



Geo-Information Infrastructure: an overview

Module 10 – Geo-Information Infrastructure

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[Geographical] data sharing makes sense for the simple reason that there is only one Earth, and we share it.

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Foreword

This report is submitted in partial fulfilment of the requirements for the assessment of Module 10 (Geo-Information Infrastructure) of the curriculum of the Master of Science course in Geoinformatics at the International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede, the Netherlands.

This report on Geo-Information Infrastructure (GII) consists of four parts. The first part addresses general issues relevant to the development of such a GII. The second part reviews the state-of-the-art in Web Cartography and visualisation of data within a GII. In the third part a specific topic within the general subject of GII is further investigated. In this report the possibility to develop a GII from a business perspective is addressed. The GII can be established as a “Data Broker” between users and providers and to run as a commercial activity. In the last part a list of relevant publications for each of the above-mentioned parts is provided.



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Introduction

One of the main assets of a society is its environment, both the natural environment and the physical environment. In order to make decisions about the environment, good geographical information is necessary. This geo-information is derived from geographic data, data describing phenomena directly or indirectly associated with a location (and time, and orientation) relative to the surface of the Earth.

Geographic data have been collected in digital form for more than 30 years. The overall rate of collection increases rapidly with advances in technologies such as high-resolution satellite-borne imaging systems and global positioning systems (GPS), and with the growing number of people and organisations who are collecting and using geographic data. That number will continue to grow with the growing awareness among information technologists that indexing data by location is a fundamental way to organise and use digital data.

The modern day information-based society requires the development of a Geo-Information Infrastructure (GII), for it enables the integration of geographical data from the various sources. Integration is increasingly important because of growing environmental concerns, pressures on governments and businesses to perform more efficiently, and simply because of the existence of a rapidly growing body of useful geographical data and geo-processing tools. The GI community, suppliers and users of data, the public and private sector and the academic community must agree on the nature and elements of a GII and how to develop it. However, there is no straightforward, universal, concise definition of a GII, for it may refer to different concepts. Sometimes, definitions only emphasise a GII in terms of information:

- *A Geo-Information Infrastructure (GII) is a set of institutional, technical and economical arrangements to enhance the availability of correct, up-to-date, to-the-point and integrated geo-information, timely and at an affordable price to support decision making processes* (Radwan, sheet 13).

Another way or a complementary way of looking at a GII, is the explicit emphasis on information transfer of geographic knowledge and skills, as adopted by the OpenGIS Consortium (OGC) and Ravi:

- *NII - National Information Infrastructure. A nation's entire collection of public and private digital information, physical networks and network software, computers, and **knowledge** about how to use them.* (Buehler & McKee, 1998b)
- *A Geographic Information Infrastructure can be defined as a collection of policy, data sets, agreements, standards, technology and **knowledge** providing a user with the geographic information needed to carry out a task* (Berends & Kok, 199?, p.1)

Nevertheless there seem to be some common characteristics in all of these definitions. These are the main elements constituting a GII: either institutional or technical elements. These elements are further elaborated upon in the next chapter.



Geo-Information Infrastructure

Rationales for a GII

There are several reasons to institute a GII:

- GII achieves horizontal and vertical integration of data. This leads to the promotion of data interchange and system interoperability for better decision making.
- GII promotes, stimulates, encourages and supports the development and use of geographical information and its associated technology.
- GII collects, organises, stores and distributes information
- GII identifies, moves and presents information
- GII provides improved data security and integrity
- GII provides easier and more consistent access to data and information
- GII reduces the cost of data acquisition, storage and management

In general the benefits of a GII are threefold. In the first place a GII serves a national interest in supporting decision-making processes related to either its physical or natural environment. In the second place a GII serves a corporate interest as a source of data and as a means to easily and rapidly communicate with the client and deliver the requested product in order to be a service-oriented organisation. Furthermore, data provision may serve as a means for cost-recovery in both the public and private sector. This topic is discussed in detail in chapter four.

The basic components

The geographic information infrastructure is a set of basic services, which makes possible the exploitation of geographic information in the society in different business sectors and tasks. The major components of the infrastructure must be identified in order to develop the infrastructure and to guarantee an adequate level of services.

The major components of the infrastructure are:

- **Organisations, discussion platforms:** the roles and tasks of the parties must be clear