department responsible to the Lord Chancellor. Its main task is to provide the land title security and statutory conveyancing machinery for the transfer of property interests. It is required by statute to be self financing and makes no call on public funds. All transactions involving property in England and Wales must be registered by the Land Registry. In 1994-95 it dealt with 3.81 million transactions, including 1.5 million new ownerships, 1 million new mortgages and the cancellation or variation of 1.25 million other interests in land (HMLR 1995, p.7). In the process the number of titles to land held by the Land Registry increased from 14.9 million at the end of March 1994 to 15.5 million at the corresponding date in 1995. As a result of these activities the Land Registry generated a gross income of £231 million in 1994-5 and produced an operating surplus of nearly £40 million during the same period (HMLR 1995, p.37).

In the last few years the Land Registry has made considerable progress in computerising these records and plans to complete the project by 1998. By the end of March 1995 over 11 million out of the 15.5 million titles had already been computerised (HMLR 1995, p.12) but there were marked regional variations in the extent of computerisation. For example, less than half the titles in the East Midlands region had been computerised at this stage as against a 100% computerisation in most of the North and South West regions.

With over 70% of all titles accessible on line users are increasingly taking advantage of the direct access and telephone search services offered by the Land Registry. The direct line service permits any credit card holder with an appropriate terminal to have on line access to the register whereas the telephone search services enable a credit card holder to lodge applications by telephones for searches of the index map with respect to land charges.

2.2.2 The Ordnance Survey

The Ordnance Survey of Great Britain was founded in 1791. Since May 1990 it has been an Executive Agency with considerable autonomy regarding the conduct of its own affairs

> "It is responsible for the official, definitive surveying and topographic mapping of Great Britain. It is a government department funded by Parliamentary vote. The responsible minister is the Secretary of State for the Environment." (OS 1995, p.5).

To carry out these tasks the Ordnance Survey employs 1,950 staff at its headquarters in Southampton and its network of field offices throughout the country.

The core activity of the Ordnance Survey is to maintain the national topographic database in the form that meets current and future demands. The basic parameters of this database were established over a century ago in 1863 when it was agreed that all urban areas in Britain should be mapped at the 1:500 scale (later adjusted to 1:1250 scale because of the costs involved): or rural areas to the 1:2500 scale and the remaining mountain and moorland areas to the 1:10000 scale (McMaster 1991, p.11). In May 1995 the Ordnance Survey completed the digitisation of all 57,792 1,250 map sheets, 159,271 2,500 map sheet and 3,694 mountain and moorland map sheets. As a result it now provides an accurate up-to-date seamless map product for the whole country.

In addition to this product the Ordnance Survey has developed a wide range of digital products derived from this and other databases. These include the Addresspoint product developed in conjunction with the Royal Mail which uniquely identifies and precisely locates each of the 25 million residential, business and public postal addresses in Great Britain, the OSCAR (OS Centre Alignment of Roads) range of products related to street centre line information and many others. In developing these projects the Ordnance Survey works closely with both public and private sector partners.

The Ordnance Survey also works closely with other public agencies in relation to the supply of geographic information (Rhind 1995). In a few cases these connections are specified by law. The Land Registry, for example, is by statute obliged to record its data holdings on Ordnance Survey maps. In its recent Framework document the Ordnance Survey also announced plans to create a National Geospatial Database by linking its national topographical database to other spatial data held by government departments and agencies with a view to providing a "one stop shop" for customers requiring the Government's spatial data (OS 1995, p.5). These plans will be considered in more detail later in this paper in the context of the British National Geographic Information Infrastructure debate.

The Framework document also makes clear that the government requires the Ordnance Survey to discharge its responsibilities "while maximising the recovery of its costs in meeting customer demand" (OS 1995, p.5). The need to recover some of its costs is nothing new. Nearly 20 years ago the then Secretary of State for the Environment, Peter Shore, gave the Ordnance Survey a 40% cost recovery target. However by the early 1990s this had increased to 80% despite the essential contribution that its activities make to the national interest in many fields. Consequently it is not surprising to find that one objective of the framework document is "to agree a National Interest Mapping Contract with government services and activities undertaken in the national interest." (OS 1995, p.5).

2.2.3 The Government Statistical Service

The United Kingdom is unusual in that it has a decentralised government statistical service which comprises the statistical divisions of all the main government departments as well as the Welsh, Scottish and Northern Ireland offices. Nevertheless most of the main data collection and survey activities are concentrated in two agencies, the Central Statistical Office and the Office of Population Censuses and Surveys. Since 1st April 1996 these two agencies have been merged to form a single agency called the Office of National Statistics which is accountable to the Chancellor of the Exchequer. The Head of the Office of National Statistics is also the Director of the Government Statistical Service and the Registrar General for England and Wales. The main reason for this merger is the need to give greater coherence and compatibility in government statistics. Consequently, in addition to taking over the statistical responsibilities previously carried out by these two agencies, the new agency has been charged with establishing a new central database of key economic and social statistics drawn from the whole range of statistics produced by government to common classifications, definitions and standards (OPCS 1995, p.2).

The Central Statistical Office (CSO) was set up in 1941 following the concerns expressed by the Prime Minister, Winston Churchill, about the use of different statistical data by government departments. The main focus of its work has subsequently been the compilation of the national accounts and it also provide the co-ordination required for the successful operation of a decentralised statistical service. The Central Statistical Office became an executive agency in 1991 and it is envisaged that its successor will have an expanded role in this capacity.

Work on labour market statistics was transferred to the Central Statistical Office from the Employment Department in 1995. This includes the National On-line Manpower Information System (NOMIS) which is maintained under contract by the University of Durham and provides subscribers with direct access to official government statistics down to the smallest geographical area (Blakemore).

The Office of Population Censuses and Surveys (OPCS) was created in 1970 by the merger of the General Registry Office which had been in existence since 1837 and the Government Social Survey which came into being in 1941. Prior to the merger with the Central Statistical Office the Head of OPCS was accountable directly to the Secretary of State of Health. The basic tasks of OPCS are to secure the registration of vital events such as births, marriages and deaths and to provide high quality demographic, social and medical information and analysis. The OPCS is also responsible for the organisation of the decennial census of population and housing in England Wales and carries out surveys for other government departments and public bodies. In April 1994 over 1,800 staff were employed by the OPCS in ten divisions spread over three sites in London, Titchfield and Southport (OPCS 1994, p.9).

Unlike the CSO, there has always been a very strong geographic dimension to the work of the OPCS. As a result this agency has worked closely with other key players in the geographic information field in the planning of its decennial censuses and the development of geographical information products from these censuses (see Coombes 1995 for a review of current practice). The OPCS also maintains the Central Postcode Directory. This contains records of each of the 1.7 million postcodes in the United Kingdom together with a National Grid reference for one address within each postcode area and the OPCS codes for the administrative areas within which it lies.

2.3 Main Users of Geographic Information in the Public Sector

2.3.1 The Department of The Environment

The Department of the Environment is the largest single user of geographic information in government as well as being a substantial supplier of geographic information in its own right. It has a very diverse portfolio of responsibilities covering local government, housing, land use planning and environmental protection. The Secretary of State for the Environment is also the minister responsible for the Ordnance Survey.

The focal point for geographic information within the Department of the

Environment is the Planning and Land Use Statistics section of the Planning Directorate. This section services both the Inter-departmental Group on Geographic Information (IGGI) whose activities in connection with the development of national geographic information policy will be discussed in section 4.1 of this paper, and the Information Development Liaison Group (IDLG) which is the main central/local government statistics forum. This section is also responsible for the collection of land use statistics including the land use change statistics collected through the Ordnance Survey.

2.3.2 Other Ministries and Government Agencies

A wide range of other ministries and government agencies make use of geographic information. Over 30 of these are represented on the Interdepartmental Group on Geographic Information (see above). These include agencies with responsibilities for agricultural and environmental matters such as the Ministry of Agriculture, Fisheries and Food, the Forestry Commission and National Rivers Authority, agencies with responsibility for economic and social matters such as the Department of Education, the Employment Department, the Home Office and the Department of Transport. The findings of a survey of GIS in government departments carried out by the government centre for computer systems (CCTA 1994) gives some indication of the diversity of GIS applications in these departments. Strategic applications include those developed by the Forestry Commission for the maintenance and production of forest management maps and the Countryside Commission for Wales geographic database of corporate environmental data. Stand alone applications include the evaluation of the Safer cities programme in the Home Office and the prioritising of areas with regard to legal policy by the Legal Aid Board.

2.3.3 Local Government

Local government in England and Wales is a mixed system of unitary and two tier authorities. Unitary authorities are responsible for the main urban agglomerations while the remainder of the country is administered by a two tier system of county and district councils. All these authorities make extensive use of geographic information in their work. These authorities have their own associations and also support the research and development work that is carried out by the Local Government Board. The Geographic Information Advisory Group of the Local Government Management Board played a key role in the development of the three parts of BS7666 which were published in 1993 and 1994. These define the industry standards for indexing street information, indexing land and property data and the address structure required by the two indexes respectively (Cushnie 1994).

2.3.4 The Utilities

The provision of electricity, gas, telephone and water services in England and Wales has been privatised by the government. Nevertheless the utilities still operate in some respects as public sector agencies. The National Joint Utilities Group represents the interest of the utilities with respect to geographic information.

3. THE INSTITUTIONAL CONTEXT

3.1 Introduction

This section considers the position of the key players with respect to the marketing of geographic information and its legal protection within the general institutional context of British government information policy.

3.2 Marketing Information

Throughout that last ten years there have been strong pressures on all government departments in Britain to recover some of their costs by exploiting their data holdings and departments have also been encouraged to release some of their data holding to stimulate the private sector information market. An important objective of the Tradeable information initiative which was launched in 1986 was "to make as much government held information as possible available for the private sector to turn into electronic services" (DTI 1990). Government departments were asked to review their information holdings to identify data which could be made available and guidelines for charging for such information were provided by the Department of Trade and Industry. These distinguish between two categories of tradeable information. In cases where an established market exists for government tradeable information which they already provide, departments were asked to charge a reasonable market price. In the case of tradeable information which has not previously been exploited it was suggested that departments made contracts initially on the basis of charging only for costs incurred over and above those associated with handling the information for their own purposes (DTI 1990).

In practice, however, Treasury rules regarding cost recovery have generally superseded these principles as can be seen from the recent guidelines for charging for statistical services and products produced by the Government Statistical Services. The most important of these are

a) The cost of collecting, processing, analysing and presenting statistical information for official use should be met from public funds.
b) Statistical information which is published for wider use, in printed or electronic form, should normally be priced to recover the full costs of making that information available in excess of that required for government use....
c) The full cost is the total cost of all the resources used. For statistical services, this will commonly include product development, computing, editorial, production, marketing and distribution costs and the cost of capital ... It will also include the costs of collection, where collection was not for official use" (GSS 1995, p.4).

These guidelines apply to most government departments but not to

Executive agencies set up by government such as the Land Registry and the Ordnance Survey which have considerable autonomy over charging. As noted above the Land Registry is required by law to recover all its costs and sets its prices accordingly. The Ordnance Survey has also developed its own practice for trading in this area and does not follow specific government guidelines (Policy Studies Institute 1995, p.65). According to its executive agency framework document it is expected to maximise the recovery of its costs in meeting government demand. The current level of cost recovery is around 80%.

As its range of digital products has increased, the Ordnance Survey has negotiated Service level agreements with some of its main groups of customers to make its data available to members on a shared purchase basis. The first of these agreements with the local authority sector was reached in March 1993. This has resulted in a marked increase in data use. As a result 80 percent of British local authorities were using digital data in 1995 as against 20 percent in 1993 (Rhind 1995, p.2). Since that time further agreements have been reached with the public utilities and a consortium of Scottish office government departments and agencies. Such agreements are seen as being of mutual benefits to both data supplier and data user. For the Ordnance Survey they reduce the costs of administering a large number of separate agreements with individual users and also promote a more widespread diffusion of its products than would otherwise had been the case. From the standpoint of the user there are obvious financial savings as well as less uncertainty regarding the extent of possible future commitments.

From this brief description it can be seen that there are elements of cost recovery, making a profit and stimulating the economy in current British government practice with respect to marketing information. One of the main objectives of the tradable information initiative was to stimulate the growth of information service. However this must be set against the background of an increasing emphasis on cost recovery embodied in the recent guidelines for statistical services and products. At the same time it must be recognised that many of the agencies which deal with geographic information operate largely outside these guidelines and have much greater pressures on them to cover the majority or even all their costs. As a result a recent report (Policy

Studies Institute 1995, p.66) concluded that "pricing policy in the UK is arbitrary. It is unclear whether the government wants to recover costs, make a profit or stimulate the private sector".

3.3 Legal Protection

Matters relating to the legal protection of geographic information in Britain are largely dealt with by the Copyright, Designs and Patterns Act of 1988. This covers literary and artistic works as well as information held in computer databases. To qualify for copyright protection under the Act a work must be "original". Insofar as databases are concerned it is enough to show that their compilers have expended work and effort to create them (sweat of the brow) without necessarily having to put in any creative effort. In this respect British copyright law differs from that in other European countries such as the Netherlands where a work must bear the personal stamp of its creator to be considered as "original" with respect to copyright (AGI 1993, p.9). Consequently most geographic information products in Britain are covered by the provisions of copyright law provided that they involve skill and labour and have not been copied.

The person who creates the work is regarded as the initial owner of copyright. However, employers are presumed to own the copyright in the case of works created by their employees in the course of their duties and the Crown has the copyright in works produced by civil servants.

Copyright owners are allowed a fixed period in which they may exploit their rights. This is normally during the life of the author plus a further year. For computer generated work the duration of copyright is 50 years from their creation (Larner 1992).

The holder of Crown copyright is the Controller of Her Majesty's Stationery Office and the provisions of the copyright act insofar as they relate to government departments are administered by the copyright unit of HMSO. This deals with requests for permission to reproduce crown copyright material. However, the administration of Crown copyright relating to maps is delegated to the Director General of the Ordnance Survey who is also responsible for deciding the rules and terms for reproducing this material (Ordnance Survey 1994). Ordnance Survey digital map data is available under a variety of copyright licensing agreements. Of particular importance in this respect is the distinction made between the conditions of digital copyright licences for agreement business use within organisations and the use of Ordnance Survey data in commercial third party products. Given that royalties constitute a considerable proportion of its income the Ordnance Survey fiercely defends its intellectual property rights and won a high court case regarding copyright in 1995 (Rhind 1995).

In addition to copyright legislation geographic information comes under the 1984 Data Protection Act which regulates the use of digital information relating to individuals. All users are required to register and abide by its principles to ensure that personal data is obtained and processed fairly and used only for previously specified purposed (Data Protection Register, 1993).

4. ELEMENTS OF NATIONAL GEOGRAPHIC INFORMATION STRATEGY

4.1 The Chorley Report

The starting point for much of the present discussion about the need for a national geographic information strategy in Britain is the publication in May 1987 of the Report of the Committee of Enquiry on Handling Geographic Information chaired by Lord Chorley (DoE 1987). The main body of this report is divided into two more or less equal parts. The first of these consists three chapters reviewing recent developments in geographic information handling technology whereas the second deals in more details with the specific issues involved and sets out the reasoning behind the 64 recommendations made to the Secretary of State for the Environment.

The first part of their report sets the scene for further discussion. It reflects the committee's enthusiasm for the new technology: "the biggest step forward in the handling of geographic information since the invention of the map" (para 1.7) and also their concern that information technology in itself must be regarded as "a necessary, though not sufficient condition for the take up of geographic information systems to increase rapidly" (para 1.22). To facilitate the rapid take up of GIS the committee argues that it will be necessary to overcome a number of important barriers to effective utilisation. Of particular importance in this respect are the need for greater user awareness and the availability of data in digital form suitable for use in particular applications.

Given this context, the committee's most important recommendations are those relating to digital topographic mapping, the linking and availability of data and the role of government. With respect to digital topographic mapping, its recommendations for an accelerated programme of digital data conversion using a simplified specification for conversion purposes are now largely a matter of historic interest given the completion of the national digital topographic database by the Ordnance Survey in 1995.

In contrast, the committee's recommendations on data availability and data linkage are still of considerable relevance. They stress the importance of maximising the use of geographical spatial data held by government and other public sector agencies. It is vital for this purpose therefore that the agencies involved should take the necessary steps to make their data available to users, preferably in an unaggregated form, except where this is prevented by the questions of confidentiality. The committee also point out that the main benefits of introducing GIS depend to a large extent on linking data sets together, and that it will be necessary to develop standard forms of geographic description to facilitate linkage based either on the coordinates of the National Grid, or in the case of socio economic data, on postcode areas used by the Royal Mail.

Underlying the whole report is the argument that Government has a central role to play in the future development of the field and that it must give a clear lead in this respect. With this in mind the committee considered a number of options before finally recommending the establishment of an independent Centre for Geographic Information with strong links to government:

1. to provide a focus and forum for common interest groups, or clubs;
2. to carry out and provide support for promotion of the use of

geographic information technology ...;

3. to oversee progress and to submit proposals for developing national policy in the following areas:

"- the availability of government spatial data, the operation of data registers and arrangements for archiving of permanent data;
- the development of locational referencing, standard spatial units for holding and releasing data, the operation of the post code system and the development of data exchange standards (cartographic and non cartographic);
- the assessment of education and training needs and provision of opportunities to meet them; and
- the identification of R&D needs and priorities, including advice to government on bids for R&D funds." (para 10.22)

Subsequent developments with respect to the development of strategies for promoting data availability and facilitating data linkage will be covered in later sections of this paper. As far as the proposals for a national Centre for Geographic Information are concerned, the government response was generally negative. It argued that it was better to encourage existing organisations to expand their range of activities rather than set up new organisations (see Masser 1988, and Rhind and Mounsey 1989 for a further discussion of the report itself and the governments response to its proposals).

Despite this, a new organisation, the Association for Geographic Information (AGI) was set up in January 1989 with help from the government. According to its current director, the basic mission of the AGI is to spread the benefits of geographic information and to help all users and vendors of GIS (Leslie 1994). The work of the Association is concentrated around three main activities: informing, influencing and acting. Informing activities include its publications, seminars and conference. Influencing activities involve liaison with government agencies and other organisations to encourage the greater use of geographic information while acting activities include various special projects initiated by the Association itself. The most important of these from the standpoint of the development of a national geographic information strategy are the work that has been undertaken on the development of standards both in the UK and in Europe and the round table discussions initiated by the Association with bodies like the Ordnance Survey on data charging policy, and the Office of Population Censuses and Surveys on problems regarding the availability of census data and planning for the 2001 census. In a recent series of meetings with key government organisations, the round table format has also been used to explore some of the key issues that need to be resolved with respect to the further development of a national geographic information infrastructure such as data availability, marketing, legal protection and standards.

The AGI is a cross between a learned Society and a trade organisation which tries to represent the interests of both its individual and corporate members who include both the suppliers of geographic information and its users (Leslie 1994). The Association has over 700 members from central and local government, the private sector, the utilities and academia. The subscriptions of these members provide the core funding for its activities. They are governed by a council elected by the members and serviced by a small secretariat of two full time staff and a part time director based in offices at the Royal Institute of Chartered Surveyors in Westminster. The AGI also represents Britain's interests on the European Umbrella Organisation for Geographic Information (EUROGI).

Another outcome of the Chorley Report is the official working group that was set up to following up those of its recommendations that required co-operation between government departments (Oliver 1994, p.2). This group was re-launched in 1993 as the Inter-departmental Group on Geographic Information (IGGI). This regularly brings together representatives from 30 or more government agencies and seeks to

"- provide a forum for government departments to consider and develop a common view on issues effecting or effected by geographic information
- facilitate the effective use, both within and outside central government, of geographic information held by government departments;
- consider barriers to realising the fullest potential of government held geographic information and take practical steps to overcome them."

The chairman and secretary of the IGGI are based in the Planning and Land Use Statistics section of the Department of the Environment.

As might be expected the IGGI has been very active in the debate regarding the development of a national geographic information strategy (see below). It also sees itself as having a key role of play in the debate between the government and the wider geographic information community. With this in mind it has worked closely with the AGI in the planning and organisation of the government round table meetings.

4.2 National Core Data

It will be clear from the previous discussion that many of the elements of a national core database for geographic information are already in place in Britain. These include the national topographic database maintained by the Ordnance Survey and associated products such as Addresspoint and OSCAR as well as the land and property information held by the Land Registry and the social economic data held by the Office of Population Censuses and Surveys. Consequently the main issues are generally perceived in Britain in terms of the linking of these data sets rather than their creation as is the case in many other countries. Of special interest in this connection are two complementary initiatives that are taking place at the present time. The first of these involves a pilot project to evaluate the feasibility of setting up a national land and property information system to link data holdings from several sources. This project also provides a useful opportunity to test the recently agreed BS7666 Land and Property Gazetteer standards in operation. The second project outlines a vision of a National Geospatial Database which goes considerably further than the data holdings linked in the previous pilot project.

4.2.1 National Land Information System

Many groups have argued for some time that special priority must be given to the establishment of a national land and property information system (see, for example, Dale 1994). As a result a joint working group of the Department of the Environment, the Ordnance Survey, the Land Registry, the Valuation Office and the Local Government Management Board was set up in 1994 to undertake a live pilot project to explore the feasibility of establishing a national land information system. The project itself covered two postal districts in Bristol containing about 30,000 properties located in over 700 streets. The basic tasks of those involved was to link together data held by the Ordnance Survey, the Land Registry, the Valuation Office and the City of Bristol itself using the unique property reference numbers (UPRN) contained in the Land and Property Gazetteer developed by the Local Government Management Board with the encouragement of the AGI, and embodied in BS7666 (Manthorpe 1995).

The system developed for this purpose operates on the Land Registry's main frame but provides on-line access from a single terminal to databases held by the Ordnance Survey in Southampton, the Valuation Office in Worthing, the Land Registry in Plymouth and Bristol City Council in Bristol. During the trial phase of this project a high matching rate of over 95% was achieved for residential properties which indicates the potential for even higher matching as data structures are further refined (Manthorpe 1995).

The national land information system pilot project demonstrates the potential advantages to be derived for users, especially legal users requiring information about property ownership and details regarding valuation and planning constraints relating to particular properties, from linking key data sets. In the light of this experience it is argued that it will be necessary to consider in much greater detail the potential demand for such a service and at the same time to consider questions such as its management and financing. Consequently it is felt that such developments offer "scope for private sector partnership and will promote greater freedom and access to essential information for the public and business" (HMLR 1995, p.25).

4.2.2 A Vision of a National Geospatial Database

The 1995 Ordnance Survey Framework Document included among its objectives plans to create a national geospatial database by linking its national topographic database to other spatial data such as those held by other government departments. A recent report from the Ordnance Survey gives some indication of the form that this national geospatial database might take (Nanson et al. 1996). The authors argue that the American concept of a national spatial data infrastructure is not applicable to Britain because of the relative autonomy of British government departments, the continuous pressures on them to reduce costs and/or raise revenue and the lack of Freedom of Information legislation. On the other hand, there has been formal encouragement from British ministers for government departments to work together and the Secretary of State for the Environment has asked the Ordnance Survey to be proactive in promoting greater co-operation. With this in mind the authors set out a vision of the national geospatial database as a virtual database which is not the property of any one organisation but "the totality of many individual datasets collected and held separately by many different organisations" (page 4).

It is argued that such a loose structure can only be made to work if certain standards are accepted and adhered to by all participants. Consequently a data set will qualify for inclusion in the national geospatial database only if it meets the following conditions

"- the data set has been created and maintained to certain defined common standards.
- the characteristics of the data set are defined in a common way and made generally available through a standard and easily accessed channel.
- the data set is accessible and defined in publicised terms.
- it is possible to link this and other data sets together through a set of standard tools ..." (p.4).

Given the initiatives already underway in Britain it is felt that there is not need for a "big bang" approach with its consequent requirement for large scale funding to achieve such a vision.

"It is the Ordnance Survey view that the national geospatial database will be created gradually by the process of data providers

> entering into partnerships - joining the club - when the time is appropriate for them to do so. This will be facilitated by the creation of the overriding data architecture described above and a technical delivery architecture to integrate data sets and to deliver the applications". (p.7).

What is needed, therefore, is to bring together all these initiatives into a combined programme of research and development in order to refine the concept of a national geospatial database. With this in mind the Ordnance Survey has set up a small group to help bring the concept closer to reality.

4.3 The Spatial Information Enquiry Service (SINES)

The Spatial Information Enquiry Service is a simple metadata service which has been administered by the Ordnance Survey since 1994. It is a database which contains details of more than 500 spatially referenced data sets held by over 40 government departments and related bodies. These details include

- title of the data set.
- purpose for which the data were collected.
- method and source of data collection.
- time period covered by the data set.
- geographic area covered.
- data items.
- spatial references used.
- base may usage.
- system/software used to store the data.
- data availability.
- contact point for further information. (Garnsworthy and Hadley 1994).

SINES can be accessed by telephone, fax, email or through the world wide web. To find out what data sources exist on a particular topic or for a particular area users can search the database using various key words. In its current form SINES provides a useful overview of what spatial information is held by government departments and also gives contact addresses for each data set so that potential users can obtain further information regarding their availability and status if they need.

5. EVALUATION

The findings of the above analysis highlight the great diversity of interests involved in geographic information in Britain within the public sector. In addition to these interests there is an even greater diversity of private sector interests ranging from hardware and software vendors to information providers and from public policy pressure groups to the academic research community. This diversity is reflected in the view that the body set up to represent these interests, the Association for Geographic Information, has to be regarded as a cross between a learned society and a trade organisation (see 3.1 above).

The analysis also draws attention to the fact that in most cases there is no single agency responsible for various types of geographic information in the UK as a whole because of the special circumstances governing the United Kingdom. Consequently it is necessary, for example, to consult two different agencies (the Ordnance Survey and the Ordnance Survey of Northern Ireland) when topographic data for the whole country is required and three different agencies (OPCS, the General Registry Office Scotland and the Department of Health and Social Security in Northern Ireland) to bring together census of population data for the UK. Given these difficulties and the relative size of the constituent elements it is also not surprising to find that much of the debate has been dominated by English interests and that the differences between these and the other members of the United Kingdom are not always fully appreciated by outsiders.

These variations present a number of problems with respect to access to data held by government departments which are exacerbated by the current confusion regarding government policy for marketing information noted above

(Section 3.2). As a result, users seeking the same information from the equivalent agencies in the constituent members of the United Kingdom may get different answers from them when they request information. These may reflect either pressures to release tradeable information, pressures to recover costs of the sale of information at market or near market levels or a failure to address such issues because of other priorities or lack of resources accordingly.

Access to information held by government departments is not only a problem for the private sector. A recent study of geographic information system use in government departments and non departmental public bodies (Hookham 1995, p.20) found that "the availability of digital information, at an affordable price, was biggest single barrier to public sector use of GIS". The findings of this study also indicate the unwillingness of many departments to release geographic information was due to a lack of resources to tackle issues such as product definition, marketing, pricing, copyright, liability, privacy and support for the development of marketing services (AGI 1995, p.2).

Copyright and data protection issues also need much greater attention than has hitherto been the case given the nature of the changes that are currently taking place with effect to both the de jure and de facto positions. The recent AGI government round table draws attention to the need for clarification on these matters with respect to the provisions of current legislation (AGI 1995, p.2). However, at the same time it is also necessary to take account of potential impacts of developments at the European level which may alter this day duray position. For example, the new EU directive on legal protection of databases may have importance consequences for copyright provision and bring Britain more into line with other European countries in this respect. It is also necessary, however, to take account of de facto developments with respect to geographic database creation as a result of the introduction of new imaging technologies which provide alternatives to conventional topographic maps for certain applications.

Despite these difficulties it can be seen from the analysis that the Chorley Report has had a considerable impact on the development of national geographic information strategies in Britain. It has played a major role in raising awareness of the issues involved and also led to the establishment of the AGI as a forum for the national geographic information community and the creation of the predecessor to the IGGI to co-ordinate geographic information activities within government departments. The recommendations of the Chorley Report also resulted in the acceleration of the Ordnance Survey national topographic database digitation programme which led to its completion last year.

Despite this, in some key respects of national geographic information strategy there has been less progress. Notwithstanding its achievements in informing, influencing and acting, the AGI has yet to take to a leading position with respect to the formulation and co-ordination of national geographic information strategy. Similarly, the powers of the IGGI are limited from this point of view. Consequently there is no British equivalent with the same political support and the same powers of the US Federal Geographic Data Committee that has played such an important role in the development and implementation of the National Spatial Data Infrastructure.

In the absence of such a body the Ordnance Survey has played a key role in the development of national geographic information strategies. It should also be noted that the Director General of the Ordnance Survey is official advisor to the UK government on all survey, mapping and GIS related matters. For this reason its recent shift in emphasis from the establishment of a national topographic database to a vision of a national geospatial database which links data sets held by other agencies must be regarded as an important move in the development of a national geographic information strategy.

However it is important to note at this stage that the merger of the Central Statistical Office and the Office of Population Censuses and Surveys to form the new Office of National Statistics could have important consequences for national information policies as a whole. Of particular importance in this respect is likely to be the establishment of a new central database of key economic and social statistics to give greater confidence and compatibility in government statistics.

Nevertheless, the findings of the analysis show that there is a great deal of interest in development of national geographic information strategies in Britain among the key players and that Britain is in some respects ahead of many other countries now the core digital national topographic database is in place. Consequently, the key players have been able to focus their attention on measures such as the national geospatial database to link other data sets to this core database rather than the creation of the core database in itself. The results of the national land information system pilot project are also encouraging.

This shows that the technical problems involved in linking data in different centres to create a virtual database can be overcome. In both cases, however, the next stage of these projects are likely to be the crucial ones from the standpoint of the further development of national geographic information strategies. The vision of the national geospatial database has still to be fleshed out into concrete proposals. Similarly the business case for the national land information system has still to be developed and accepted by government.

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Japan Strategies for National GIS Development - Preparation of GIS Data Sets and Related Activities by GSI

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INTRODUCTION

Needless to say, the development of the Geographic Information System (GIS) has been recently one of the most important tasks worldwide. In Japan, for the purpose of administrative and academic uses, digitization of geographic information and computer processing of the data have been conducted since the middle of 1970s, though small numbers of organizations or governmental bodies had dealt with it. Since about three years ago when the Geographical Survey Institute (GSI), Ministry of Construction (MOC) of Japan began to publish digital cartographic data sets, development of GIS has been accelerated. At present, the central government has got to a consensus that active encouragement for GIS development is necessary. Within these procedures, GSI has played an important role, and its responsibility is becoming more and more important. In this paper, the activities concerned to GIS development by mainly GSI and its future strategies are summarized.

서 론

최근 전세계적으로 GIS에 관한 연구개발이 매우 중요하게 인식되어지고 있다. 일본에서는 이전에는 소수의 단체와 정부기관에서만 이를 수행하고 있었지만, 1970년대 중반이래 중앙 및 지방 정부 사용용 데이터에 대한 연구 개발작업 및 구축 등 GIS에 관한 연구개발에 많은 노력을 경주해 왔다. 일본 건설성 산하 국토지리원(GSI; Geographical Survey Institute)에서는 지난 1993년 6월이래 지도제작용 수치지도를 발행하면서 GIS에 대한 연구개발에 상당한 노력을 기울이고 있다. 현재, 정부에서도 GIS에 대한 실질적인 연구개발의 중요성을 인식하여, 이를 바탕으로 국토지리원은 GIS 개발에 있어서 중요한 역할을 담당하고 있으며, 그 책임 또한 점차 증대되고 있는 실정이다. 이에, 본논문에서는, 주로 GIS에 대한 국토지리원의 활동 및 미래전략에 대하여 소개하고자 한다.

2. PUBLISHING OF DIGITAL MAP SERIES

GSI is a national mapping organization responsible for preparation of various basic maps. As a part of those activities, it has been developing digital geographic information since the middle of 1970s. In cooperation with the National Land Agency, it has developed the Digital National Land Information ("Kokudo-Suuchi-Jouhou") that is necessary for national land development planning and regional planning by the central governmental agencies and the local governments. It has also prepared the Detailed Digital Land Use Data ("Saimitsu-Suuchi-Jouhou") to support the policy making of building land administration in collaboration with the Economic Affairs Bureau of MOC. However, they have not been disclosed to the public but used only by administrators within central and local governments and researchers in universities.

In June 1993, GSI has launched to publish digital cartographic data sets called the Digital Map Series ("Suuchi-Chizu"). Since then, the variation and number of published digital cartographic data have increased year by year. At present, six kinds of Digital Map Series are available. They are Digital Map 10000 (combined), Digital Map 25000 (shore lines and administrative boundaries), 50 m mesh (elevation), 250 m mesh (elevation), 1 km mesh (elevation) and 1 km mesh (average elevation) (shown in Table 1).

Table 1 Kinds of Digital Map Series and Characteristics

Kind of Digital Map	Number of disks available (as of Mar.1996)	Characteristics
10000(combined)	232	about 5km x 5km in one disc only major cities
25000 (shore lines and administrative boundaries)	86	about 80km x 80km in one disc to be revised every year
50m mesh (elevation)	2165	about 10km x 10km in one disc about 4000 discs to cover japan
250m mesh(elevation)	88	about 80km x 80km in one disc all Japan already covered
1km mesh(elevation)	1	all Japan compressed in one disc
1km mesh (average elevation)	1	all Japan compressed in one disc
Total	2573	

They are text files in MS-DOS format and distributed by 1.2/1.44 Mb floppy disks with simple software for quick browsing of the image of data inside. Table 2 indicates the amounts of sales of each data set. In terms of the purpose for purchasing these data sets, according to the result of questionnaire to users who purchased them, education, analysis of topography, regional planning and assistance for administrative works are majorities and the use with specified purpose such as facility management, navigation and marketing is not much.

The formats of these data sets were developed exclusively for this Series, and as the result, they are not compatible with existing GIS and other mapping software applications. However, owing to the efforts of third party software developers, more than 20 application software for these digital maps has appeared to the market, such as a format converter for existing GIS software, an original GIS software for Digital Map Series etc.

Table 2 Sales of Digital Map Series (annually)

Kind of Digital Map	jun.1993-Mar.1994	Apr.1994-Mar.1995	Apr.1995-Mar.1996
10000(combined)	4026	7075	6543
25000(shore lines andadministrative boundaries)	2491	2343	3231
50m mesh (elevation)	3513	5277	14069
250m mesh(elevation)	695	3689	4788
1km mesh(elevation)	-	103	195
1km mesh (average elevation)	-	84	99
Total	10725	18571	28925

3. GEOSPATIAL FRAMEWORK DATA

Since 1995, GSI has started to prepare new type of digital cartographic data sets called Geospatial Framework Data for major metropolitan areas (Tokyo and Osaka; shown in Table 3). Table 4 indicates the contents of these data sets.

Table 3 Data Acquisition Area of Geospatial Framework Data

Tokyo Metropolitan Area	7,878km2	(Built-up area suburban development area designated by the National Capital Region Development Act)
Osaka Metropolitan Area	5,408km2	(Built-up area suburban development area designated by the Kinki Region Development Act)
Total	13,286km2	

Table 4 Contents of Geospatial Framework Data

Item	Data Structure	Attribute
administrative boundary and coastal line ("Cho-Chomok"/"O_Aza"(municipal section)as the minimum unit)	poligon,arc,point	administrative code, name of each municipality
block(square)	polygon, arc	block code("Ban")
road line network	vector,network	name of each road
road center line boundary of road and sidework boundary of road site (only for national highway)	vector	name of each road
river center line boundary of river site (only for major livers)	vector,polygon	name of each river
rail road and station	vector,point	name of each railroad and station
inland water surface specific area (park,airport etc.)	polygon	name of each area
building (only for the central districts)	raster image polygon (only public buildings)	code and name of each public building

The characteristics of these data sets are;

1) structured by several very simple items,
2) distinguishing each block as a polygon(suitable for address matching),
3) containing road network structure,
4) manageable by a personal computer and easy to be transferred.

Data sources are;

1) converted data from digital map data which GSI already has,
2) newly digitized data from the 1:2,500 base map for city planning which local governments have, or
3) newly digitized data from the 1:500 map for road management which some local offices of the Ministry of Construction have.

These data sets will be published for the use of unspecified individuals at an appropriate price as the Digital Map Series have already been. It is also intended to be distributed free of charge to every local government that provides data sources.

4. RESEARCH AND DEVELOPMENT AND STANDARDIZATION

For promoting the preparations and use of digital cartographic data sets, many efforts such as research and development works, preparation of data, standardization of data and methodology have been carried out mainly by GSI since the middle of 1970s.

Today, MOC is making a big effort for development and utilization of GIS with recognizing the necessity and important role of GIS in the high information society. Launching the preparation of new type of digital cartographic data sets by GSI is one of the examples. For establishing the new strategies relating to GIS, the headquarters of MOC and GSI are jointly organizing GIS Research Committee, which consists of professors from universities. The first report by the Committee was presented on February 2, 1996.

One of the targets of the new strategies of MOC is standardization of GIS. As for the international standardization of GIS, GSI is involved in the activities of ISO/TC211 with the support by other related agencies and professors from universities. Japan has undertaken the secretarial work of two Work Items with Japanese team leaders among 20 Work Items of TC211. GSI recognizes that the harmonization between national standards and international standards, which is discussed in ISO/ TC211, is important.

There are many ministries and agencies that are concerned or interested in GIS in the Japanese Government. Cabinet Councilors' Office on Internal Affairs is organizing Interagency GIS Task Force. Both GSI and National Land Agency are the Secretariat of it. MOC, recognizing its important role as a core member of it, has a will to enhance the cooperation with other ministries and agencies concerned.

5. GLOBAL MAPPING AS INTERNATIONAL COOPERATION TOWARD GIS HARMONIZATION

Many scientists and government policy makers today are undertaking a variety of studies in an attempt to understand and solve global environmental problems. The studies require basic geographic information that describes the present conditions of the earth's environment and detects the changes. The surveying and mapping community is charged with developing a global map of integrated geographic data with consistent specifications and at least one kilometer spatial resolution on the ground. In this context, GSI has organized International Workshop on Global Mapping. First workshop was held in November 1994, and in February 1996, another workshop was held in Tsukuba, Japan and the International Steering Committee has been established. Global mapping project can be considered as a construction of common asset for worldwide GIS harmonization.

우리나라의 국가GIS 구축전략

金 永 杓

국토개발연구원 국토정보실장

1. 머 리 말

국내의 학계와 연구기관에서 GIS(Geographic Information System)에 관심을 갖기 시작한 것은 80년대 초반부터이다. 초기에는 국내에 신기술 소개차원 또는 일부 기관의 시설물관리 실험사업 정도에 머물렀으나, 90년대에 접어들면서 여러분야에서 GIS에 관한 관심이 빠르게 확산되고 GIS관련 사업규모도 점차 커지게 되었다. 이에 따라 가장 먼저 대두된 문제는 GIS사업 추진에 기본이 되는 바탕지도의 수치지도화 문제였다. 당시 수치지도화 사업의 필요성에 대한 공감대는 널리 형성되어 있었으나, 사업추진에 적지 않은 예산이 필요하기 때문에 지도공급기관에서 수요자들의 요구에 제대로 부응할 수 없는 실정이었다. 그러나 지도공급기관들은 어려운 여건 속에서 나름대로 GIS사업구상과 실험 및 시범사업을 추진하면서 꾸준히 기술을 축적해 왔다. 한편 지도수요기관들 중 일찌기 GIS사업을 선도해 가던 일부기관들은 자체적으로 수치지도를 제작하여 사용하기도 했으나, 국가적 차원에서 볼 때 여러 가지 낭비요소가 드러났다.

수치지도 제작에 대한 기관간의 중복투자와 범용성 결여도 문제였지만, 가장

주 : 이 글은 1995년 5월 정부에서 발표한 『국가지리정보체계 구축 기본계획』을 토대로 작성하였음

큰 문제는 표준화와 정확도에 관한 것이었다. 그러한 가운데 공공 수요기관을 중심으로 GIS 활성화 방안 모색을 위한 활발한 모임이 있었다. 또한 21세기의 고도정보화사회에 대비하여 GIS 개발을 촉진하고, GIS 관련 산업을 경쟁력 있는 산업으로 육성하기 위해서는 국가차원에서의 GIS 기반조성이 필요하다는 인식이 정부내에서도 확산되기 시작했다. 이러한 과정 속에 마침내 1994년 5월 27일 경제장관회의에 『국가지리정보체계 구축방안』이 주요안건으로 상정되었고, 최고정책결정자들도 국가GIS사업에 관심을 갖게 되었다. 이후 범정부 차원에서 국가GIS사업이 본격적으로 논의되었고, 지난해 5월 19일 정부가『국가지리정보체계 구축 기본계획』을 확정해 발표함으로써 비로소 국가차원의 GIS 추진체제를 갖추게 되었다.

이 글에서는 현재 정부가 추진하고 있는 국가GIS사업의 목표, 추진전략 및 절차, 분야별 추진계획, 향후과제 등에 관하여 살펴 보고자 한다.

2. 국가GIS사업의 목표

국가GIS사업의 목표는 첫째 지형도를 비롯해서 공통주제도와 지하매설물도를 99년까지 수치지도화하여 공간정보 데이타베이스 구축 기반을 조성하고, 둘째 97년까지 공간정보 데이타베이스의 표준안을 확립하며, 셋째 98년까지 국가표준을 수용하여 공간정보 데이타베이스를 활용할 수 있는 GIS 소프트웨어를 개발하고 관련 전문인력을 양성하며, 넷째 지적도 전산화사업을 단계적으로 추진하고, 다섯째 95년~97년까지 공공부문에서 GIS를 활용할 수 있는 기반을 마련하고 지하매설물관리체계 개발을 위한 시범사업을 추진하며, 여섯째 공간정보를 효율적으로 구축하기 위한 기초연구를 산·학·연 공동으로 추진하는데 있다.

이러한 목표를 달성하기 위해 국가GIS사업은 다음과 같은 10대 핵심과제를 중심으로 추진되고 있다.

<10대 주요사업>

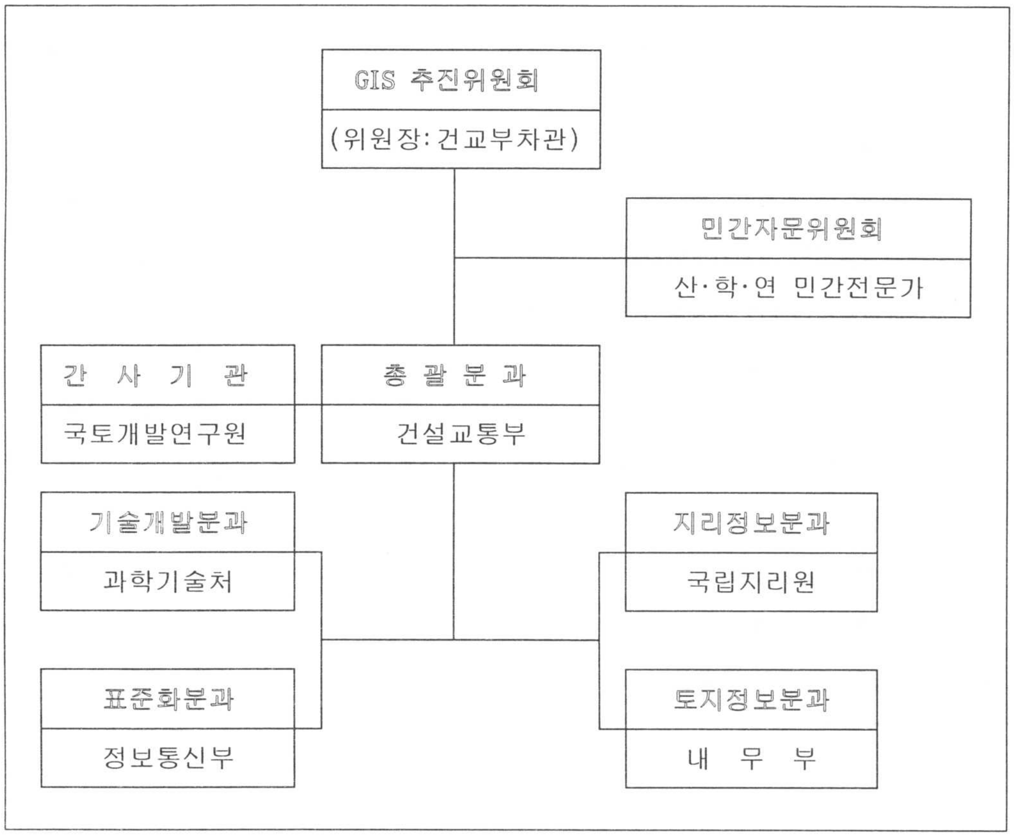
10 대 사 업	사 업 기 간
1. 기본지형도의 수치지도화사업	'95 - '97
2. 공통주제도의 수치지도화사업	'97 - '99
3. 지하매설물도의 수치지도화사업	'95 - 2000
4. 지하매설물관리체계 개발을 위한 시범사업	'95 - '97
5. 공공목적의 GIS활용체계 개발	'95 -
6. 국가GIS사업 지원연구	'95 - '99
7. 기존지적도의 수치화 및 지적재조사 사업 등의 단계적인 추진을 위한 시범사업	'95 - '97
8. GIS 관련 기술의 개발	'95 - 2003
9. GIS 관련 전문인력의 육성	'96 - '99
10. 자료 입력 및 교환 표준화	'95 -

3. 국가 GIS사업 추진전략 및 절차

3.1 추진체제

국가GIS사업에는 재정경제원을 비롯해서 내무부, 농림수산부, 통상산업부, 건설교통부, 정보통신부, 환경부, 총무처, 과학기술처 등 9개 부처와 통계청 및 산림청이 참여하고 있다. 당초 이 사업은 재정경제원이 주도했으나, 지금은 건설교통부에서 주관하고 있다. 국가GIS사업 추진체제는 관련부처가 참여하는 국가GIS추진위원회 산하에 총괄분과, 지리정보분과, 기술개발분과, 표준화분과, 토지정보분과 등 5개 분과위원회가 있고, 산학연 민간전문가로 구성된 민간자문위원회가 있다.

<추 진 체 제>



그리고 총괄분과 간사기관으로 국토개발연구원이 지정되어 국가GIS사업에 필요한 각종 계획 수립과 지원연구를 수행하고 있다.

3.2 추진전략

공업사회와는 달리 정보사회에서는 GIS 및 그와 관련된 데이타베이스들이 국가경쟁력을 강화하고 행정생산성을 높이는데 기반이 되는 사회간접자본이라는 인식이 높아가고 있다. 그런데 우리나라의 경우 GIS 활용기반이 아직 제대로 갖추

어지지 못한 실정이다. 예컨대 지형도 등의 수치지도 제작은 초기입력단계이고, 공통주제도의 수치지도화는 방향설정단계이며, 소프트웨어 및 데이타베이스 툴(tool) 등 관련 기술은 대부분 외국산에 의존하는 형편이다. 그리고 국토관리, 환경관리, 재해대책 등 GIS 활용분야에 관한 연구도 걸음마단계에 있다.

이러한 여건을 타개하기 위해서는 GIS 관련 산업을 육성하고 GIS 사업을 적극 추진해 가야 하는데, 이를 민간부문에 맡겨 두기에는 투자재원 확보, 공간정보 구축 등의 문제에서 한계가 따른다. 따라서 머지않아 다가 올 고도정보화 사회에 대비하여 GIS 개발을 촉진하고, 이를 경쟁력 있는 산업으로 육성하기 위해서는 국가차원의 GIS 기반조성이 요구된다.

이러한 배경에서 출발한 국가GIS 구축계획은 국가차원에서 GIS의 국가표준을 설정하고, 기본적인 공간정보 데이타베이스를 구축하며, GIS 관련 기술개발을 지원하여 GIS 활용기반과 여건을 성숙시키는데 그 목적이 있다.

한편 국가GIS 구축사업은 범국가적인 사업이므로 관련 부처가 모두 참여해 업무를 분담하여 추진하고 있다. 국가GIS사업에는 향후 5-6년 동안 약 2천8백억원 규모의 재원이 소요될 것으로 추산되는데, 중복투자를 막기 위해서는 공공부문과 민간부문에서 공동으로 재원을 마련하는 것이 바람직하다. 따라서 소요재원 중 64%는 중앙정부와 지방자치단체에서 투자할 계획이고, 나머지는 민간부문에서 재원을 공동으로 조성할 계획이다.

그리고 생산된 각종 공간정보가 공공과 민간에 원활히 유통될 수 있도록 계획기간 중 공간정보의 유통을 전담할 기구를 설치하고, 아울러 (가칭)공간정보유통관리법 등 새로운 법제를 도입할 계획이다.

현재 추진 중에 있는 1단계 국가GIS사업이 99년도에 마무리되면, 이어 2000년부터 공간정보의 유지보수, GIS핵심기술의 국산화, 지적도의 전산화 등 2단계 사업을 계속 추진할 계획이다. 국가GIS사업을 추진하는데 있어서 정부가 전략적으로 주도해야 할 부문을 좀 더 구체적으로 열거하면 다음과 같다.

<정부 주도 부문>

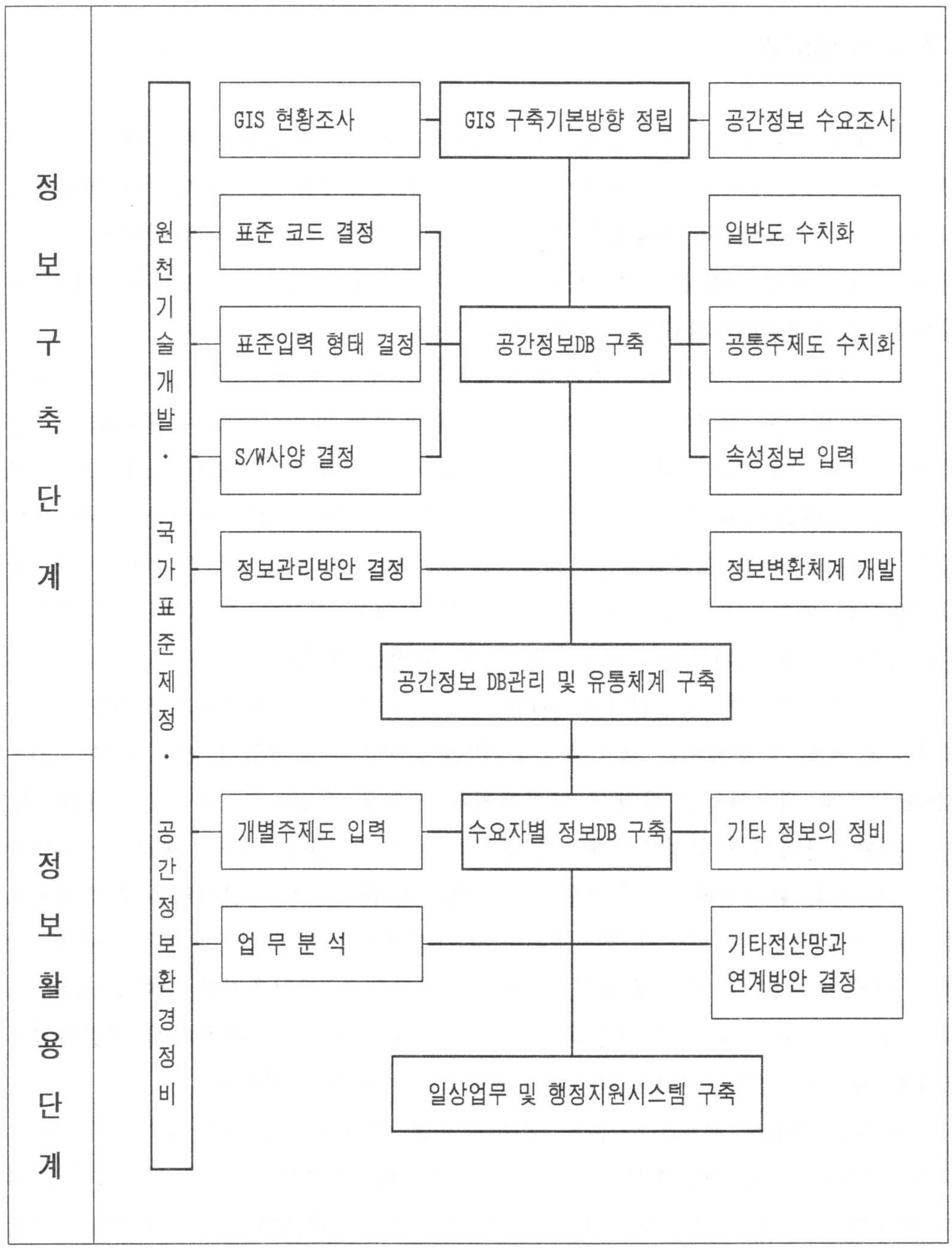
공간정보의 표준화 및 DB 기반구축	기술개발지원 및 전문인력양성
- 기본도형정보 표준화 - 공통데이타 포맷 표준화 - 데이타베이스 설계 - 각종 지도의 수치지도화	- GIS 핵심기반기술 개발지원 - GIS 응용기술 개발지원 - GIS 전문인력 교육 및 양성 지원
공공 GIS활용체계 개발지원	**제도 정비 및 재원 확보**
- 공간의사결정지원체계 - 행정지원체계	- 정보유통기구(Clearing House)의 설치 운용 - 관련제도 및 법규 정비 - GIS기반 조성을 위한 공공부문과 민간부문의 공동재원 조성

3.3 추진절차

국가 GIS사업은 정보구축단계와 정보활용단계로 나누어 추진되고 있다. 정보구축단계에서는 공간정보의 수요와 공급현황을 조사하고, 공간정보체계의 기본틀을 정립하며, 공간정보 데이타베이스를 구축하고, 공간정보 관리 및 유통체계를 개발할 계획이다.

정보구축작업이 일정 수준에 이르면 구축된 공간정보가 널리 활용될 수 있어야 할 것이다. 정보활용단계에서는 수요자의 목적별로 데이타베이스를 구축하고, 공간의사결정지원체계를 개발하며, 일상업무 및 행정지원시스템을 구축하여 공간정보를 실질적으로 활용할 수 있는 기반을 마련할 것이다. 국가GIS의 구축과정을 개괄적으로 도시하면 다음 그림에서 보는 바와 같다.

<국가 GIS 구축 과정>


정보구축단계
정보활용단계
원천기술개발 · 국가표준제정 · 공간정보환경정비
GIS 현황조사
GIS 구축기본방향 정립
공간정보 수요조사
표준 코드 결정
표준입력 형태 결정
S/W사양 결정
공간정보DB 구축
일반도 수치화
공통주제도 수치화
속성정보 입력
정보관리방안 결정
정보변환체계 개발
공간정보 DB관리 및 유통체계 구축
개별주제도 입력
수요자별 정보DB 구축
기타 정보의 정비
업 무 분 석
기타전산망과
연계방안 결정
일상업무 및 행정지원시스템 구축

4. 분야별 추진계획

4.1 총괄분과

국가GIS구축사업은 장기간에 걸쳐 막대한 비용이 소요되는 사업이기 때문에 공간정보 데이타베이스 구축과 함께 활용체계의 개발사업 및 지원연구가 병행되어야 비로소 그 활용도와 효율성을 높일 수 있다. 따라서 총괄분과위원회에서는 지하매설물관리체계 개발을 위한 시범사업을 비롯해서, 공공목적의 GIS활용체계 개발사업, 국가GIS사업 지원연구를 추진하고 있다.

지하매설물 전산화사업은 최근에 문제시되고 있는 대형사고 등을 사전에 예방하기 위한 방안을 강구하기 위하여 공공GIS활용체계 개발사업의 우선사업으로 실시되고 있다. 그런데 지하매설물 전산화사업은 많은 예산과 시일이 소요되므로 전국적으로 시행하기 이전에 소규모 도시를 대상으로 시범사업을 추진함으로써 시행상의 문제점을 미리 도출하여 그 해결방안을 마련하는 것이 효과적이다. 이에 따라 4월부터 연말까지 과천시를 대상으로 시범사업을 실시한 후, 내년에는 개발된 관리체계에 대한 평가사업과 세부개발지침을 확정할 예정이다.

각종 수치지도가 완성된다고 하더라도 그 자체로는 효용가치가 낮으므로, 그 활용도를 높이기 위해서는 공공목적의 GIS활용체계 개발사업이 병행되어야 한다. GIS활용체계 개발사업은 올해에 세부계획과 지침을 수립하고, 내년에는 개발가능한 GIS활용사업의 타당성분석과 기본설계를 마친 후, 98년부터는 재난 및 재해관리, 교통관리, 환경관리 등 우선순위가 높은 GIS활용체계 개발사업을 본격적으로 추진할 예정이다. 사업추진 우선순위는 국가경쟁력과 행정생산성 등 국가목표 달성에 대한 기여도, 투자의 효율성, 개발후의 파급효과, 사업추진의 난이도 등의 인자를 종합적으로 고려하여 결정될 것이다. 그리고 공공 GIS활용체계 개발사업에 필요한 재원은 정부와 지방자치단체가 공동으로 마련할 계획이다.

국가GIS사업은 새로운 기술을 국내에 처음 적용하는 분야가 많기 때문에 그 시행과정에서 기술측면, 정보축적 및 관리측면, 활용도측면 등에서 여러가지 문제가 발생할 소지가 많다. 따라서 사업 추진에 앞서 관련분야의 선행연구를 수행함으로써 시행착오를 줄일 수 있을 것이다. 이러한 점을 충분히 고려한 국가GIS사

업 지원연구는 총괄분과위원회 주관하에 국토개발연구원이 주축이 되어 추진하고 있다. 지난해부터 99년까지 5년동안 수행할 지원연구는 모두 29개 과제이다.

4.2 지리정보분과

국가GIS 구축계획이 시행되기 이전에는 수치지도가 대체로 개별 수요자의 목적에 따라 제작되어 왔기 때문에, 범용성이 적고 중복투자되기도 했을 뿐만 아니라, 정확도와 신뢰성이 감소하는 등 많은 문제점이 발생하였다. 이러한 문제점을 해소하고 국가GIS구축을 촉진하기 위하여 지리정보분과위원회에서는 국가차원에서 지형도 · 공통주제도 · 지하매설물도의 수치지도화 사업을 추진하고 있다.

<지형도 수치지도화 사업>

수치지도 제작범위	사업 우선 순위
- 1/1000 지형도 : 78개 도시지역 - 1/5000 지형도 : 산악을 제외한 전국 - 1/25000 지형도 : 산악지역	- 1/1000 수치지도 · 6대도시 : 96년까지 완료 · 기타도시: 97년까지 완료 - 1/5000 수치지도 : 수도권 및 대도시지역
재 원 조 달	**사업집행 및 성과관리**
- 1/1000 지형도 : 정부와 지자체 (50:50) - 1/5000 지형도 : 정부와 공사 (50:50) - 1/25000 지형도 : 정부예산	- 지자체분담금은 지리원에서 일괄 집행 - 공사출연금은 국토개발연구원에서 집행 - 완성된 수치지도 성과는 국립지리원이 검증후 관리 · 보급

95년에 시작해서 97년에 완료할 예정인 지형도 수치지도화사업에는 총 558억원이 소요될 것으로 추산되며, 97년부터 3년간 추진될 공통주제도 수치지도화사업에는 총 200억원의 예산이 필요하다. 2000년까지 계속될 지하매설물도 수치지도화 사업에는 엄청난 자금이 필요할 것으로 보이나, 정확한 사업비 규모는 시범사업과 실태조사가 끝나야 산출할 수 있을 것으로 판단된다.

4.3 기술개발분과

지금 추세대로라면 앞으로 국내 GIS시장은 빠르게 팽창하여 10년이내에 현재의 100배 이상 성장할 것으로 전망된다. 그러나 아직 우리나라의 GIS 관련 기술수준이 매우 낮기 때문에, GIS사업 추진에 필요한 매핑 소프트웨어를 비롯해서 GIS 기본소프트웨어 및 데이타베이스 툴의 경우, 대부분 외국제품에 의존하고 있는 형편이다. 그러므로 기술개발에 대한 투자를 적극적으로 추진하지 않으면, 향후 국내의 GIS관련 사업규모가 대폭 확대될 경우, 외국 기술에 대한 의존도는 더욱 높아질 것이다. 그런데 GIS관련 기술개발투자는 그 효과도 커지만 반대로 위험부담도 따르므로 국내 GIS산업 발전을 촉진하기 위해서는 국가GIS사업과 연계하여 기술개발을 추진하는 것이 바람직하다.

기술개발분과위원회는 이러한 점을 고려하여 GIS 기술개발과 전문인력 육성지원에 주력하고 있다. 계획에 따르면 동 위원회 주관하에, 1단계로 98년까지 국가표준을 수용하고 공간정보 데이타베이스를 활용할 수 있는 GIS 소프트웨어를 해외기술협력과 자체기술개발을 병행하여 개발하고, 2단계로 2003년까지 세계시장에 진출할 수 있는 GIS 기반기술을 개발할 수 있는 독자능력을 확보할 목표를 설정해두고 있다. 이처럼 기술개발사업은 단기적인 수입대체보다 장기적인 기술수준 향상의 측면에서 접근하며, 산학연의 협동체제를 구축하여 사용자와 개발자가 모두 참여해서 공동으로 개발하고 필요한 재원도 공동으로 분담하는 방식을 따르고 있다. 프로토타입 개발단계에서는 국가가 주도하여 추진하지만, 상업화 단계에 이르면 민간이 주도하도록 할 계획이다. GIS관련 기술개발 1단계사업에는 총 180억원의 자금이 소요될 것으로 추산하고 있다.

국가GIS사업의 추진과정에서 가장 어려움을 겪고 있는 GIS 전문인력 부족문제를 해결하기 위하여 장단기 GIS전문인력 육성대책을 마련하고 있다. 단기적으로는 GIS설계 및 감리, GIS정보처리분야 등 GIS관련 기술자격제도, GIS 전문인력 단기 양성제도 도입 등을 검토하고 있으며, 장기적으로는 대학에 GIS관련학과 및 교과과정 설치문제를 비롯해서 고급인력 기초연구 지원제도 도입방안을 검토하고 있다. GIS 전문인력의 단기양성 프로그램을 뒷받침하기 위해 정부는 총 41억5천만원을 지원할 계획이다.

4.4 표준화분과

GIS관련 정보와 기술의 표준화 문제는 GIS정보의 유통촉진과 산업발전을 위해 무엇보다도 우선적으로 추진되어야 할 선행과제이다. 각종 지도의 수치지도 제작사업이 수요자 목적별로 추진됨으로 해서 자칫 범용성과 호환성이 결여되지 않도록 ISO 등 국제표준이나 전산망기술기준에관한지침 또는 전산망표준화지침 등 국가표준과 연계된 GIS 표준을 정할 필요가 있다. 따라서 표준화분과위원회는 97년까지 지형도·지적도·공통주제도·지하매설물도를 포함한 기본공간정보 데이타베이스의 표준안을 확립하도록 되어 있다. 표준화 대상은 표에서 보는 바와 같이 자료입력표준, 데이타베이스 구축내용표준, 자료교환표준, 매핑 툴의 기본요건, 응용부분 등으로 구분하고 있다.

우선적으로 표준화를 추진해야 할 대상과제로는 지형도·지적도·해도 등 국가기본도, 공통 데이타 포맷, 관련 법규 및 제도의 개선문제 등을 들 수 있다. 표준화 제정절차는 먼저 GIS 관련기관 및 표준과 관련하여 이해관계를 가진 개인 또는 단체는 필요에 따라 표준화 대상에 대한 표준안을 작성하여 표준화분과위원회에 상정할 수 있다. 상정된 안건은 위원회의 심의를 거치게 되는데, 확정된 안건은 현행의 전산망표준화지침에 따라 GIS 표준안건으로 고시토록 되어 있다. 그리고 전산망표준화지침에 따라 GIS관련 제품의 시험과 인증 절차를 거치도록 한다.

<표준화 대상>

구 분	내 용
디지타이징 표준	신기술의 발달을 수용할 수 있는 표준을 정함
DB구축내용 표준	심볼의 통일 글자표기 통일 도엽코드체계 연속지도에 대한 표준 레이어 번호별 할당 색깔에 대한 표준 기본도의 축척에 대한 표준 기타 필요한 내용의 표준
데이타교환을 위한 표준	공통데이타 포맷 설정
Mapping Tool의 기본 요건	래스터·벡터 혼용기능 연속지도 기능 공간인덱스기능 RDBMS INTERFACE 기능 USER SUBROUTINE 기능 멀티미디어 INTERFACE 기능 REALTIME MONITORING 기능 기타 유용한 기능
응용부분	이용자 그룹을 통하여 표준화대상 도출

4.5 토지정보분과

토지정보분과위원회에서는 지적도 전산화를 통해 통합적인 토지정보시스템을 구축하기 위한 사업을 추진하고 있다. 이 사업은 1단계로 97년까지 기존 지적도의 입력사업과 지적재조사사업을 단계적으로 추진하기 위한 시범사업을 실시하고, 그 이후에는 2단계로 기존 지적도면 전산화사업을 비롯해서 본격적인 지적재조사사업과 종합토지정보시스템 개발사업을 단계적으로 추진할 계획이다.

지난해 창원시를 대상으로 지적재조사 측량을 통한 종합토지정보시스템 구축 실험사업을 수행한 바 있으며, 올해에는 대전시 유성구를 대상으로 기존 지적도면 전산화 시범사업을 실시하여 토지대장과 지적도면을 통합한 지적사무 전산화를 추진할 계획이다.

5. 국가GIS사업의 전망과 과제

우리나라에 GIS기법이 도입되어 태동한 시기는 얼마되지 않았다. 하지만 중앙정부가 범정부차원에서 이 사업을 직접 주관하고 조타수 역할을 하면서부터, 국가GIS사업은 그 기본틀과 앞으로의 항로가 짜임새 있게 잡혀 있는 셈이다. 현재 추진되고 있는 1단계사업이 공간정보 기반구축 단계라고 하면, 향후 2천년 이후에 추진될 2단계사업에서는 1단계에서 구축한 기본지리정보를 유지관리하고, GIS핵심기술을 개발하며, 지적도 전산화사업과 지적재조사사업 등에 초점이 맞춰질 전망이다. 그 밖에도 사회 각 분야에서 기본지리정보를 바탕으로 GIS활용체계를 구축하는 사업이 활발히 전개될 것이며, 아울러 GIS를 이용한 각종 분석연구도 크게 활기를 띨 것으로 전망된다.

국가GIS사업이 중앙정부의 지원 속에 활기차게 추진되고 있고, 앞으로 GIS관련 산업이 더욱 빠른 속도로 발전해 갈 것으로 전망되나, 아직까지는 기술인력 육성문제를 비롯해서 저변확대를 위해 해결해 나가야 할 과제들이 산적해 있다. 그 중 주요한 몇 가지 과제를 살펴보면 다음과 같다. 첫째 재원확보 문제이다. 사실상 사업추진 초기연도라 할 수 있는 올해는 정부의 적극적인 예산지원으로 모든 사업이 순조롭게 추진되고 있다. 그러나 앞으로는 정부 뿐만 아니라 지방자치단체와 정부투자기관 그리고 민간에서도 일부 재원을 분담하도록 계획이 잡혀 있다. 국가GIS구축 계획이 차질없이 추진되어 국가정보화를 앞당길 수 있도록 정부를 비롯한 각 부문의 지속적인 참여와 재정적 지원이 요구된다. 둘째 GIS기술은 우리나라에 소개된지 얼마 안되는 새로운 기술이므로 이를 수용할 법률과 제도가 제대로 갖춰져 있지 못한 실정이다. 그러므로 GIS산업의 발전을 뒷받침하고 공간정보 구축을 제도적으로 지원할 수 있도록 법제를 정비하고 관련 조직을 정비하는 방안

을 차근차근 마련해 나가야 할 것이다. 셋째 정보수요에 신속하고 탄력적으로 대처하면서 정보산업의 시장개방 등에 대비하여 대외 경쟁력을 높이고 자생능력을 배양하기 위해서는, 국가차원에서 기본공간정보 데이타베이스의 구축작업과 병행하여, GIS분야를 활성화시킬 수 있는 공간정보관리유통기구의 설치가 필요하다. 그 밖에도 국가GIS기본도에 대한 보다 구체적이고 명확한 개념정립, 빠른 시장팽창에 따른 전문인력 부족, 국가기간전산망사업 및 초고속전산망 구축계획과의 연계문제 등등 앞으로 풀어 나가야 할 과제들이 산적해 있다.

6. 맺는말

사회 일각에서 "공업화는 늦었지만 정보화는 앞서가자"는 운동이 전개되고 있다. 국토 및 지리 부문의 정보화는 국가GIS 구축사업을 통해 새로운 전기를 맞이하고 있다. 흔히 정보화사회의 사회간접자본으로 간주되는 GIS의 발전수준이야말로 앞으로 한 국가의 정보화 수준을 재는 척도가 될 날도 머지 않았다.

우리나라는『국가지리정보체계 구축 기본계획』의 2차년도에 접어 들면서, 각 분과위원회를 중심으로 국가GIS사업이 활발히 추진되고 있다. 그런데 계획이 진척되면서, 앞에서 언급한 바와 같이 개념적·제도적·기술적으로 집중 검토해야 할 과제들이 여러가지 대두되고 있다. 이러한 과제들은 관계·학계·산업계에 종사하는 GIS관련 전문가들이 다 함께 지혜를 모아 하나씩 해결해 나간다면, 비록 사업 추진과정에 다소의 시행착오와 난관이 있다 하더라도, 국가GIS사업은 본래의 목표를 무난히 달성할 수 있을 것이다.

그리고 국가GIS 구축의 기반조성 단계인 현 시점에서는 우리에게 선진국가들의 GIS 구축전략과 추진경험이 절실히 필요하다. 그러한 점에서 이번 국제세미나는 외국의 전략과 경험을 우리나라에 적용할 수 있는 가능성을 모색해 보고, 아울러 다각적인 국제협력방안도 강구해 볼 수 있는 좋은 기회가 되리라 본다.

Australia's Plans for a National Land and Geographic Data Infrastructure

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SUMMARY

The availability and quality of geographic data are the critical variables in the application of geographic and land information system (GIS/LIS) technology to economic, social and environmental issues. The Australia New Zealand Land Information Council (ANZLIC) has developed a general model for the development of a national geographic data infrastructure. The objectives in developing an infrastructure are to produce standardised fundamental datasets that support high-benefit GIS/LIS information products, to avoid unnecessary duplication of cost and effort in developing and maintaining those data, to facilitate access to and application of those data, and to enable the integration of other application-specific data by all users.

The ANZLIC infrastructure model comprises four components:

- **Institutional Framework**: which defines the policy and administrative arrangements for building, maintaining, accessing

and applying technical standards and fundamental data. Leadership is provided by a 'national geographic data council' that addresses custodianship, directories, distribution, education and training, GIS/LIS applications, and program integration and coordination.

- **Technical Standards**: which define the technical characteristics of the fundamental data. These include standards for the reference system, data model, data dictionary, data quality, data transfer, and metadata.

- **Fundamental Datasets**: which are produced within the institutional framework and fully comply with the technical standards. Market research and cost/benefit techniques are used to identify the fundamental datasets and funding priorities.

- **Distribution Network**: which is the means by which the fundamental datasets are made accessible to the community, in accordance with policy determined within the institutional framework, and to the technical standards agreed.

The content and processes for each component are outlined in the paper. The potential institutional and resource obstacles to successful implementation are outlined and, finally, the paper outlines the way in which Australia has addressed these issues and recent developments internationally.

While the infrastructure model is not intended to be prescriptive, elements may be adapted to the needs and circumstances of Korea. It is suggested that the general model might be used as a benchmark to review current programs and practices. The model may confirm the validity of some approaches, challenge that of others, or indicate possible new activities. Some elements may be immediately adaptable, while others will require modification to suit local needs and circumstances.

요 지

사회, 경제 및 환경문제를 해결하기 위한 방안으로 GIS/LIS 기술을 활용하는데 있어 지리적 자료의 질과 유용성은 중요한 요소이다. 호주뉴질랜드 토지정보위원회(ANZLIC)는 제도적문제, 표준화문제, 데이터베이스구축문제, 공간정보유통문제를 포괄할 수 있는 국가지리정보체계 모델을 개발해 왔다. 국가지리정보체계를 구축하는 목적은 GIS/LIS를 지원할 수 있는 표준화된 기본자료를 마련하고, 구축한 자료를 개발, 유지하는데 필요한 비용과 노력의 중복을 피할 수 있도록 하는데 있다. 그리고 정보에 대한 접근과 응용을 쉽게하여 사용자가 자신의 목적에 맞게 구축한 자료와의 통합이 가능하도록 하는데 있다.

이 글에서는 국가지리정보체계의 구성요소와 진행절차를 개괄적으로 다룬다. 그런 다음, 토지정보위원회가 계획하고 있는 정보구축방법, 구축에 따른 문제점, 해결방안에 대해 간략하게 설명하고자 한다.

1. INTRODUCTION

1.1 The Importance of Land Information

Geographic and land information systems (GIS/LIS) are often defined in terms of technological processes, i.e. they are described as systems for the capture, storage, analysis and display of geographic data. For the purposes of this paper it is more useful to consider GIS/LIS from a functional point of view; to consider them as systems for creating geographic information products. Diagrammatically, we can depict this view in the following way:

REAL WORLD ---> GEOGRAPHIC DATA ---> INFORMATION PRODUCTS

where the arrows represent the application of technology. The loop is closed when the GIS/LIS information products are used by decision makers to improve economic, social and environmental conditions in the real world. The potential of GIS/LIS technology is to achieve this objective rapidly and in a cost-effective way.

The most critical component of this model is the geographic data, because:

- the cost of building and maintaining the geographic database can be ten to a hundred times greater than the cost of the hardware and software, and;
- the quality of the information product is most dependant on the quality of the data.

From this it follows that, while the technological framework can be upgraded or replaced with new developments, the investment and integrity of the data must always be protected.

1.2 Pressures on National Surveying and Mapping Agencies

Throughout the world, national surveying and mapping agencies are under pressure from many sources. That pressure includes rapid technological development, changing market demands, reductions in resources, and changing political and social requirements. At the same time, decision makers are demanding more sophisticated information products to help address complex issues at the local, national, regional and global level. These products must meet high quality standards and deliver real value.

Governments are seeking improvements in efficiency, and are adopting commercialisation, corporatisation and privatisation to improve performance. They are demanding that agencies more clearly demonstrate the economic, social and environmental benefits of their programs. The community is also seeking greater access to data collected in the public interest.

These developments place great pressure on the institutional structures and the human and capital resources of agencies. If we are to realise the potential benefits of our investment in land and geographic information we have to develop strategies for building national geographic databases.

1.3 Scope of Paper

This paper provides a model strategy for building a national geographic data infrastructure. While most of the discussion is focused at the national level, the model can be readily applied at both the province level and at the regional or global level. The paper then goes on to discuss the obstacles to the development of that infrastructure, describes how we have addressed the problem in Australia, and reports recent developments in the Asia Pacific region.

2. NATIONAL GEOGRAPHIC DATA INFRASTRUCTURE

2.1 Concept

National infrastructures are developed for health, education, transportation and a wide range of other economic and social needs. Information, including land information, is emerging as one of the most critical elements underpinning decision making for economic and social development, and governments throughout the world, including Australia and the USA, have recognised the need to assign resources to establishing an effective information infrastructure.

The national geographic data infrastructure model described in this paper comprises four core components-institutional framework, technical standards, fundamental datasets, and distribution networks. These core components are linked as follows:

INSTITUTIONAL FRAMEWORK
defines the policy and administrative arrangements for building, maintaining, accessing and applying the standards and datasets

TECHNICAL STANDARDS
define the technical characteristics of the fundamental datasets

FUNDAMENTAL DATASETS
are produced within the institutional framework
and fully comply with the technical standards

DISTRIBUTION NETWORK
is the means by which the fundamental datasets are made
accessible to the community, in accordance with policy
determined within the institutional framework, and
to the technical standards agreed

2.2 Objectives

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 standard fundamental geographic datasets is essential if the full potential of GIS/LIS 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.

3. INSTITUTIONAL FRAMEWORK

3.1 Leadership

It is essential that an institutional structure be identified to lead the development of the national geographic data infrastructure. A common model is for the national mapping agency to be designated by government as the lead agency, with a committee or council comprising representatives of the other key geographic data producer and user agencies providing policy guidance and coordinating mechanisms. The lead agency often chairs the council and provides administrative, research and development support. Advisory committees or working groups may be formed for some issues.

The responsibilities of the 'national geographic data council' may include:

- identifying national geographic data priorities and appointing custodians for datasets;
- establishing operating policies for geographic data custodianship and distribution;
- coordinating the data production and maintenance programs of the custodians;
- defining and supporting a national directory (system) for geographic data;
- managing the development and implementation of technical standards;
- sponsoring multi-agency GIS/LIS demonstration and pilot projects;
- defining and supporting education and training programs.

This structure is especially adaptable to provincial systems of government. The national council might comprise one representative from the national government and one from each province. Each member of the council would also be the chair of their provincial coordinating structure, with similar responsibilities within that jurisdiction. With this structure, an additional responsibility of the national council would be to define the responsibilities of each level of government, and to coordinate the multi-jurisdiction policies, standards and programs.

It should be noted that the ANZLIC model does not include the development of a single central database. There are two reasons for this. Firstly, such an approach greatly complicates institutional issues such as responsibility and cooperation and, secondly, database and communication technology has made centralised database architectures unnecessary. The model provides for a distributed database of independent datasets conforming to a common set of policies and standards.

3.2 Custodianship

A key feature of the model is the emphasis on the concept of custodianship. Responsibilities of custodian agencies may include some or all aspects of data acquisition, storage, maintenance, quality assurance, security, access, documentation and distribution. Custodians are also responsible for consulting with external users in the administration of their functions. These responsibilities must be well defined, particularly where a custodian chooses to delegate or contract a function to another agency, such as maintenance of a specific data item. Custodians may be identified for new datasets that have not yet been produced. Such custodians, or 'dataset lead agencies', would then have the additional responsibilities of defining the initial dataset specifications and production priorities, in consultation with users.

In return for these responsibilities, custodians also have certain clearly defined rights. These may include the right to charge a fee for data access, to market and distribute the data to certain classes of users, and to access and use the data administered by other custodians.

Criteria which may be considered in the allocation of dataset custodianship include statutory responsibilities, operational needs, technical capability and availability of resources. Where many agencies have an interest, capability and capacity, the agency that requires the highest standards of quality may be the most appropriate custodian.

3.3 Directories

The national geographic data infrastructure should include a directory, or directory system, through which all potential users can determine the availability and key characteristics of datasets. The directory may include both the fundamental datasets that are part of the infrastructure, and other datasets that are available from the public and private sectors. The addition of a 'data forecasting' capability, that identifies datasets currently in planning or production, increases the value of the directory.

The directory contains metadata for the geographic datasets comprising the national infrastructure. Metadata is "data about the data" and includes the key technical characteristics of the data, access conditions and procedures, and how to obtain further information. The form of the directory might be as simple as a guide book or as sophisticated as an on-line database. But however the directory is implemented, the critical issues for the national council to address will be the ease of access to the directory, and the completeness and currency of the metadata.

3.4 Data Distribution

Custodians with data distribution responsibilities must administer pricing structures and licensing conditions for the access and use of data by external parties. Distribution policies are generally based on either a 'public interest' or a 'commercial' approach. While commercial data producers operating in the private sector will clearly adopt a commercial approach, government agencies in the public sector may adopt any position on the continuum between public interest and commercial, depending on current government policies and the relevant laws regarding copyright and government information.

The arguments in favour of a commercial approach by government agencies include the generation of revenue to fund data acquisition and maintenance, increased producer efficiency and accountability, regulation of demand, and clear attribution of costs. The arguments in favour of a public interest approach include maximisation of benefits through maximising access, equity of access, and support for development of value-added industries in the private sector. The approach adopted may be identical for all users and uses, or it could be varied to discriminate between public and private sectors, and/or between non-profit and commercial applications.

Licences are a mechanism to protect the interests of the data producer. The vendor sells a licence to use the data, rather than the actual data, in much the same way that software is distributed. Licence conditions may address the on-selling or giving away of the data to third parties, use of the data in derived commercial products, and acknowledgment of the producer in any published work. The licence may for example require royalties to be paid for commercial use of the data.

Key issues to be considered by the national geographic data council in establishing a government-wide data distribution policy therefore are:

- the basic pricing principles to be applied (public interest or commercial);
- whether or not prices should be varied according to the nature of the user or use;
- what restrictions if any should be included in the licences.

These issues are essentially political, and will often be addressed in the context of the overall government information infrastructure.

3.5 Education and Training

In designing and developing the infrastructure, the national geographic data council may identify a shortage of appropriately educated and trained people as an impediment to successful implementation. An effective council should be in an ideal position to address this issue with government, funding agencies and academic institutions. The inclusion of funding agencies and academic institutions on the council or its committees is one way of ensuring that they understand the needs.

3.6 Applications

The national council also has a key role in ensuring that the geographic data are effectively applied to real economic, social and environmental issues. This can be achieved through support for projects that demonstrate the application of GIS/LIS technology. Multi-agency projects that build on the data integration and analysis strengths of the technology would be particularly appropriate. Such projects help develop inter-agency cooperation, provide valuable experience on which infrastructure policies and priorities can be considered, develop technical skills, and provide cost/benefit data to support funding proposals for major GIS/LIS programs.

4. TECHNICAL STANDARDS

4.1 Standardisation Processes

National standards bodies may provide the institutional framework for development and support of technical standards for GIS/LIS data. National geographic data standards should be independent of the system standards developed by GIS/LIS vendors. This enables the geographic data to be utilised on any system, and for systems to be upgraded and replaced without loss of data. The general model for standards development and implementation involves the following stages:

- first draft prepared by a technical committee;
- draft is tested and issued for user comments;
- test results and comments are then analysed;
- draft/test/consultation cycle may be repeated if necessary;
- formal standard is issued, along with supporting software and documentation;
- government agencies implement the standard and provide incentives for industry;

- standards body monitors user comments and other technological developments;
- standard is maintained - updated, amended, extended or replaced, as appropriate.

Incentives for industry to adopt national standards may be implemented through purchasing and contracting activities. Government agencies can make support for and compliance with national standards a condition of purchase or service contracts. Compliance with a single set of integrated national standards should be more efficient for industry than having to comply with the divergent standards of individual agencies.

Many national and international bodies have already produced standards in each of the areas described below. It may therefore be neither necessary nor appropriate to develop completely new standards. Time and effort may be saved by adapting existing standards to national needs, with the added advantage of support by the major GIS/LIS vendors. The International Standards Organisation is currently addressing 'geomatics' standardisation through technical committee TC211 and Korea is participating in that committee. This ISO work should provide the framework for both national and international geographic data standardisation.

4.2 Reference System

The geographic reference system, or geodetic datum, is a fundamental standard to enable integration of geographic data. The availability of Global Positioning System (GPS) technology has greatly improved geodetic knowledge at the national, regional and global levels, enabling computation of precise geocentric datum. Within a national geographic data infrastructure, the two key requirements are for the fundamental data to be stored on a single accurate national reference system, and for the relationship between the national and geocentric reference systems to be well defined (if they are not the same).

The development and maintenance of a national geographic reference system, in the era of satellite positioning systems, requires a technological infrastructure of its own. The core of this geodetic infrastructure is a 'fiducial network' of GPS stations, linked to the national and preferably also the regional and global geodetic systems. In addition to the fundamental geographic data, this geodetic infrastructure also supports the geoscientific and navigational users of satellite positioning technology.

4.3 Data Model

There are two levels to a data model standard - the conceptual data model and the logical data model (or data structure). A third level, the physical data model or file structure, is implemented in the data transfer standard. The conceptual model provides a schema for the representation of the real world in the form of geographic data. The schema provides a semantic structure for the spatial and attribute components of the fundamental data and for the relationships between the various datasets. The conceptual level is then mapped into one or more logical data models, which specify how the relationships are to be defined. This is the level at which, for example, a topological or raster data structure would be specified.

4.4 Data Dictionary

The data dictionary standard is built on the conceptual data model. It provides standard definitions for the spatial and attribute components of the fundamental datasets. For example, the feature 'road' may have a range of attributes such as 'class', 'surface' and 'width', and the attribute 'class' may have a range of values such as 'principal', 'secondary' and 'minor'. All these terms must be unambiguously defined in a data dictionary to enable accurate interpretation and efficient integration of data in GIS/LIS applications. Data dictionaries must be developed for each fundamental dataset, and cross-referenced to ensure consistency.

As more and more data are produced and the applications and communications technologies becomes more efficient, the lack of semantic standards such as data dictionaries has become a larger impediment to GIS/LIS success than the lack of technology-related standards such as data transfer.

4.5 Data Quality

Geographic data quality standards may be descriptive, prescriptive, or both. A descriptive standard is based on the concept of 'truth in labelling', requiring data producers to report what is known about the quality of the data. This enables data users to make an informed judgement about the 'fitness for purpose' of the data. A descriptive data quality standard may require producers to provide information on the following five key characteristics: lineage, positional accuracy, attribute accuracy, logical consistency, and completeness. A prescriptive standard would define quality parameters for each characteristic, for a particular application.

Recognition of the importance of data quality and quality standards should lead to the introduction of formal quality management and quality assurance techniques in geographic data production.

4.6 Data Transfer

Transfer standards provide an intermediate format for the transfer of data between different computing environments. They comprise a set of rules for encoding data into fields, records and files for transfer via a specified media.. A data model is a prerequisite to development of the encoding rules. The intermediate nature of transfer standards is an important characteristic - they are not intended to be product or database structures. Transfer standards are optimised to achieve effective communication of all data and metadata, whereas product and database structures may be optimised for efficiency of storage, application or maintenance.

The transfer standard provides a GIS/LIS vendor-independent target for encoding data for output, and for decoding data for input. Vendor-independence enables production and application agencies to utilise whichever hardware and software systems are the most cost-effective for their needs, without compromising 'corporate government' principles.

It is hoped that the proposed ISO activity will result in an international geographic data transfer standard which, with government agency and GIS/LIS vendor support, will facilitate effective data communications within and between nations.

4.7 Metadata

A metadata standard will specify how data are described in the national directory and in data transfers. Characteristics to be described may include the dataset name, content, coverage, quality and structure, and information on access procedures and restrictions. The metadata standard can be viewed as a microcosm of the other data standards, requiring (meta)data model, dictionary, quality and transfer specifications of its own.

5. FUNDAMENTAL DATA

5.1 Identification and Priorities

A key function of the national geographic data council is the identification of national geographic data priorities - what are the fundamental datasets that should be produced by government and what are the funding priorities? Individual agencies will have very strong views on needs and priorities, based on their own programs. A methodology is therefore needed to determine corporate government needs and priorities, as a basis for funding development of the fundamental datasets. The methodology proposed here is based on the analysis of economic, social and environmental benefits.

The analysis is a combination of market research and cost/benefit analysis techniques. It commences at the 'information product' end of GIS/LIS technology, as that is the point from which 'real world' benefits are derived. Key activities are to:

- identify 'application' agencies that currently or potentially utilise geographic information products to address economic, social and environmental issues;
- determine the technical characteristics of the information products that they need to deliver real world benefits;
- determine the technical characteristics of the geographic datasets needed to produce those information products;
- calculate financial and other indicators for the benefits that would be derived from the information products;
- identify gaps in the availability of datasets, and unnecessary duplication in dataset production and maintenance;
- calculate the cost of producing and maintaining the additional datasets, and the savings through elimination of unnecessary duplication.

The results of these research activities are then analysed. The fundamental datasets are those which underpin multiple high-benefit information products. The analysis results in a statement of which datasets are fundamental to successful national GIS/LIS implementation, a ranking of those datasets in terms of benefits, and an estimate of the costs, savings and benefits that would be derived from coordinated production. The identified datasets provide the foundation for the national standard data model.

Datasets to be fully specified and ranked by this methodology may include aerial and satellite imagery, the cadastre, census results, land use and land cover, place names, administrative areas, transportation networks, utility networks, coastline, rivers and lakes, elevation, soils, vegetation, fauna, geology, climate, pollution, hazardous sites, and areas of environmental significance. Technical characteristics of the datasets would include the spatial accuracy, associated attributes, attribute accuracy and currency. If appropriate, the level of government (national, state/province, local) responsible for production and maintenance, and any variations in characteristics according to geographic location, would also be specified.

5.2 Production and Integration

After identifying and prioritising the fundamental datasets, the national geographic data council can appoint dataset custodians and address funding of production and maintenance programs. At this point, governments may also consider the extent to which the production and maintenance of fundamental datasets should be contracted by custodians to the private sector.

Cooperative arrangements will be needed to ensure that the fundamental datasets are spatially integrated. That is, where a real world entity such as a road centreline is represented in two or more datasets, such as the transportation network and census boundaries, the spatial representations should be coincident.

6. DISTRIBUTION NETWORK

The distribution network is the technological framework established to give the community access to the fundamental data. It was noted earlier that the model does not propose a single central database. Rather, the model anticipates that datasets will be held on a number of independently maintained systems by the respective custodians, and that they will be linked by common standards and policies. Physical linkages between those systems might be through a range of mechanisms including dedicated telephone lines, local area networks, wide area networks and integrated-services networks.

The national geographic data network will be a part of the developing, more general national infrastructure for information distribution and access. The role of the national geographic data council in developing the distribution network is to foster the integration of fundamental datasets into the network and to coordinate with other infrastructure coordinating bodies to develop a national consensus. The council should encourage the adoption of standard data transfer protocols and national policies for access and pricing.

However it is implemented, the key element of the network is the data directory system which should be freely accessible and contain highly accurate metadata for the fundamental datasets, including advice on gaining access to the data.

7. OBSTACLES TO SUCCESSFUL IMPLEMENTATION

7.1 Institutional

There are many potential institutional obstacles to the successful implementation of a national geographic data infrastructure. These may include:

- competition between agencies for leadership of the institutional structure;
- independence of agencies being stronger than the corporate government ethos;
- government restrictions to data access based on national security considerations;
- inadequate analysis of fundamental data requirements and priorities ;
- underestimation of the cost of producing and maintaining quality data;
- lack of consensus on technical aspects of standards;
- low level of 'customer focus' in the major data producing agencies;
- continual cycle of pilot projects instead of long term major applications programs;
- poor or inconsistent support from policy, funding and coordination agencies.

The solutions to such obstacles will of course vary according to the national circumstances. However an awareness of the potential institutional obstacles should assist when considering the time, effort and strategy required for successful implementation. If several of these obstacles are already major features of the current framework, then it may be appropriate to include actions to address them in the implementation plan.

7.2 Resources

In addition to the institutional obstacles, any lack of funding, appropriately trained people and appropriate technology will obviously be significant obstacles. Again, it is not appropriate to propose strategies for addressing such issues within this paper. It should however be recognised that a low level of resourcing will only delay successful implementation of the infrastructure, but a failure to resolve the institutional obstacles will guarantee that the full potential of GIS/LIS technology will not be realised.

8. HOW AUSTRALIA HAS ADDRESSED THE PROBLEM

8.1 Australia New Zealand Land Information Council

The Australia New Zealand Land Information Council (ANZLIC) is the peak intergovernmental council providing leadership for effective management of land information in the interests of the nation. It does this by:

- addressing land information issues at the national level;
- supporting the development and implementation of national land information management guidelines and standards; and
- providing a national forum for the sharing of experiences and exchange of information on land information management at the policy level.

ANZLIC uses the term land information to describe all forms of information that can be related to geographic position. It encompasses information about natural resources, the environment, land ownership, land use, transport and communications, mapping, demography and socioeconomic factors.

8.2 Background to the Formation of ANZLIC

In the late 1970s, governments in Australia had been confronted by similar administrative and technical issues in relation to the management of their land information databases. Cost-efficient access to compatible land information was required in order to assist in effective decision making. At that time there had been no formal coordination amongst land information managers.

There was a growing need to coordinate the collection and transfer of land-related information between the different levels of government, and to promote the use of that information in government decision making. A conference, Better Land Related Information for Policy Decisions, held in 1984 and attended by representatives from the three levels of government in Australia, recommended that a peak coordinating council be formed. This council would be given the role of promoting and developing a national strategy to facilitate the exchange of land information.

With the support of the Australian Prime Minister, State Premiers and the Chief Minister of the Northern Territory, the Australian Land Information Council (ALIC) was formed and held its first meeting in March 1986. The Commonwealth Government, all Australian States (with the exception of Queensland) and the Northern Territory were represented. The meeting agreed that a standing advisory committee, then known as the Australians Advisory Committee on Land Information (AACLI) also be established.

Queensland and the Australian Capital Territory were represented for the first time as observers in 1989 and were subsequently accepted as full members. New Zealand had been represented on ALIC and the advisory committee since 1987 with the same participating rights as the Australian members. In November 1991 New Zealand formally became a full member and ALIC was renamed ANZLIC. AACLI is now known as the ANZLIC Advisory Committee on Land Information.

8.3 Membership of ANZLIC

The members of ANZLIC are senior government officers who represent the land information steering committees in their jurisdictions. Those steering committees provide the principle mechanism for consulting with the broader spatial data community. The committees have various names and structures, but the steering committee at the federal government level is the Commonwealth Spatial Data Committee (CSDC).

Membership of the Advisory Committee consists of heads of agencies with the operational responsibility for coordinating land information management in each of the jurisdictions.

8.4 ANZLIC's Achievements

The most significant achievement for ANZLIC recently has been the development of a draft National Policy on the Transfer of Land Related Data. This policy was developed in response to responsibilities given to ANZLIC under the Intergovernmental Agreement on the Environment, which was signed by the Prime Minister, Premiers and Chief Ministers in May 1992. The policy addresses the cost and licensing arrangements applied to data collected in the public interest when transferred to another party for a non-commercial application. That draft policy has been submitted to the Council of Australian Governments for consideration and each of our member jurisdictions is taking steps to implement the policy in their governments.

Another significant development in recent times has been the introduction of the Spatial Data Transfer Standard (SDTS). Some years ago, ANZLIC identified the need to replace the existing transfer standard AS2482, which is unsuited to complex, topologically structured GIS data. The Council decided that the best approach would be to adopt the standard that was being developed in the USA. The principle reasons for this decision were that:

- a lot of work had been carried out, over many years, in the USA in developing the standard and it would be imprudent to duplicate that effort; and
- major US GIS vendors would be committed to supporting the US standard whereas it may be difficult to gain the same level of support for a uniquely Australian standard.

ANZLIC recognised, however, that implementing SDTS was not a trivial exercise and that agencies would need support and encouragement to do so. The Council invested $300,000 over three years to help establish the Australasian Spatial Data Exchange Centre, AUSDEC, to provide that support. Standards Australia, and Standards New Zealand, have now issued SDTS as a draft for comment and issue of the joint standard is expected in mid-1994.

Other recent standards activity has included the development of a draft Land Use Code which Standards Australia has now issued as a draft for comment. A workshop on natural resources data standards in Canberra in February has helped to identify other areas that need attention and ANZLIC will provide the leadership and stimulation to ensure that standards will be developed and adopted.

The members of ANZLIC believe that the community must have a better understanding of the economic benefits that arise from the building of the national data infrastructure. Accordingly, the Council commissioned the international accounting firm, Price Waterhouse, to conduct a study of the benefits and costs associated with a national geographic data infrastructure. That report has now been published and is being distributed widely within Australia and New Zealand.

8.5 ANZLIC's Current Activities

ANZLIC has a strategic plan for 1994-97 and is developing a strategic plan for 1997/2000. Both of these strategic plans focus on the development of a geographic data infrastructure for Australia and New Zealand, as described by the model in this paper.

A key activity under the strategic plan is to promote the concept of a national geographic data infrastructure. There will be wide consultation on this issue, as ANZLIC hopes to stimulate a lot of debate. The outcome will be a better community understanding of the underlying data infrastructure, the data sets needed in the public interest, the relationships between them and the data standards required. To foster this debate, ANZLIC is engaging a professional public relations firm to assist it in reaching the various target groups that it needs to influence. These target groups are diverse. They include politicians, senior government officials, academia and the technical community. ANZLIC is also developing a discussion paper to initiate discussion on issues of custodianship and custodian responsibilities, and definition of fundamental data sets and their characteristics. It is expected that it will also enable better discussion of the priorities for data collection, maintenance, storage and distribution.

ANZLIC will continue to place a high priority on the development of standards. Current activity includes the development of a standard for rural street addressing, standards for road centre-line data and the development of various data dictionaries for use with SDTS.

ANZLIC believes that a national directory of land and geographic data is essential for the efficient and cost-effective use of data. To this end, ANZLIC is supporting the implementation of a national directory within the federal government. A standard for meta-data is being developed and the Council will promote a policy of free transfer of meta-data between jurisdictions.

ANZLIC is examining the education and training needs of the Land and Geographic data community. This year, a report will be prepared on the required skills profile for the industry, which will be promoted within the education and training sector. Later, a report on the gap between the required profile and the existing skills will be prepared.

8.6 Australian Space Council Initiatives

The Australian Space Council recently completed a feasibility study for the development of an Australian Earth Observation Network (AEON) for the distribution of data. The review embraced a broad spectrum of data - much broader than simply remotely sensed images - and it is the authors' view that if the proposals are accepted then AEON could provide the "distribution network" required by the infrastructure model promoted in this paper.

9. INTERNATIONAL DEVELOPMENTS

9.1 Asia Pacific Region Geographic Information Forum

The national level view of the geographic information infrastructure expressed this paper is only a part of the global geographic data infrastructure. Just as communication and transportation infrastructures require cooperation between the nations and regions of the world, so too will the development of the global geographic data infrastructure.

The continuing development of global communication and information technologies makes the emergence of a global geographic data infrastructure inevitable. A number of multi-national and international programs are already contributing elements to the global model, although a comprehensive and integrated structure does not yet exist. There would be many practical benefits in enhanced cooperation between Asia Pacific nations during the development of both the national and global levels of the infrastructure. These include the sharing of experience, and the closer integration of national infrastructures to facilitate regional development.

At the 13th UN Regional Cartographic Conference for Asia and the Pacific, held in Beijing in May this year, it was agreed that a body comprising the heads of national surveying and mapping agencies be established. It is planned that this body will conduct a program of activities, between the UN Regional Conferences, designed to support the development of national geographic data infrastructures and the integration of national infrastructures to form an Asia Pacific regional infrastructure. Such activities may include development of detailed guidelines for infrastructure development, information and staff exchanges, and the cooperative development of regional standards and datasets.

The first meeting was held in June 1995 in Kuala Lumpur, Malaysia. At that meeting, a management committee and secretariat were established to continue the discussions held in Kuala Lumpur. They will be further explored at the second plenary meeting which will be held in Sydney, Australia in October 1996.

10. CONCLUSION

10.1 Summary of Infrastructure Objective and Model

The objective in developing a national geographic data infrastructure is to efficiently provide the fundamental geographic data needed to support sound economic, social and environmental decision making. The infrastructure model may be conceptualised as four concentric circles. At the centre is the distribution network, which is surrounded by the fundamental data, which are surrounded by the technical standards, which are in turn surrounded by the institutional framework. In summary, the four integrated components comprise:

Institutional Framework

- geographic data council providing leadership, coordination and policy;
- dataset custodians with clearly defined responsibilities and rights;
- directory that enables users to determine data availability and suitability;
- data distribution policy and systems for meeting customer needs;
- education and training programs to provide appropriately skilled people;
- pilot and demonstration projects leading to major applications programs.

Technical Standards

- common geographic reference system, linked to a geocentric datum;
- data model at the conceptual (schema) and logical (structure) levels;
- data dictionary defining the meaning of spatial features and their attributes;
- data quality standard based on descriptive or prescriptive principles;
- data transfer standard for encoding spatial and attribute data;
- metadata standard specifying how data are described (directory and transfer).

Fundamental Data

- integrated datasets that underpin high-benefit information products (produced and maintained by custodians in accordance with the reference system, data model and quality standards; described in the national directory in accordance with the metadata standard; distributed to public and private sector users in accordance with the distribution policy, in transfer standard format).

Distribution Network

- the means by which the fundamental datasets are made accessible to the community, in accordance with policy determined within the institutional framework, and to the technical standards agreed.

10.2 National Implementation

The description of a national geographic data infrastructure provided in this paper should be viewed as a general model, not as a prescription. The model must be adapted to the needs and circumstances of the individual nation. Some elements may already be in place in a similar or different form, and some may simply be inappropriate.

It is therefore recommended that the general model described in this paper be used as a benchmark to review current programs and practices. The model may confirm the validity of some approaches, challenge that of others, or indicate possible new activities. Some elements may be immediately adaptable, while others will require considerable modification to suit local needs and circumstances. The integrated nature of the model may also provide a structure for drawing together some activities that are presently disconnected.

A Canadian Solution for Spatial Data Clearinghouse: Federated Multi-Database Infrastructure for GIS Interoperability

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ABSTRACT

Access to a federated set of dispersed spatial databases over a wide area network is a major issue. Considering that these databases are part of a local area network and the possibility that there can be a variety of GISs and DBMSs residing on a heterogeneous array of platforms, this precipitates complex problems of data transfer from system to system, not to mention problems arising from the dissimilarities in format and the standards for interchange. From the users point of view, the data should be current, available in readily usable format, easily accessible, supported with database

management functionalities and allow selective feature retrievals. The user should have the option to use whatever database or GIS which is appropriate for the application.

Delta-X, a code name for a federated spatial information management system, is an approach to providing interoperability in a network of heterogeneous databases. It establishes interoperability between different relational DBMS's, simple files and object repositories. Data is made accessible to users through a distributed virtual global schema definition. By this means, the independence and autonomy of control, of the individual datasets registered in the federation, are still respected, while still maintaining some integrated uniform access with respect to a particular GIS environment.

To assist the system users in identifying the source of data required for their applications, a complementary system: MetaView/GIS spatial browser was developed. MetaView/GIS provides access to metadata of various databases, such as: extent of coverage, content, ownership, format, datatype, access, cost' etc.. The Delta-X and MetaView are an integral part of Geomatics Canadas spatial information infrastructure, and provide a unique solution for the development of a Canadian spatial data warehouse.

요 지

광범위한 네트워크상에 분산된 데이터베이스에 접근하는 것은 매우 중요한 문제이다. 이러한 데이터베이스가 근거리통신망(LAN)의 일부이며, 다양한 GIS와 DBMS가 서로 다른 컴퓨터기종에 존재한다는 것을 고려한다면, 교환표준이나 포맷차이에서 발생하는 문제는 말할 것도 없이 시스템간에 자료전송시 복잡한 문제로 대두하게 된다. 사용자의 입장에서 보면 정보는 유통되어야 하고 쉽게 이용할 수 있는 형식이어야 하며, 접근이 용이해야 한다. 또한 데이터베이스 관리기능을 갖고 있고 선택적인 조건에 따른 정보검색을 할 수 있어야 한다. 사용자는 활용하고자 하는 목적에 따라 데이터베이스와 GIS를 이용할 수 있는 선택권

을 가질 수 있어야 한다.

Delta-X는 연방 공간정보관리시스템을 위한 코드명으로 서로 다른 데이터베이스로 이루어진 네트워크내에 호환성을 제공하기 위한 출입로이다. Delta-X는 서로 다른 관계형 DBMS, 단순한 파일과 객체저장소(object repositories)간의 호환성을 제공한다. 사용자는 분산된 가상지구도표(virtual global schema)을 통해 정보에 접근할 수 있으며, 이러한 방법으로 연방에 등록된 개별 정보의 독립성과 자율성을 보장할 수 있다. 반면, 특별한 GIS 환경에서도 접근할 수 있는 통로를 유지하고 있다.

시스템 사용자들이 자료를 활용하는데 필요한 자료원 정보를 확인할 수 있는 보조 시스템인 MetaView/GIS 공간브라우저를 개발하였다. MetaView/GIS는 다양한 데이터베이스의 메타데이터에 접근할 수 있다. 즉, 커버리지의 공간범위, 내용, 소유권, 포맷, 자료유형, 접근여부, 비용 등을 알 수 있다. Delta-X와 Metaview는 지오매틱스캐나다의 공간정보기반의 매우 중요한 부분이며, 캐나다 공간정보유통기구의 개발을 위한 해결책을 제공하고 있다.

1. INTRODUCTION

Geomatics Canada Mandate is to provide accurate and current spatially georeferenced information about Canadian landmass. The Geographic Information Systems and Services, a Division of Geomatics Canada, was set-up in 1987 to develop applications to promote the use of the Department data, and to explore research that will aid in the growth of GIS technology. Initially, our main concern was to improve access to GIS data through improved communications facilities, and developing the technology required for building a spatial information infrastructure in the Sector to facilitate the ordering and distribution of GIS data.

In 1988, the Division established the National GIS Technology Centre and acquired several GISs from several vendors. The GIS software was installed on personal computers (PCs), and UNIX workstations. The various systems were interconnected into an ethernet local area network (LAN). The heterogeneous GIS environment was selected due to the wide variety of GIS software and hardware platforms available on the market, and to simulate conditions in large organizations, where different GISs are used to store their spatial data in different databases.

The operation of the GISs in this simple LAN, in which a number of workstations (nodes), each runs a different vendor GIS software based system, and our efforts to retrieve data from various databases residing in other LANs in the Sector quickly revealed a number of operational problems, such as:

- the transfer of data between a number "n" of GISs requires "n^2" conversion packages,
- the different GIS have underlying database management systems (DBMS) that are based on different data models: relational, network, and object-oriented,
- the data required by GIS applications resides in several database in different data types: vector, raster, structured text, free text, and knowledge base,
- the available data is generally not in the format required by the GIS and some processing and restructuring are required before it can be incorporated into the GIS application environment, checking data out of
- the server and restructuring it into its local GIS data storage is cumbersome,
- checking the data back onto the server, either as a new version or as an updated and revised form of an existing one posed more problems for database administrator,
- GIS databases available in agencies and institutions that are geographically dispersed

- in procuring data from other agencies, user must purchase all the information compiled for that map sheet and extract the feature relevant to the applications, and
- large volumes of datasets are currently not maintained with any DBMS. They are maintained simply as large sequential files on reels of tapes.

These and other related problems are what the federated multi-database spatial information management system (code named the Delta-X project) is concerned with. Such a model of operation is not exclusive to GIS. Similar problems have been addressed in purely corporate database environments. The Delta-X is a multi-database system with a common integrated global conceptual schema definition. The global database is intended to achieve interoperability between DBMS that have been specialized for three distinct data types: spatial data (vector and raster), structured text and free-text. Our design provides an integrated access to data stored in relational databases, object oriented databases, simple file systems and information retrieval and document management systems. The current implementation does this through *Remote Procedure Calls* by formulating queries in the format of the target systems. Where the target systems are relational DBMS, SQL is used as the language for remote data access. Simple file systems are mapped into relational tables. Thus, Delta-X establishes interoperability between relational DBMSs and GISs.

To provide a user accessible data warehousing user assistance for inventory and metadata review, a complementary system: MetaView/GIS Spatial Browser (MV/GIS) was developed as a front end to the Delta-X. The MV/GIS and Delta-X systems are the basic component of our Division' s spatial data infrastrucure and provide a solution to Geomatics Canada data warehousing.

2. THE DELTA-X SYSTEM

2.1 The Delta-X Common Spatial Data Model

This is the conceptual data model into which other GIS internal representations can be mapped. For vector data, the Delta-X spatial data model maintains up to degree four topology. This global conceptual scheme forms the intermediate transition schemes for data exchange between different GISs. The global conceptual data model has a mapping onto either a relational database, as a collection of relational tables, or into an object-base as a colony of categories. A Delta-X server maintains the vector data in a relational database if the underlying database management system is relational, e.g., Ingres, Oracle, Informix, etc. Similarly, the Delta-X server retains the data in a set of equivalent category classes in an object oriented database, if the underlying DBMS is object-oriented, e.g., ODE, ObjectStore, Objectivity. The significant idea is that Delta-X server transparently delivers data to and receives data from clients' GIS environment.

The illustration with the vector data shows the general approach for handling data in Delta-X. This approach, where by a common defined global data model is materialized for actual representation in local databases management system, is extended to handle the various classes of data-type required in GIS. For example, raster data such as remote sensed images, structured text that are related to spatial objects, and free text are all represented in the common global schema definition. Since some of these data types have internationally defined standards of representation, e.g., GIF, JPEG, MPEG, SGML, HTML, etc., these are maintained as files in their respective standard formats, and related to the defined spatial features through spatial indexes. A number of such non-vector data types are related to the spatial features using index techniques.

2.2 Spatial Indexing

Even over a small area of coverage, maintaining all the relevant information for all data types, quickly grows into a significant large database. Delta-X organizes space into hierarchical tessellated regions and maintains two distinct levels of index schemes for identifying a feature in defined space. The first level of index identifies a regular polygonal cell of the region of coverage that has been hierarchical tessellated into a near unicorn grid. The second level of index associates features within each cell with other information types. The first level uses a quadtree-like method of spatial index. The second level draws from a number of one-dimensional and multi-dimenesional index techniques depending on the data-type to be indexed.

The partitioning of the space into cells (tiles), by the first level of index enables the large volume of data to be accessed and controlled in manageable units. By this means, all data of a specific region or cell, and controlled by a particular organization or agency, can be grouped together. Geographic coordinate system (longitude and latitude) forms the common and basic coordinate reference system by which regions and features are related across multiple databases. The local database may derive the actual projection and coordinate reference system used in referencing spatial objects within that particular environment.

2.3 The Delta-X Features and Services

Delta-X performs multiple client-server roles. First, Delta-X servers control the data storage in commercial DBMS systems. Second, it is a client-server transaction processing system, and handles message and data exchange between Delta-X database and/or other specialized servers and Delta-X clients. Third, Delta-X performs specialized server functions, such as data conversions to and from the internal data interchange format. Finally, it acts as a proxy client on behalf of GIS systems that produce or consume data -- it is the source or destination of data in Delta-X transactions.

A single Delta-X server can be accessed by many Delta-X clients at the same time. Even a single Delta-X client can start many transaction on the same Delta-X server. In our current implementation, all conversion processes share the same CPU. The Delta-X server architecture, however, can also be implemented on a parallel machine or on a cluster of workstations on a dedicated LAN, where each transaction process runs on a different machine. All transaction processes share the same database.

Delta-X has a client component and server component. On a client, Delta-X provides a GUI that enables GIS users to start and control transfer/conversion transactions and a software which communicates with the server. On a server, Delta-X provides the client-server and server-server communication software, a module that transfers data, a network management agent, an interface to a database, and a set of data conversion routines. The server's network management module facilitates setting of server' s operational parameters, authentication keys, the entering and leaving of the Delta-X federation, and it also raises alarms to network management when the server malfunctions. Data on the server can be stored in any commercial database model-relational or object-oriented.

The exact internal format of data stored in Delta-X servers is database-specific, but all database servers share the same data model and logical schema, and they can store the same types of data. The internal database schema used at a particular server is transparent to all other servers in the federation. A separate database interface module adapts each internal database schema to a uniform data interface used within Delta-X. Conversion routines are also database-specific and GIS-specific. Note that the conversion routines and the database schema are the only entities in Delta-X that are specific to standard data formats or GIS systems.

The clear separation of data storage functions (the Delta-X server) from data processing functions (GIS) in a network not only facilitates data sharing and creation of logically organized application-specific data repositories, but it also enables to take advantage of the latest development in both of the DBMS and GIS worlds. For example, the RDBMS currently used in the Delta-X prototype can be replaced with an OODBMS without any impact on the clients and on other servers. In fact, different Delta-X servers using different database management systems can seamlessly co-exist in a Delta-X federation and exchange data with each other. Similarly, Delta-X can support a new type of GIS without the need to change the internal data interchange format and schema. These features allow different organizations with different data processing systems and/or architectures to join the same Delta-X federation and to share data with each other.

The Delta-X server is a node in a network of Delta-X servers which has a data repository containing a part of shared data stored in the Delta-X federation. As shown in Figure 1, the Delta-X comprises modules to perform the following functions:

- Transaction management and surveillance
- Data storage, access, and management
- Data conversion
- Client-server and server-server communication over a LAN or WAN
- Naming and authentication for Delta-X clients

The Transaction Monitor (TM) module performs transaction management tasks, such as transaction scheduling, transaction monitoring, authentication of transaction requests, locking of data, resource administration, and transaction commits, aborts and recoveries. TM receives requests for new transactions from Delta-X clients or requests to process already running transactions from fellow servers in the Delta-X federation. The Delta-X server validates the requestor' s permissions for accessing the requested data and notifies the clients about the status of transactions in progress. TM also logs accounting data in order to support billing of users who access data

stored in the federation.
If required, TM will relocate the transaction to another server to, for example, perform a conversion or finish a data transfer. After the data conversion has been finished, TM will initiate the transfer of converted data, temporarily stored on the server, to its final destination. There is one Convertor module for the conversion of each GIS data format to and from the Delta-X internal data format. All Convertors are database and GIS dependent.

The Data Mover module is responsible for sending or receiving data between the clients and servers and/or between the servers themselves. It is implemented on top of the TCP/IP protocol stack.

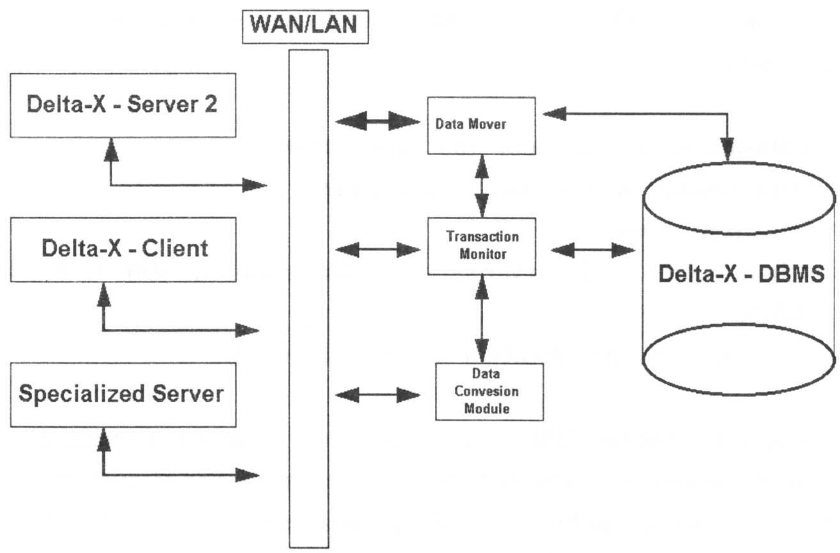

Figure 1: The Delta-X Server

2.4 Network Configuration

As shown in Figure 2, Delta-X is a loosely coupled network of servers and clients. Clients and servers attached to the same LAN form a cluster. Clusters are connected to each other via a WAN, which forms the backbone of the Delta-X system. Servers and clients can also be connected directly to the WAN or, via a dial-up line, to one of the servers. The set of all clusters, clients and servers connected directly to the WAN, and clients remotely connected to cluster servers forms the Delta-X federation. Communication between clients and servers in the federation is TCP/IP-based (both over the LAN and the backbone WAN). Any client can request a transaction from any server in the federation. A dedicated server in a cluster performs name and authentication services for all clients in the cluster. A server can also perform name and authentication services for clients remotely attached to the server. Although having a dedicated server for certain functions, a client can connect to and request data from any server in the federation.

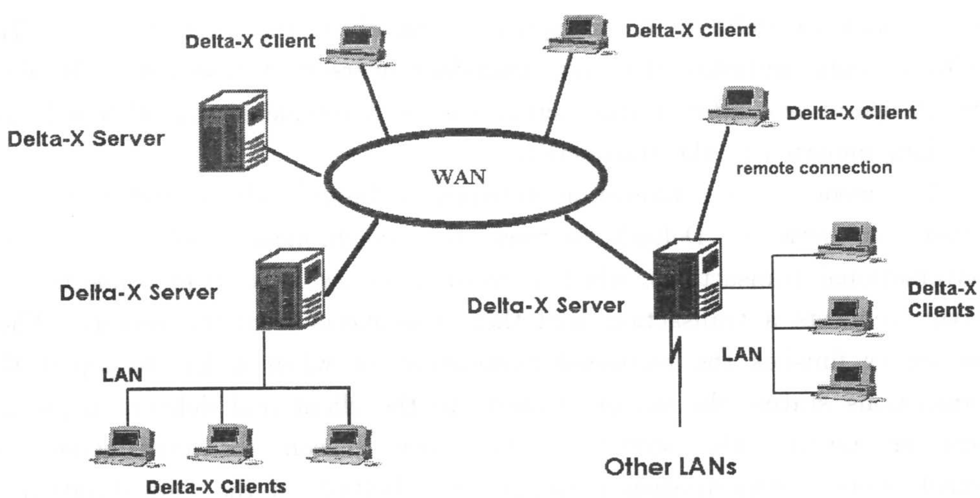

Figure 2: The Architecture of the Delta-X System

One dedicated server in the federation "the Delta-X Master", monitors and coordinates the activities of the other servers, and holds the configuration of the Delta-X federation. When a server wants to join or leave the Delta-X federation, it must contact the Delta-X Master Server, which updates its configuration tables, and distributes them to all other in the federation. The Delta-X Master Server is duplicated for uninterrupted availability. A server is essentially a database server which is also capable of converting data from client into an internal Delta-X format and vice versa, and storing the converted data in its database.

When another client wishes to import this data, the Delta-X server translates the data into the target clients format and transfers the data to the target client. The target format can be any common GIS format and the target machine can be either a UNIX workstation or a PC. The Delta-X server handles requests both from clients and from other servers in the federation. A transaction may start on one server, but it may migrate to another server, for example, to carry out a conversion from one data format into another, or to finish a data transfer. When a GIS wants to import or export data to Delta-X, it relinquishes control to the Delta-X client. The Delta-X client initiates the data transfer/conversion transaction. In data import operations, after a transaction has been completed, the GIS will use the data imported in the transaction.

The mode of communication between a Delta-X client and a Delta-X server or between Delta-X servers is asynchronous. Delta-X supports conversational transactions, which proceed as follows. A client connects to a server, requests a transaction, and then disconnects from the server. When the server finishes the requested transaction, or when it has to report the transactions status, the server connects to the client and delivers requested data or reports the status. The main reason for introducing the asynchronous communication paradigm into Delta-X is the long duration of the conversion/transfer transactions. A typical transaction can take some time to complete and it would not be reasonable to maintain a connection between a client and a server and thus to tie up network resources for the whole duration of the transaction. The asynchronous communication between the server and the client has several other advantages. First, the server can simultaneously process multiple transactions from multiple clients without running out of communication channels. Second, asynchronous communication between Delta-X entities facilitates nesting and chaining of Delta-X transactions. The implementation of client-server and server-server asynchronous communication is based on the SUN remote procedure calls over TCP/IP.

2.5 Client Services

Delta-X client is a software that runs on the users machine and enables Delta-X users to start and control Delta-X data conversion and movement transactions. Users can either export their data to Delta-X or import data from Delta-X.

The Delta-X client also supports administrative functions, such as joining or leaving the Delta-X federation or access rights control, and viewing of data stored in Delta-X databases.

Raster and vector data can be viewed. Display of data by a user prior to importing the data is important since a data conversion transaction can take a long time to complete.

As shown in Figure 3, the Delta-X client comprises the following modules: the Administration and Data Transfer and Conversion graphical user interfaces (GUIs), the Transaction Management module, and the Network Communication module.

The Administration GUI enables the user to perform administrative tasks. The administration GUI is only packaged on Delta-X clients used by Delta-X site administrators. Regular users do not use it. As shown in Figure 4, the Data Transfer and Conversion GUI enables the user to select parameters for a data conversion & transfer transaction (e.g. the format of the source or destination data or the location of the data), to start the transaction, to monitor the transactions progress on the Transaction Status Display and to control some aspects of the transaction.

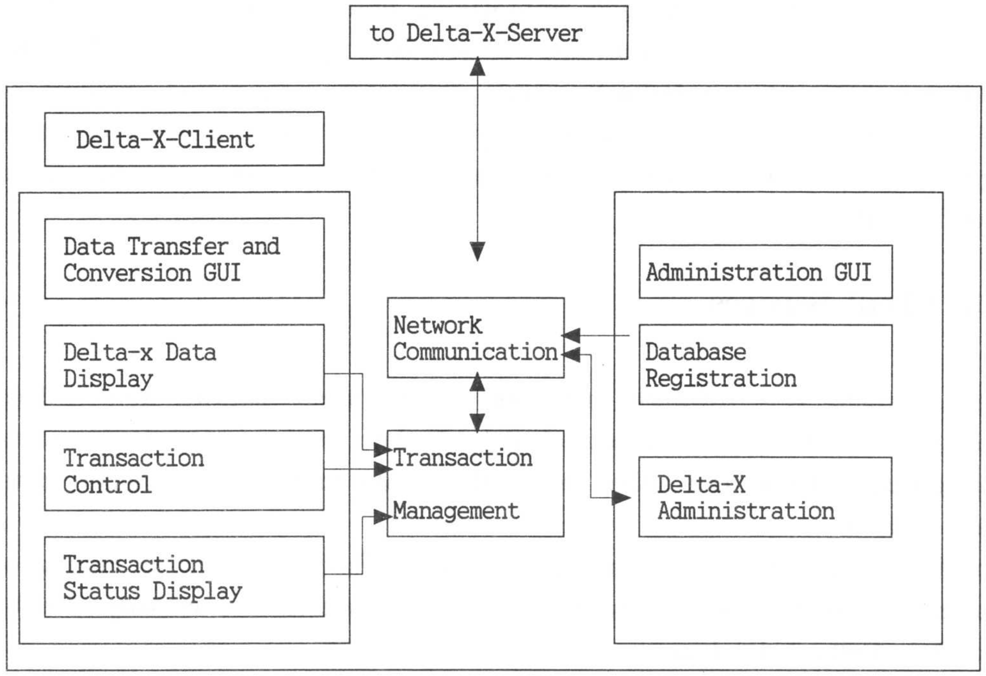

Figure 3: The Delta-X Client

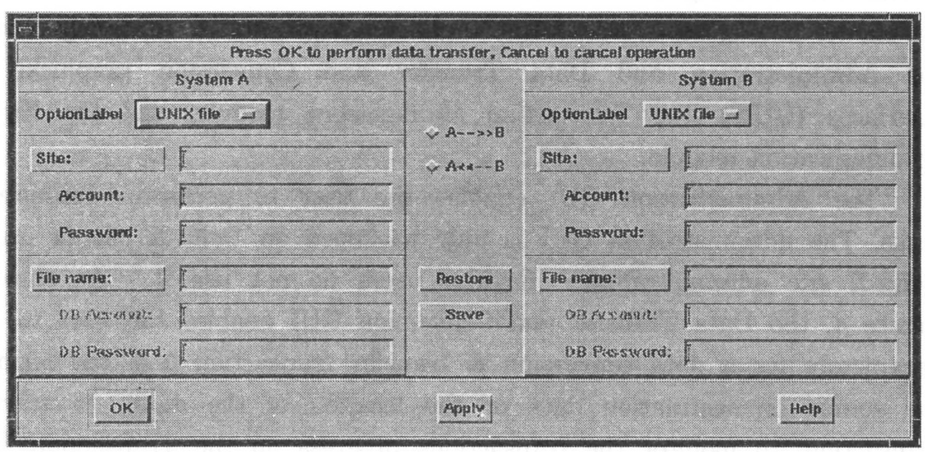

Figure 4: Data Transfer and Conversion GUI

A Delta-X client can simultaneously control multiple transactions on multiple servers. The Data Transfer and Conversion GUI also supports viewing of textual, raster and vector data to which the user has access rights and which is stored on any server in the Delta-X federation.

The network communication module performs all communication tasks with Delta-X servers. The communication functions can be either requests to view spatial data stored in one of Delta-X data repositories, or requests to perform data transfer/conversion transactions. The client display window is shown in Figure 5.

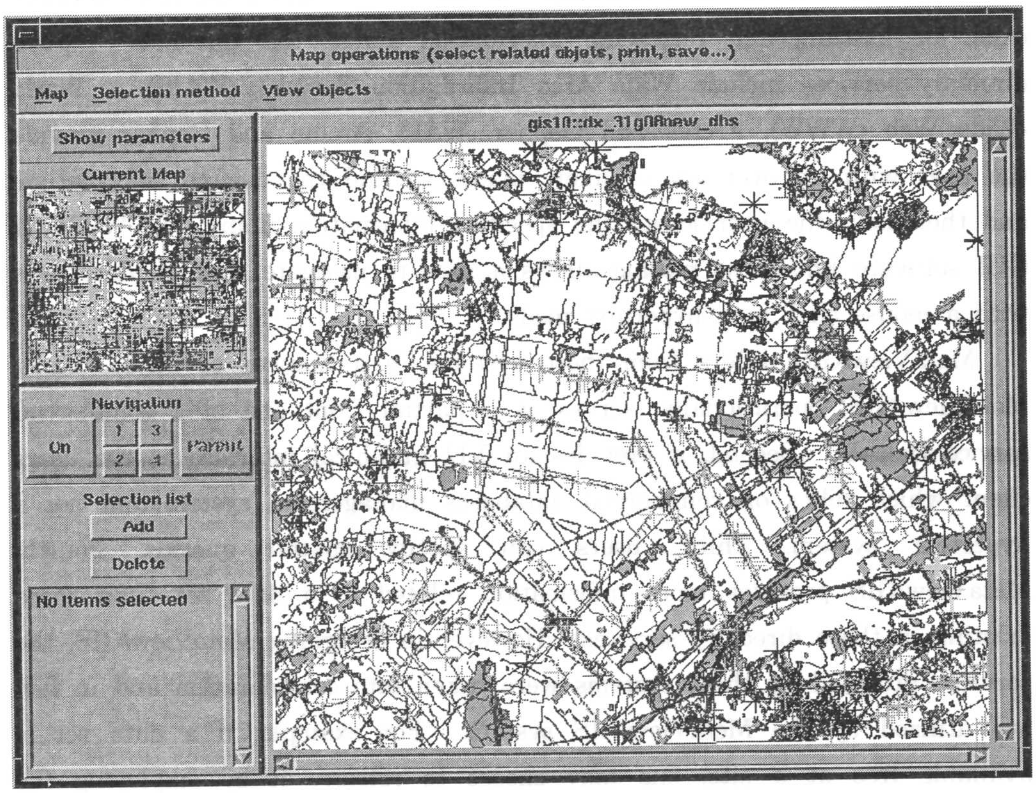

Figure 5: The Client Display Window of Delta-X Server

3. MetaView/GIS Spatial Browser

MetaView/GIS Spatial Browser was developed as a front end to the Delta-X to assist the GIS system users in identifying the source of data required for their applications. MetaView/GIS facilitates access to metadata of various database, e.g.: information on specific datasets, ownership, geographic coverage, format, availability, access mode, cost, etc.

MetaView/GIS is configured as a client-server model to run over Internet. The client is a user UNIX workstation, e.g. a GIS, and the server component runs on MetaView/GIS site. A number of other client-server directory services exist for locating and retrieving information across the Internet. Such directory services include Wide Area Information Server (WAIS), World-Wide Web (WWW), Archie and Gopher. WAIS, Archie and Gopher provide the user with an overview of likely places to find the desired information, and then help the user locate the specified information items. In WWW, a GUI software known as mosaic allows a user to navigate through databases with a mouse click in a hypertext mode.

MetaView/GIS differs from these systems in a number of ways. First, MetaView/GIS, operationally, serves as a partial front end of a commercial service Delta-X. Second, it provides an X11 graphical interface at the users client which relies on commercial databases management system and not a hypertext system. Third, users can specify spatial queries. Fourth, MetaView/GIS provides more information related to a data set than those existing in these directory services. However in designing MetaView/GIS, the services provided by these systems were taken into consideration and in fact are utilized by the MetaView/GIS system. For example, if a data set is available free at a site, one may choose to retrieve it by employing the services of the other directory services.

3.1 MetaView/ GIS Operational Concepts

One of the main difference between MetaView/ GIS and the other directory services is the ability for a user to specify queries using region selection. MetaView/GIS maintains two types of databases: one contains map data, the other contains the metadata. The map database contains data for displaying maps of the world. The other database maintains the metadata, directory, catalogue, etc., of data sets in other databases. The first database is internal to the MetaView/GIS system, and users cannot therefore influence its organization and/or modification. The metadata database is however available for updates by certain category of users. There are two main users of the MetaView/GIS system; those who will maintain the data in the database and those who will interact with the database to access information about data sets and databases.

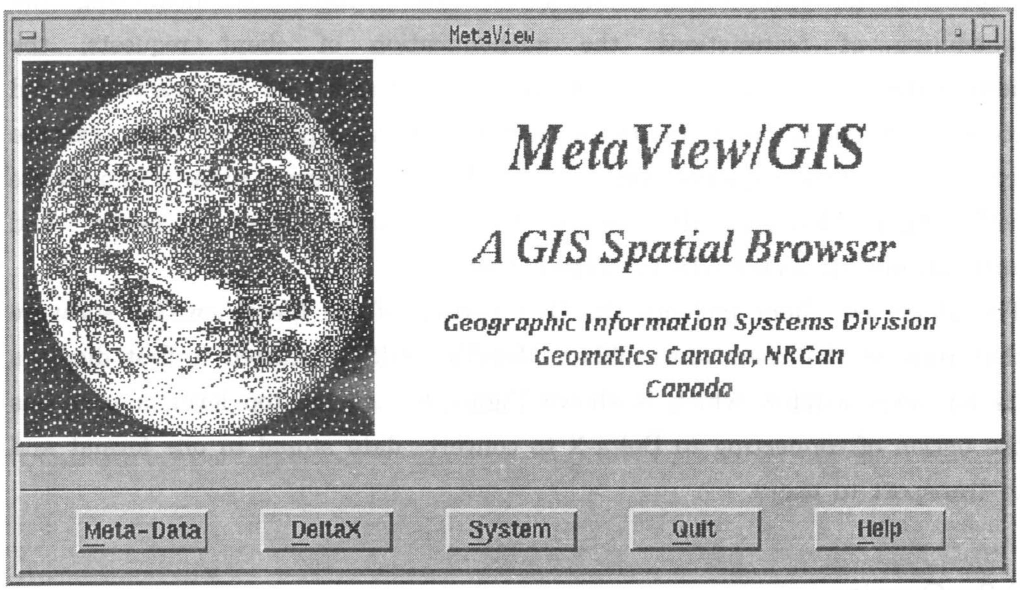

Figure 6: Top Level Window of MetaView/GIS

The MetaView/GIS software is organized on a client/server model. The server has the MetaView/ GIS databases. A client runs at the users site. Queries by the users are bundled and transferred to the server, which retrieve the necessary data from the database and return it to the client. Similar to the Delta-X, the communication between the client and the server is done in an asynchronous mode over a communication network. As shown in Figure 2, the Delta-X clients and servers, are basically, the MetaView/GIS servers and clients.

3.2 MetaView/GIS Server and Clients

The MetaView/GIS server interfaces between the MetaView/GIS clients and the databases of the system. Similar to the Delta-X, the MetaView server is responsible for transaction management; this includes the monitoring and scheduling of transactions, the authentication of client requests, the administration of resources and the commit/abort of transactions and recovery. Further, other MetaView Server has the capacity to store, execute and manage data requests, connect to a client to transmit data, communicate with other MetaView/GIS servers for assistance when necessary and authenticate MetaView/GIS privileged clients.
The MetaView client includes the GUI portion of the MetaView/GIS software that runs at the users site. When MetaView/GIS is started it first displays its top level window which is shown Figure 6. At the top level, a user has the option of connecting to Delta-X to convert data stored in one format and to transport to users.

3.3 Queries

The Spatial Browser is used to search the database by any of the

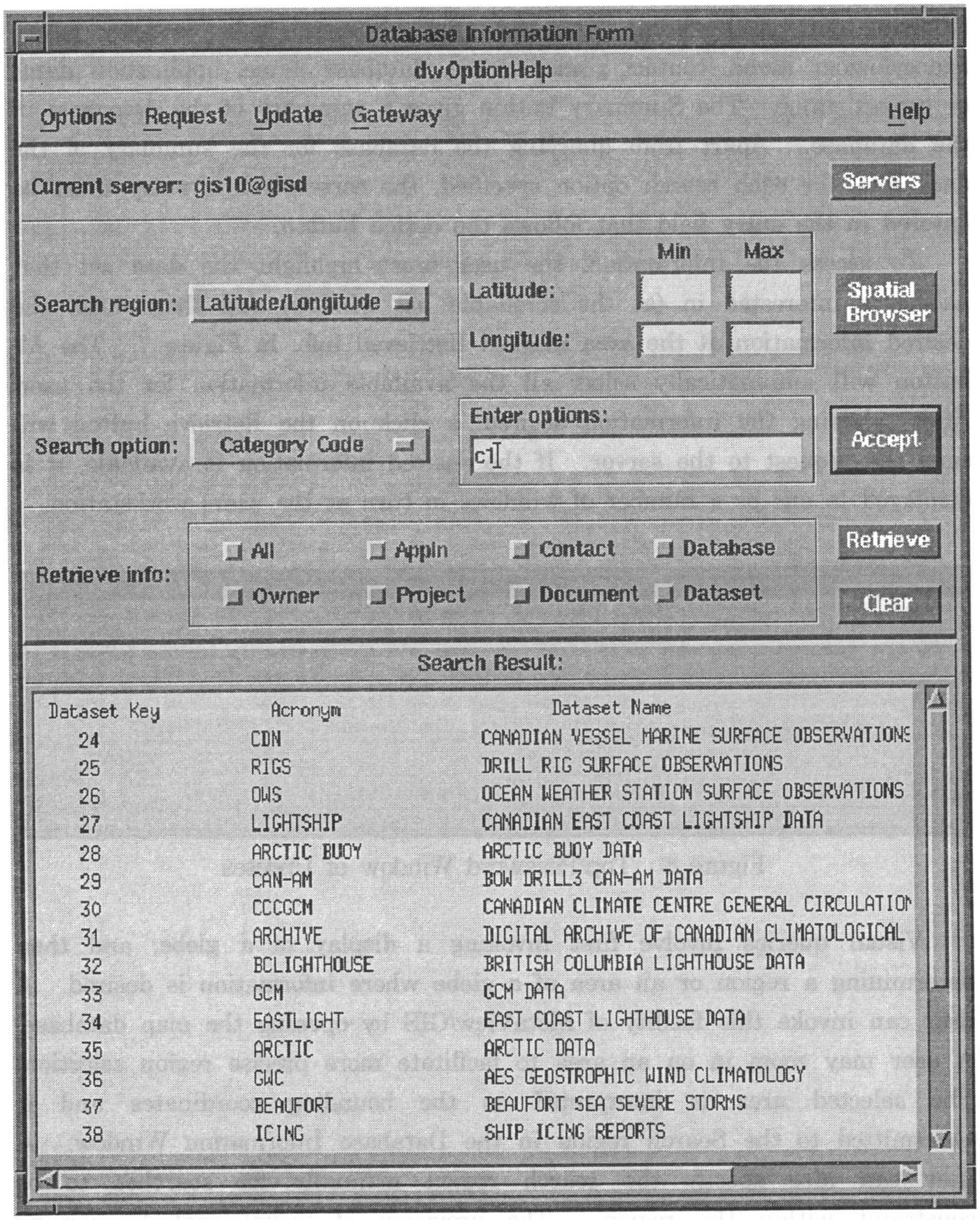

Figure 7: Main Window of MetaView/GIS

following options: keywords, data set name, category code, category name, agency/owner name, contact person name, database name, application name or project name. The Summary button gives a summary of the data sets in the database. Apart from querying the database for the summary of the data sets, for each search option specified, the corresponding entry must be entered in the entry field that follows the option button.

To access the information, the user must highlight the data set that he/she is interested in (at the scrollable list window) and then select the desired information at the area marked Retrieved info: in Figure 7. The All button will automatically select all the available information for the user. After selecting the information desired, a click on the Retrieve button will send the request to the server. If the desired information is available, it is displayed in one or a number of windows in turn at the users workstation.

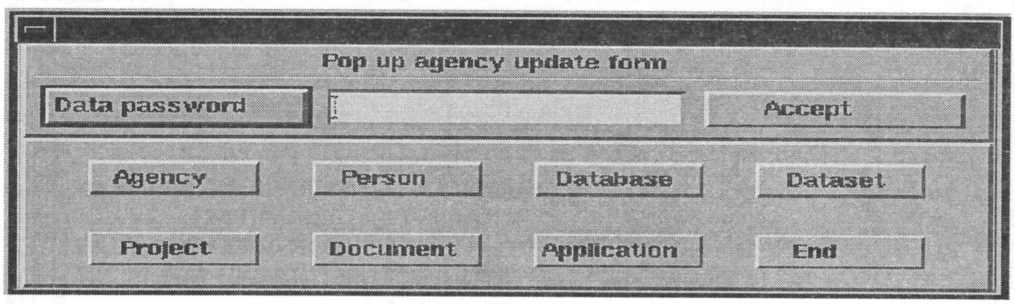

Figure 8: Top/Password Window of Updates

Visual queries involve first invoking a display of a globe, and then determining a region or an area of a globe where information is desired. A user can invoke this facility of MetaView/GIS by opening the map database. A user may zoom in on an area to facilitate more precise region selection. The selected area is interpreted as the bounding coordinates and is transmitted to the Search region in the Database Information Window. A user can also specify the search region manually for searches to be constraint within the region. The provision of visual spatial querying capability is one of the main distinguishing features of MetaView/GIS.

3.4 Metadata Update Functions

There are essentially, two classes of users of MetaView/GIS. A general public user and a privileged user. The privileged clients are the database owners that provide the metadata of their databases/data sets to the MetaView/GIS database. The owners of the databases or the data sets need to insert data in MetaView/GIS database, and to update existing information. MetaView/GIS provides a more flexible approach and friendly entry forms for these purposes. As shown in Figure 8, to insert a new data or modify an existing information, such privileged users must pass a password validation check. All database owners have password that allows them to gain access to the MetaView/GIS update functions. Updates made by authorized user are logged in temporary tables in the database. These changes are actually effected by the database administrator (DBA).

3.5 Other MetaView/GIS facilities

The main window of the browser, allows users to make request by using either and on-line or off-line tool. A user can ftp or telnet to another machine to transfer data. These systems use third party networking software for their functions. An off-line request can also be made by a FAX. The system prepares a fax report for the user based on the data set that is presently being accessed. A handy mail tool is also available for users. These functions can be accessed with the menu Request/Off-line/Fax and Request/Off-line/Mail.

Also, other MetaView spatial browser services include SQL, for advanced users who may wish to interact with the MetaView/GIS databases directly, and Delta-X for the access, retrieval of data sets from databases in the federation. MetaView provides access to other directory services, e.g. GCNet, Mosaic, Archie and FreeNet. GCNet: is a directory service developed developed for users of remote sensing information. Mosaic is an Internet information browser and WWW client of NCSA. The Archie information system is a network-based information tool offering pro-active data retrieval and indexing for widely distributed collections of data. Perhaps the best known application of the Archie system is to maintain the Internet Archives database. FreeNet: is a National Capital FreeNet information service based in Ottawa, Canada, allowing users to connect to other FreeNets across the globe.

4. CONCLUSIONS

Although the Delta-X and MetaView/GIS spatial browser work with geospatial data, its architecture, design and implementation can be applied to any type of data. The successful implementation of both systems in our Division, provided unprecedented capabilities to all the GIS workstations on our network. Our users can browse through the directory and metadata database of the federal government data holdings developed by the Inter Agency Committee on Geomatics. Data transfer between the various GIS databases and standard file formats are further proof of the validity of our concept and the success of our implementation, and the use of the Delta-X and MV/GIS in the Canadian geospatial data warehouse.

The Delta-X operational paradigms describe a methodology for the integration of multi-database management concepts and data interchange in a network of heterogeneous databases. The system as designed is a sufficiently open system that freely admits new participants, either as new databases management systems or new GIS technology, with minimum overhead. The only essential requirement is that new database or GIS vendors must provide the mapping functions that translate information between their proprietary data format and our global conceptual data model.

We have described the essential functionalities in Delta-X and we have shown the software modules required to be integrated to achieve a successful implementation. GIS database development is an exercise being carried out as national projects in several countries. We believe the approach taken by the Delta-X design will form the reference model by which similar projects will emerge to establish eventually, a global network of GIS databases.

Although our efforts are directed toward the implementation of the system in the Department, and the commercialization of the system, further developments and enhancements are in progress. The prototype implementation will be gradually extended to enhance the system security, to make Delta-X fault-tolerant and highly available by adding host stand-by servers and/or introducing data replication across the servers in the federation. Further, support for parallelism and load-balancing within the cluster and across the whole Delta-X federation is necessary.

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UK Strategies for a Spatial Database Clearing House - The Role of a National Mapping Agency -

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UK

ABSTRACT

In simple terms a spatial database clearing house provides details of where to find existing data. Such information is usually referred to as Metadata i.e. information about the location, content and quality of existing datasets. However, a spatial database clearing house can perform a number of other functions including the provision of a National Topographic Database (NTD). In addition, to be effective, a spatial data clearing house must adopt certain standards and address various policy issues related to pricing and access to data within the framework of a National GIS (NGIS).

This paper will review these functions in the context of a National Mapping Agency - Ordnance Survey, UK - and development of a NGIS. Particular attention will be placed on the development of a metadata standard and associated metadatabase which is a pre-requisite for a clearing house.

요 지

공간정보 유통관리기구란 기 구축된 정보를 어디에서 찾을 수 있는가에 대한 상세정보를 제공해주는 기구이다. 이러한 정보를 Metadata라고 하는데, 정보가 있는 위치, 내용 및 품질에 대한 정보가 그것이다. 그러나 공간정보 유통관리기구는 이외에도 많은 다른 기능들도 수행할 수 있다.

이 논문은 영국 국립지리원(Ordnance Survey)의 기능과 국가GIS 개발과정에 대해 살펴보고자 한다. 아래에 소개되는 주요분야에 대한 토의내용을 담고 있다.

- 메타데이타베이스의 설계 및 구축
- 국가지형도의 기초자료 구축
- 표 준
- 시스템 기반
- 자료에의 접근 및 분배
- 정책적 문제 (저작권, 가격, 접근성 등)

1. INTRODUCTION

As the use of Geographical Information Systems (GIS) spreads the benefits of bringing different datasets together is becoming increasingly apparent. These benefits may be derived in a number of ways, from the re-use of existing datasets, through to combining datasets to improve data quality (through the identification of data inconsistencies) and the creation of value added products.

In Britain a wide range of geographical data (or geospatial data as we prefer to call it) already exists, often with national coverage. To facilitate its use and improve data sharing a fundamental requirement is to have better information about datasets. Such information is commonly referred to as metadata. The provision of this information is a primary role which a spatial data clearing house can perform.

2. METADATA - INFORMATION ABOUT DATASETS

Metadata may be defined as providing information about what datasets exist, who holds them and whether and how they are available. In Europe, technical committee TC 287 of the Comité Europé en de Normàlisation (CEN) has developed a draft metadata standard. The standard defines the following main elements of metadata:

- *Dataset Identification* - this includes the title of the dataset;
- *Dataset Overview* - an overall description of the dataset, including: a brief description (abstract) of the dataset; an indication of the purpose and usage of the data; the type of data (vector, raster) it contains; and the spatial reference of the data;
- *Dataset Quality Parameters* - an overall description of the dataset's quality using the parameters described in the CEN Quality Standard (discussed in more detail later in the paper);
- *Spatial Reference System* - information about how the geographic features contained in the dataset are positioned in space e.g. by direct referencing (a co-ordinate system) or indirect (a postal address);
- *Geographic and Temporal Extent* - the geographic coverage of the dataset and the time period which it covers;
- *Data Definition* - detailed information about the feature types, attribute types and relationships between them;
- *Classification* - a semantic model, expressed as a thesaurus, of the classes of features, their definitions and their hierarchical relationships contained in the dataset;
- *Administrative metadata* - information about how to acquire a dataset, including information on the location of a dataset (address and contact numbers of the owning organisation); and information which is relevant to the distribution of the dataset such as restrictions on use, copyright, pricing, media of delivery etc.
- *Metadata Reference* - information about the metadata themselves, for example, the date the metadata was last updated or checked.

In Britain, as in many other countries, metadatabase systems have been created to hold metadata and make it more easily accessible. One example, is Ordnance Survey's metadatabase service known as SINES (Spatial Information Enquiry Service). SINES describes some 500 government held geospatial datasets and allows them to be selected on the basis of keyword (for example geographic theme), location and organisation. At present SINES does not provide the detailed information described in the above standard, rather, high level information which provides an overview of a dataset and contact details for getting further information. The service is available, free of charge, either by phoning in, e-mail or, since October 1995, over the World Wide Web[1].

Many other examples of metadatabase systems exist, including at the European level. The MEGRIN GDDD system provides information about all European topographic datasets and is to be upgraded to conform with the emerging CEN Metadata standard. As the number of systems increase we will soon need a meta-metadatabase system to provide information about the content of the different metadatabases! The real challenge however, is to ensure that data producers can provide sufficient metadata without incurring excessive costs; and that data users have enough information to assess the suitability of a dataset(s) for their particular purpose. Central to this is a consistent understanding of data quality.

3. QUALITY - IS A DATASET FIT FOR PURPOSE?

Metadata includes information about the quality of a dataset i.e. the fitness for purpose of a dataset. In other words, an assessment of the suitability of a dataset is very much in the eye of the beholder - one person's 'good' quality is another's rubbish. However, in order to share data it is necessary to provide some mechanism for describing data quality. In Europe such a mechanism now exists in the form of a draft standard which proposes a model for describing data quality.

1) The SINES web service is provided as part of the OS pages which can be found at http://www.ordsvy.govt.uk/

It suggests that for any dataset there should be a set of quality information that comprises:

- mandatory information about the *lineage* of the dataset e.g. information about how the data was produced, source of information, date of production, original reason for production etc.;
- optional information about *usage* e.g. who used the data, for what purpose, when etc.
- optional *parameters* that describe specific aspects of a dataset. These include:
    - positional accuracy e.g. relative or absolute accuracy of data
    - thematic accuracy e.g. accuracy of classification of data
    - temporal accuracy e.g. how up-to-date is the data
    - completeness e.g. errors of omission
    - textual fidelity e.g. accuracy of spelling

A summary of this information should form part of the metadata which describes a dataset. The adoption of this standard also provides a mechanism for providing information at the more detailed, feature and attribute, level.

4. OTHER STANDARDS

In the context of a spatial data clearing house and a NGIS the adoption of standards for metadata and data quality are a necessary pre-condition to providing an effective service. However, additional standards will also be required covering:

- geometry and structure data models (schema);
- data transfer;
- geographic referencing;
- query and update;
- definitions;
- data classification.

In Europe many of these standards exist in draft form thanks to the efforts of TC 287. It remains to be seen how effective they are and how quickly they are adopted.

5. Core Datasets

The model proposed in the UK, and in most countries, for a NGIS is a 'hub' model in which data is held and updated in different places but which can be identified easily (through the clearing house) and integrated through adoption of common standards, tools and data policies. In other words it is not intended that all data is centralised within one organisation (a *data warehouse*). However, the clearing house may contain a number of core national datasets which aid the process of data integration. In the UK Ordnance Survey holds a number of national datasets that are fundamental to a NGIS and which can be provided as part of a clearing house service.

These datasets include:

Large scales topographic data - 230,000 maps in digital form at scales of 1:1,250; 1:2,500; and 1:10,000. These data are continually being improved and the intention in the near future is to structure this data in such a manner that it will provide:

- a consistent reference framework in the form of topographic (land parcel) units with maintained and universal identifiers;
- simple real world feature classification;
  'clean' geometric data i.e. data from which node, link, polygon topology can be created and maintained;
- sufficient quality information, including at feature level;
- support for both graphic and data requirements.

ADDRESS-POINT - a dataset which provides a co-ordinated reference for every postal address in Great Britain and thus allows geospatial data referenced by address to be more easily integrated.

- OSCAR - a structured dataset representing the road network of Great Britain.
- Boundaries - a structured dataset of all administrative boundaries in Great Britain.

Such datasets allow other datasets referenced by different 'geographies' to be brought together. The intention in the UK is to bring these datasets even more closely together into a National Topographic Database (NTD) - an integrated large scales database of accessible consistent. accurate, reliable and up-to-date data. A spatial data clearing house can play, therefore, an important role in making such a NTD and other datasets easily accessible.

6. ACCESSIBILITY TO DATASETS

The ideal position for any user of geospatial data would be to have access to a 'one stop' shop in which datasets can be identified, selected, downloaded, invoiced and paid for at one location-the ultimate spatial data clearing house and desired goal of a NGIS. In the UK we still have some way to go before we achieve this vision. However, on-line access to certain datasets, notably land ownership information, is becoming increasingly common in the UK and other European countries.

Ordnance Survey currently makes its large scales topographic data available on various media from its headquarters in Southampton. However, paper plots can be purchased from a distributed network of agents through our Superplan service. This allows a user to buy a site centred map, that can be varied in specification (e.g. feature code selection, line styles), from many different locations around the country. The up-to-date topographic data is supplied to the agents on a regular basis and held locally. Pricing and invoicing is an integral part of the system and is done automatically at the time the user selects data. The intention is to extend this system to allow provision of the digital data themselves - 'data from agents'.

7. POLICY AND INSTITUTIONAL ISSUES

The paper has highlighted a number of factors that contribute to the efficient and effective operation of a clearing house. Perhaps more important than the technical issues are the 'institutional' issues covering data pricing, copyright, availability of data, legal issues, government policy etc. A NGIS must address these issues in order to provide guidelines within which a clearing house can provide its service. From the user's perspective they will want ready access to data, with minimal restrictions and at a price they can afford. The supplier will require an appropriate return for the data and adequate protection against its misuse e.g. illegal copying. This balance must be achieved within the constraints of government policy and market forces. The spatial clearing house should contribute to this debate and can play a key role in facilitating discussions to resolve often difficult and complex issues.

8. CONCLUSIONS

This paper has reviewed the role of a spatial data clearing house with particular reference to the provision of metadata - data that describes datasets. In the UK, whilst no single organisation has taken responsibility for this role, the paper has illustrated, by reference to Ordnance Survey, how a National Mapping Agency (NMA) may fulfil the role of a spatial data clearing house. This role may be broader than just the provision of metadata and may include provision of core datasets, development and implementation of standards and helping to tackle the many 'institutional' issues that impact upon data sharing. In so doing a NMA can contribute to the wider development of a NGIS rather than just the provision of a metadata service.

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National Mapping Agencies : Looking to the 21st Century

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ABSTRACT

It is always guesswork to foresee what the coming years will bring. Nevertheless, this paper attempts to look 5 to 10 years down the road to see what national mapping agencies might look like, in terms of their roles and responsibilities. What we can be certain of is that the traditional surveying and mapping organizations are becoming dinosaurs, threatened with extinction. Survival of National Mapping agencies will depend on the ability to understand and adapt to the trends that are forging future directions.

Leading these trends is the world economy, with emphasis on deficit reductions, downsizing the public services, and increasing demands for more value for tax dollars. Globalization of the economy and of the marketplaces is well underway, leading to a global arrangement of interdependent nations. Client demands will, more than any other factor, influence where national mapping agencies are headed. Clients are no longer satisfied with the traditional content, scale and relevance of the paper maps.

The ability to harness emerging technology in delivering programs has

always been a major strength of National agencies. However, technology development is becoming so accelerated that the near-future clients will demand only basic, geographically-referenced data from National Agencies and will have the capacity to produce the customized and personalized products they will require.

These forces together are driving entrepreneurial government, where national mapping agencies recover costs and generate revenues in a move towards at least partial self-financing. Coupled with this is the trend to move those activities that can best be done by the private sector out of government. Privatization is more than a trend, it is a reality. In Canada, the popular phrase is "the business of government is getting out of business" .

But such Agencies can create their own, preferred future. That lies in leading the creation, maintenance and adherence to national standards of a national spatial data infrastructure, linked to other NSDI' s of the world via the Information Highway. Agencies will no longer just accumulate data, but will be involved in transforming that data into information, and, ultimately, into knowledge. They will be leaner, meaner, and more clearly focused in terms of the service they will provide.

요 지

앞으로 다가올 미래를 예측한다는 것은 항상 짐작 수준에 머물지만, 그럼에도 불구하고 이 글은 앞으로 5년에서 10년사이 캐나다 국립지리원의 역할 및 책임과 관련하여 어떠한 모습으로 변모할 것인가에 대해 조망해보려 한다. 확신할 수 있는 것은 전통적인 측량 및 지도제작 기관은 소멸의 위협을 받는 공룡이 되어 간다는 것이다. 즉, 국립지리원의 생존은 미래를 만드는 경향을 이해하고 받아 들이는 능력에 좌우될 것이다.

이러한 경향을 주도하는 것은, 적자축소를 중요시하고 공공 서비스를 축소하며 세금에 상응하여 더 많은 가치를 요구하는 세계경제이다. 경제와 시장의 세계화가 순조롭게 진행중이고, 이로 인해 상호 의존하는 국가간의 협정이 이루어진다. 특히 고객의 요구는 어떤 다른 요소보다도, 국립지리원이 어디로 나아가야 하는지에 대해 영향을 미칠 것이다. 고객은 더이상 기존의 전통적인 지도내용, 축척, 종이지도에 만족하지 않는다.

제공 프로그램에서 최신 기술을 이용하는 능력은 항상 국가기관의 주요한 힘이 되어 왔다. 그러나 기술개발이 점점 가속화되어, 가까운 미래의 고객은 국가 기관으로부터는 단

지 기본적이고 지리참조 데이타만을 요구할 것이다. 반면, 고객들은 자신들이 수요에 부합하는 정보를 제작할 수 있게 될 것이다.

이러한 역동력은 기업적 정부로의 변화를 촉진하고 있으며, 여기서 국립지리원은 최소한 부분적인 자체재정능력을 가짐으로써 원가를 보상받고, 수익을 올릴 수 있을 것이다. 이것과 결부하여 민간 부문에 가장 적합한 활동들은 정부로부터 민간부문으로 옮겨가는 경향이 있다. 캐나다에는 "정부가 하는 일은 점차 문닫게 될 것"이라는 유행어가 있다.

그러나 그러한 기관들은 자신의 미래를 만들 수 있으며, 이 미래는 초고속 정보통신망을 통해 세계의 국가공간정보기반과 연결된 국가공간정보기반의 국가표준을 만들고 유지관리하는데에 있다. 각 기관들은 더이상 내부에 데이타를 축척하지 않을 것이고, 그 대신 데이타를 정보(Information)로 변형시키고, 궁극적으로 지식(Knowledge)으로 될 것이다. 이들 기관은 자신들이 제공하는 서비스에 보다 더 주의를 기울이게 될 것이다.

1. INTRODUCTION

It is unquestionably an honour for me as the former Assistant Deputy Minister of Geomatics Canada and now Managing Director, Geomatics of SHL VISION* Solutions of Ottawa to have been invited to present this paper at your International Seminar. This paper is a formidable challenge in that I am speaking on the future of national mapping agencies.

As we are sure you will agree, trying to forecast what activities will be for the next year or two is fraught with uncertainties and imprecise projections. Stretching that forward look 2 to 5 years down the road, the essence of strategic planning, is an exercise in educated guesswork. Beyond five years, trying to accurately define what the future will bring is a combination of good judgment, based on the best available information, good luck and a generous amount of clairvoyancy.

Unfortunately, we are not clairvoyant. We do not possess a talent for seeing into the future. As to good luck, while it is probably normally distributed, from a statistical point of view, it is not something that we would like to rely on. We believe we have always exhibited good judgment, but we will leave you to make your own conclusions on that subject.

How then do we position national mapping agencies at the coming turn of the century? We must first attempt to describe the changing environment that is influencing the future direction. If we can understand the forces, we stand a better chance of projecting where those forces will take us. But first, a brief look at vision is in order.

2. IN SEARCH OF A VISION

National mapping agencies are as diverse as they are many. Their structures and organizations differ widely, as do their size, accountability within their respective nations, and their roles and responsibilities. They do, however, share a common mandate to provide the basic topographic information for their country.

Each of these agencies is struggling to define a vision for its future. With that vision, the agency can establish the goals and measures that will be needed to get there. This is a traditional approach, but one that is doomed to failure if we do not account for the changing paradigm that national mapping agencies are encountering. The forces that are driving that shift will make the traditional surveying and mapping organization an obsolete entity by the end of this decade. Morrison of the USA states that part of the shift is the questioning of the very need for a national mapping agency. (Morrison, 1995)

Trinder and Fraser of Australia suggest that the surveying profession is facing a critical point in its future, and that unless the essential challenges are met, surveying could be reduced to a small niche activity. They suggest that many of the activities associated with geomatics will be taken over by other, non-geomatics professionals. They propose a contrived future, under the geomatics banner, where the surveying and mapping sub-disciplines thrive under a much broader range across spatial information management and science. (Trinder and Fraser, 1994)

Peter Ellyard was more direct when he said that it is likely that the surveying and mapping profession will continue to decline in significance if things continue as they are. He refers to such a future as a "probable future". However, the future which the profession can create for itself he calls the "preferred future". (Ellyard, 1994)

We can extend these ideas to national mapping agencies. If we are not proactive and design our own preferred future, we risk an imposed future, one where these agencies decline in importance and value to society.

3. EXTERNAL INFLUENCES

In order to create that preferred future, we must understand and account for the influences that are driving the paradigm shift that the agencies are undergoing as we move to a new century. Those influences are many and complex, and we will deal with those we believe are the most critical for all of us. They are:

- The World Economy
- Globalization
- Changing Client Needs
- Organizational Changes
- Environmental Issues
- The Information Highway
- Technology

4. THE WORLD ECONOMY

The industrial nations of the world are just emerging from the 1990-1992 economic recession, with the weakest recovery of any recession that we have undergone. That recession was the longest and second-deepest since the Great Depression. The economy, for all practical purposes, was in decline for more than two years. Businesses saw demand for goods and services plunge drastically as consumers, fearing further debt and job loss, cut back on their spending abruptly and severely. As a result, corporate profits tumbled to a post Great Depression low. Compounding the situation, inflation forced interest rates to near-record real levels.

Many national debts reached crisis proportions. We are all aware of the very serious budgetary measures that New Zealand was forced to implement to control their economic problems. We have been facing a similar situation in Canada. For example, at the end of the 1994-95 fiscal year, Canadas total debt stood at $725 billion, or about $25,000 for each and every Canadian.

National debts are a priority of governments today, and will be for the rest of this decade. Reduction in government spending, coupled with measures to increase revenues, is and will continue to impact directly on national mapping agencies.

Governments around the world are scaling-back programs. They are undergoing, or have undergone, major downsizing and reorganization exercises. Figures 1 and 2 illustrate the reductions in personnel that the Ordnance Survey (Rhind, 1995) and Geomatics Canada, respectively, have undergone in the last fifteen years. The Ordnance Survey has seen approximately a 42% reduction, with a 34% reduction for Geomatics Canada. We suggest that these are representative of a general trend affecting national mapping agencies.

In Canada, we just completed Program Review, the most comprehensive review of federal government activities ever undertaken in our country. This culminated in the 1995 Budget, which demonstrates Canada' s commitment to deficit reduction, economic growth, and responsive and efficient government. Departments are seeking new ways to deliver programs and services at lower cost to Canadians. Program Review has been the catalyst for this renewal.

The Budget announced significant reductions in funding to the various departments and agencies. For example, Natural Resources Canada (NRCan) will go from a $1.1 billion budget in 1994-95 to approximately $435 million in 1997-98. Geomatics Canada, a sector of NRCan, will, over the next 3 years, see a budget reduction of $23.7 million. This represents a 31% reduction from the 1994-95 budget. It will also mean that the total staff complement will fall to around 580 persons. In terms of Figure 2, it means the personnel involved in the surveying and mapping side of the organization will number about 500, or a reduction of 53% from the 1979 total.

Nevertheless, the world is moving toward an economy in which information is of primary importance. As the holders of the fundamental geographic information for our respective nations, Industry and Government can shape their own destiny working together and thrive in the emerging information society.

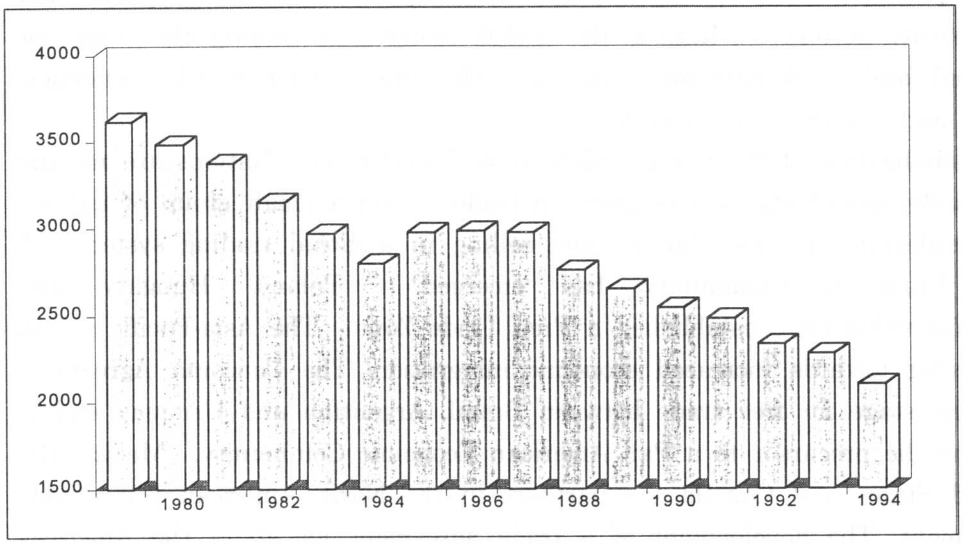

Figure 1 Downsizing at Ordnance Survey

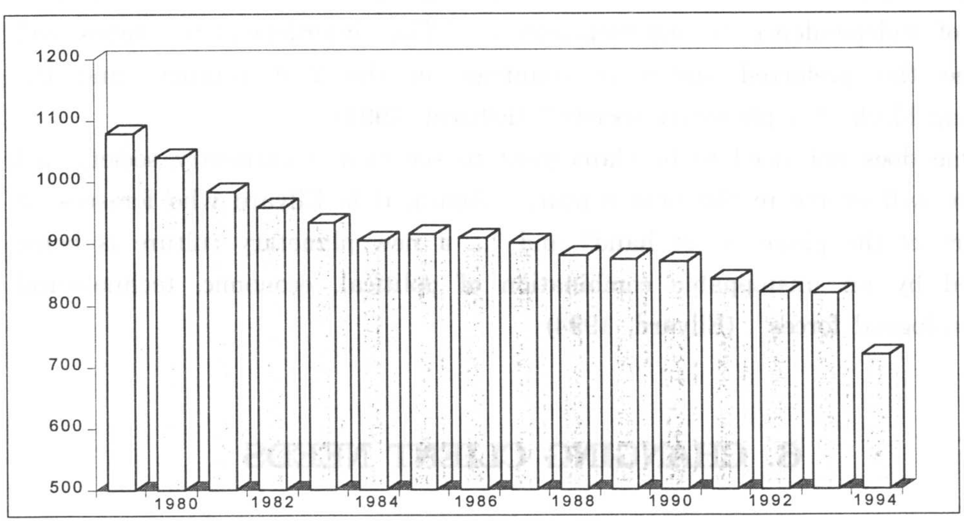

Figure 2: Downsizing at Geomatics Canada
[surveying and mapping activities only]

5. GLOBALIZATION

The economic situation is driving a globalization process, one that goes beyond regional economic arrangements. It has created a climate of interdependence between nations, one that impacts on both the public and the private sectors. Indeed, the global economy is setting the stage for national and local economies and sets the rules under which economies, public and private, must operate.

Globalization of the market place is well underway. Nations are moving from independent states dependent on trade within a small group of nations to interdependent states buying and selling in a global trading system. A new European Community has emerged. Poland, Hungary and Czechoslovakia have established a Free Trade Zone. The Asia-Pacific region is moving towards increased economic integration. The Concorda Agreement sets the stage for free trade between Brazil, Argentina and Uruguay and is seen as the precursor to a Pan American Economic Community. Mexico, the United States and Canada are partners in the North American Free Trade Agreement. The development of a trade agreement for all of the Americas seems inevitable, as is a single interdependent European alliance. Peter Ellyard suggested: "... nations are undergoing the next transition, from that of independence to interdependence. This interdependent status will become the preferred status of countries in the 21st century, and the building block of a planetary society." (Ellyard, 1994)

One does not need to be clairvoyant to see that a planetary society and culture will evolve in the next century. Again, it is Ellyard who foresees "a century of the planet is at hand" and "... a new planetary culture is being molded by an unstoppable combination of political, economic, technological and ecological forces". (Ellyard, 1994)

6. CHANGING CLIENT NEEDS

National mapping agencies have long enjoyed a position of power and authority. Spatial data, in analogue, and later in digital form, has been their raison d'être, their specialty. Our clients were well-served when we provided paper maps to describe the geo-science and topology of the land. However, that position is coming to an end.

We are already witnessing a revolution from our clients. They are demanding a higher quality and wider range of products. They are no longer content to put up with what is available. Clients are also looking for governments to provide "one-stop shopping" for the various national spatial data produced by separate government departments.

The current emphasis in our respective national agencies is on user surveys -- identifying not just who the clients are, but also what are their requirements. Not only must Agencies be client-focused, but they must also provide dynamic products that are adaptable to clients changing needs.

Mapping Agencies have thrived on technology. Until the 1980's they were the collectors of topographic data. That was probably due to the fact that only national mapping agencies could afford the equipment and infrastructure required to map on a national scale. As the technology improved and became more accessible, private sector capabilities emerged and many of us shifted from data gatherers to data managers. As the 1990's play out, the performance and simplicity of computer hardware and software, coupled with dramatically decreasing prices and increasing accessibility, means that clients will need only access to data to produce the customized products they want. Indeed, it is suggested that technology is developing so rapidly that by the end of the century clients will look to national mapping agencies only as a source of digital topographic information. And, if they cannot supply that information quickly enough, or with the desired quality or relevance, those clients will seek other suppliers.

Our agencies have existed for hundreds of years. Yet, within a span of 20 years, we are witnessing more than a mere paradigm shift with respect to our clients. We have seen the emphasis go from providing products to providing data, and now from data to information. By the turn of the century, the emphasis will pass from information to knowledge, where knowledge is defined as the application and productive use of information. A significant aspect of the preferred future is becoming a knowledge-based organization. That means understanding how to convert our geographic information into knowledge that has immediate value to our clients. As Jakobsen points out, customers are our long term guarantee for survival. (Jakobsen, 1995)

The challenge for the private sector is also becoming clear: more and more, their success will depend on their ability to competitively provide high quality products and services. The adoption of internationally recognized quality standards, ISO 9000, is becoming a de facto condition for doing business in Europe and elsewhere around the world.

7. ORGANIZATIONAL CHANGES

The economic trends coupled with the reduction in federal budgets infers that the role of government in spatial data production and management is changing. Some suggest that national mapping agency roles will be reduced to coordinators of government activities and national standards, with the production of spatial data taken over by the private sector and non-government organizations. Privatization is a popular policy, as governments seek ways to reduce the size and cost of the public service.

The Ordnance Survey is a prime example of the user pay principle. The OS reported in 1993-94 that 72% of the overall budget came from the sales of products and services, with the remaining 28% from government appropriation.(Rhind, 1995) The Department of Survey and Land Information of New Zealand has seen cost recovery objectives rise steadily from 30% in 1987 to the current, 70% level. (Gartner, 1995)

National mapping agencies are being challenged on their mandates and need to exist. The systematic topographic mapping of a nation at specified scales no longer meets the needs of an information-hungry society. Digital topographic data, unbounded by scale or area, is the basic information that is required. The National Mapping Division of the US Geological Survey is seeing its mandate move from a provider of topographic maps to a responsibility for the national spatial data infrastructure. In Canada, as a direct result of Program Review, a study has been initiated into the integration of federal geomatics activities. Aside form Geomatics Canada, there are 8 other government agencies that are involved in mapping, ranging from the hydrographic charts of Fisheries and Oceans Canada to the military maps of National Defence. A preliminary, fact-finding study has determined that federal agencies spend a total of $ 174 million, employing in excess of 2500 persons, on geomatics activities. The integration study has examined the common expertise, technology, utputs and client bases to determine how an integration or amalgamation might more effectively deliver federal geomatics programs. The recommendations of the study are currently being addressed.

The global trend is towards entrepreneurial government. The challenge is to more effectively use public finances and to subject government operations to the laws of the marketplace. The response is taking the form of:

- Reductions in the size of the Public Service;
- Commercialization of certain government activities;
- Restructuring of the government machinery; and
- A redefinition of the process for developing public policy and the role of the various players involved in this process.

National mapping agencies will have to be entrepreneurial to survive. The Executive Agencies of the UK. the Special Operating Agencies of Canada and the State Owned Enterprises of New Zealand are preferred models for program delivery mechanisms.

During the past year in Canada, the effective, efficient and economical delivery of government programs has been under intense review. One of the results is the evolution of a series of alternative mechanisms. Every program, depending on its mandate, degree of autonomy requirements, market responsiveness and financing capability can fit into one or more of these mechanisms, which are shown in Figure 3.

In Figure 3, the further to the left of centre, the more involvement one sees in delivering a public good service, one that requires increasing degrees of policy input and also financing from the public purse. To the right of centre, the implications on national issues and policy become less and less. Moving up from the centre sees a increase in the autonomy of organizations

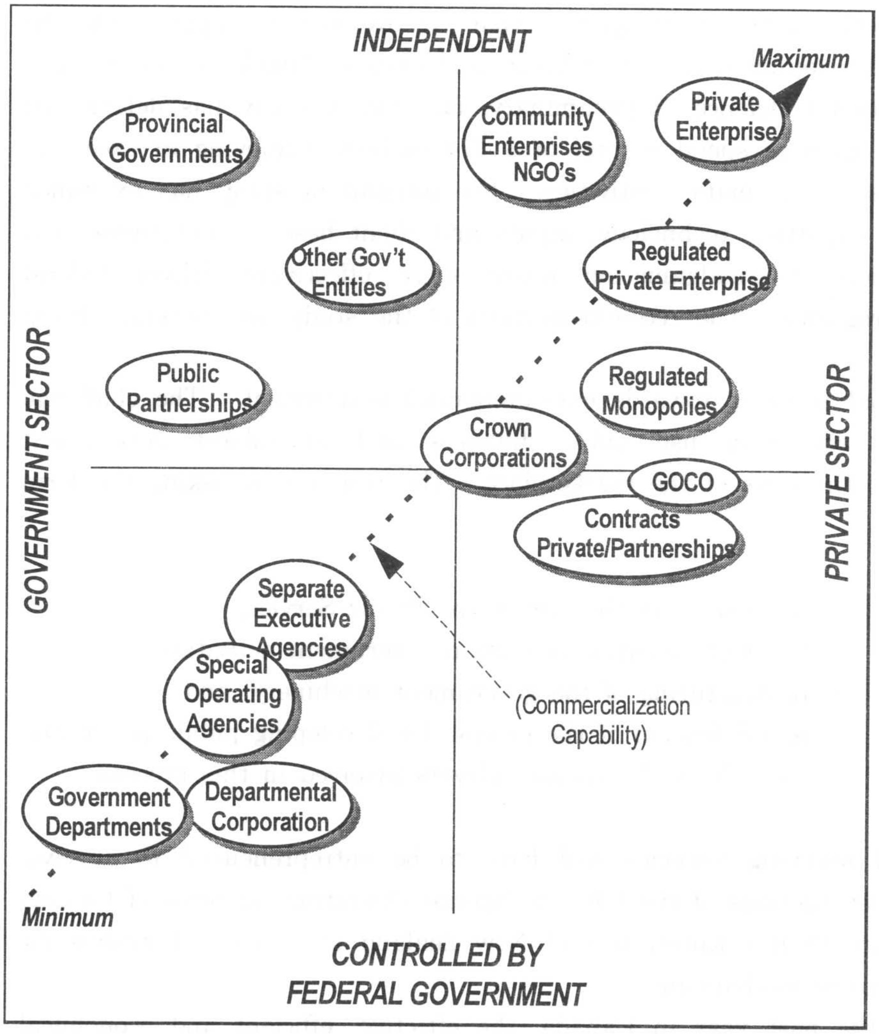

Figure 3: Alternative Delivery Mechanisms

from central government, coupled with increased commercialization capability. At the lower left, we find the traditional government department, where control by the central government is maximum and commercial capability is minimum. At the top right is the private enterprise, with minimum government involvement and maximum commercial capability.

The core activities of national mapping agencies are under minute scrutiny. These are the fundamental products and services that governments must provide to citizens, and which are funded out of the tax base. The trend in recent times is to strip away all those activities that are not certified as part of the core. Such activities are made self-sustaining, devolved to the private sector, or eliminated. The Honourable Paul Martin, Canadian Minister of Finance, has proclaimed: "The business of government is to get out of business". This is a challenge that faces every national mapping agency, but obviously to varying degrees.

We also must recognize that geomatics firms in the competitive economy of the future will only succeed in the international marketplace if domestic markets operate efficiently -- a strong domestic base is essential to compete abroad. This, in turn, requires that national mapping agencies move their production tasks to the geomatics companies of the private sector.

In Canada, we have had a contracting-out program in place for nearly 20 years. Last year, Government contracted out $25 million worth of work. The attendant technology transfer and expertise development is helping to build a strong domestic capability for our industry. By 1997, it is expected that all of the production work will be done by the industry.

8. THE ENVIRONMENT

The accumulative damage that has and continues to be inflicted on the planet is a current preoccupation. The planetary society emerging in the 21st century will be even more conscious of undoing that damage and minimizing further adverse effects. Sustainable development of natural resources is one of today's priorities of the Government of Canada. It will be a priority of the planet for the foreseeable future.

While cleaning up our environment is a considerable task, the planet has made a good start. The 1992 Rio Earth Summit was the largest international meeting in history. Representatives of almost all nations worked together to develop the Rio Declaration, conventions on Climate Change and Biodiversity, and the Agenda 21 action plan.

A new planetary environmental order is being realized, and national mapping agencies can have a prominent role in that order. As Dr. Htum has indicated, the spatial information needed to fully support sustainable development is lacking in most parts of the world. (Htum, 1995)

Collectively, we have the spatial data that decision-makers need. We represent the most effective means to continuously monitor the state of the environment. We must be a part of the implementation of Agenda 21. This action plan represents tangible evidence of all nations concerns about the future of the planet. Those concerns are further fueled by the estimates that the world' s population will double to 10 billion by 2030, that 20 million hectares of rain forest disappear each year, that 1.3 billion people lack sanitary drinking water or facilities, that 1.5 billion lack sufficient fuel for heating and cooking, and that less than 25% of the world population lives in the industrialized nations, yet they consume 75% of the world energy and 85% of wood products. (Byrne, 1994)

Agenda 21 encourages nations to develop internally acceptable methodologies for data bases of land uses and to develop and maintain data bases for management of coastal areas.

9. TECHNOLOGY

Mapping organizations will, as always, be technology dependent. Our agencies have a rich history of successfully exploiting emerging technology to deliver our programs.

The major technological trend for geomatics will involve linking the multitude of existing spatial data bases, as we move towards integrated, total solutions to geomatics markets.

Information will be our primary commodity and the growth potential will be in developing value-added applications and uses of that information.

Technological innovations will also affect the structure of our organizations and the conduct of our work, as well as the management of our organizations.

The following are but a representative sample of the changing technologies that are driving the geomatics future.

Custom maps will be made using public domain software running on desk-top computers linked to Internet. Low volume maps will be printed on demand, at user-specified scales and boundaries.

Small scale map coverage can now be provided by automatically processed imagery from satellite remote sensing systems. Technology is already under development for fully automatic topographic mapping at medium scales. Remote sensing technology will inevitably provide the data for compilation and revision of maps at all scales.

Aerial photography will remain a viable data source for photogrammetric mapping at certain scales. However, it is clear that easy access to high-accuracy, high resolution satellite imagery will change the way that public and private mapping agencies as well as end users will view the task of mapping. Satellite sensor systems for mapping from space are currently under rapid development. Higher resolution sensors with stereo capability, as well as increased spectral possibilities are either becoming available now, or are in the development or planning stages by various nations. Radar imaging and radar interferometry are emerging as significant new tools. In November of last year, Canada launched RADARSAT, the worlds first fully-operational satellite dedicated to radar applications.

The remote sensing application market, which includes mapping from space, is expected to grow to US$ 5 billion by the end of this century. (Thurgood, 1995).

Geographic Information Systems and related applications will also continue to enjoy substantial growth. It is suggested that funds spent on GIS are growing at an estimated 30% per year (Trinder and Fraser, 1994). While the cost of GIS workstations and software is dropping significantly, the high cost of getting data into the spatial data bases will continue to impede the growth of GIS. This impediment is the cause of the large gap between the potential of GIS and actual use.

Differential GPS services are being established and will grow in importance and extent. GPS will be inextricably entwined with GIS in the future, providing the positioning element of real time spatial data acquisition. And, GPS will move on from a military-based to a global, civilian-controlled satellite positioning system.

Interoperability is a cornerstone of tomorrow' s GIS. This will define the pathways for linking disparate and isolated spatial information systems. It will also imply the existence of common user interfaces that support the integration of consistent, reliable data sets. (Hecht, 1995)

10. THE INFORMATION HIGHWAY

The Information Highway has been under construction for some time. Since the early 1960' s foundations for the highway were laid with the development of computer technology to manage spatial data. Traditional mapping gave way to an new era of computer-assisted mapping.

The 1970' s saw the creation of the Canadian Geographical Information System, the world' s first national data base of spatially related data. Through the 1980' s software development had evolved to where digital data bases sprang up all over. These were generally independent and isolated and we have all experienced the frustration of trying to link data that does not conform to common standards.

During the 1990' s, and beyond, the task will be to link those data bases into a national spatial data infrastructure, or NSDI. Externally, the task will be to link the various NSDI' s to develop spatial data marketplaces, accessible via the Information Highway.

The Information Highway is already spanning continents. It is the NSDI' s of the world that will form the major nodes of that highway. Those nodes are essential if spatially-related data is to be readily transported and integrated by the decision-makers of tomorrow.

Communications technology coupled with information of all kinds is the basis of the Information Highway. The sophistication of communications is indeed making the world a smaller place in which to live. Constraints of physical separation or time differences are no longer significant. The fusion of computer and communications technologies is bringing about a major social transformation with dimensions so vast that they are difficult to discern.

The age of the Internet has arrived, allowing communications anywhere and at any time. With Internet, the science fiction concept of cyberspace is closer to reality.

The Information Highway will not only allow the delivery of vast amounts of information throughout the world, but will allow information content that is made to order and extremely personalized.

Some see the Information Highway as the crucial part of the new economy -- an economy based on ideas and innovation instead of natural resources. It is a way to build economic knowledge bases. Industry needs the Information Highway to compete globally and to increase productivity; government needs it to reduce costs and to increase efficiency.

An industry expert estimates the Information Highway to potentially be a US$35 trillion market. Many governments and private companies are maneuvering to take a share of that market.

Geomatics Canada has moved to the Information Highway. It has linked the unique geographic information system capabilities to the Internet. The National Atlas Information Service (NAIS) leads this development. The electronic atlas provides a true global gateway to sustainable development information.

The NAIS World Wide Web site provides interactive access to major national data bases, as well as unique map-making and analytical tools. For example, the user can:

- Search a 500,000 geographical names data base;
- Make national or regional maps of wetlands, earthquake zones, or the habitats of endangered species;
- Map pollution in his or her "own backyard" (with data from Environment Canada); or
- Visit native, rural and urban communities.

This service provides an effective balance of free information and revenue-generating sales of maps and digital data. Client response has been overwhelming. In just one year, over 100,000 maps of Canada were made electronically, with the data provided free of charge, around the world!

11. DEVELOPING STRATEGIES FOR THE FUTURE

Joint ventures or strategic alliances involving private companies, universities and public agencies will give access to research, to the efficiencies of the private sector, and to the public sector' s abilities to manage complex projects. A large part of alliances between the public and private sector will result in commercially viable value-added products and services. (Ryttersgaard, 1995)

While the activities funded by public money are continually being stream-lined, there is a concurrent pressure for national mapping agencies to look for new areas of activity that will generate the revenues needed to supplement government appropriation. This has created another problem, the lack of marketing expertise in such agencies. In the recent past, such marketing has been avoided, simply because any increased revenues went to the public accounts and could not be used to even offset the cost of marketing. The current emphasis on cost recovery and revenue generation is instilling another element of cultural change in national mapping agencies.

Agencies are also faced with new challenges in trying to explain to bureaucrats why it is essential to continue to fund core activities. They are not very good at publicizing what they do or getting the medias attention for success stories. In fact, history includes deliberate actions to avoid the media and to maintain a low profile. The need now to wave the flag and to demonstrate value to society is another element of the paradigm shift that is being experienced.

12. NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

We see the future of national mapping agencies as not just participants, but leaders in the development of national strategies to manage spatial data. After all, it is the data base of digital map data that underpins all other national, spatial data. NSDI's must address the maximum accessibility, availability and application of geographically-referenced data.

Geomatics Canada began, in 1994, the development and implementation of GeoRoute, a national spatial data infrastructure. The object is simply to facilitate the retrieval and use of geographically-referenced information from a host of separate data bases. These data bases are produced by various levels of government, the private sector and other non-government organizations. They cover topics from natural resources to the environment to social and economic data. Integration of these disparate data bases will provide information decision-makers need, easily and cost-effectively. For example, topographic contour information, soil maps, forest cover data and hydrology can be combined to identify fragile areas where prudent forestry is needed to prevent soil erosion and avoid damage to the water system. The resulting map of fragile areas can be further combined with administrative maps to identify zones of management responsibility.

GeoRoute will undergo a staged development, beginning with the data bases of Geomatics Canada and then extending to other federally-owned spatial data bases, and finally to data bases of non-government organizations.

Canada has also established the Mapping 2000 Alliance, bringing together expertise from the public, private and academic sectors. One development of the Alliance is ChartNet, a client/server software application for the collaboration, production, maintenance, and distribution of electronic hydrographic charts in a high-speed, wide-area network environment.

Such initiatives are not limited to government agencies. CORE Software Technology of California has developed ImageNet^{TM}, an on-line, image, vector and other spatial data archive and preview system. ImageNet promotes remote access to visual data products such as satellite imagery, aerial photography, vector data, and so on.

National data bases cover many categories of information, are dispersed among a variety of sources and exist in a number of different formats. Locating, verifying, ordering, receiving, and translating the various pieces of data is so difficult and costly as to discourage the exploitation of otherwise excellent data. NSDI' s, such as GeoRoute, will enable bringing together the electronic entry points of the various data bases. It will allow the user to browse the available data, without regard to a myriad of formats and, most importantly, it will allow the user to download and translate the appropriate data into the local user format.

Building an NSDI is much more that developing the translators, standards and communication protocols to link disparate spatial data bases. It requires building a complete national infrastructure. This involves a national network linking local, wide-area and international networks. This national network must not only be widely accessible but also be simple to use, and transparent to the user.

In a feature article in *Computing Canada,* the authors compare the simplicity and complexity of the NSDI to that of turning on a light in one' s home. That simple, effortless task links one immediately to a complex and powerful electrical infrastructure that spans the nation. (McLaughlin and Nichols, 1992)

Technical problems will be the lesser worry in building an NSDI. Dealing with the political and organizational and financial issues will be the central concern. An NSDI means accessibility to data that was previously coveted and jealously guarded by institutions. This raises the problems of ownership of data, copyright, licensing, data distribution, security of data, liability for the deficiencies of data, and so on. The inherent right of citizens to access and use public data is drastically opposed to the right of public institutions to generate revenue from the use of that data. All of these fundamental issues must be addressed for the NSDI' s and the Information Highway to be effective.

13. CONCLUDING REMARKS

National mapping agencies are undergoing the most intense review ever of their raison d'etre. Economic realities are driving downsizing, streamlining, privatization, budget reduction and revenue generation. Yet, in spite of all this, the future for these agencies can be as bright as we want it to be.

We, collectively, control most of the world' s spatially-related geographic information, a commodity that will be the basis for the knowledge-based society of the 21st century. We can continue to exercise that control, for the benefit of society. But that control will be taken from us if we do not adapt to the changing realities.

Our preferred future is at hand. It is up to us to design and implement it. Otherwise, we face the uncertainties of an imposed future.

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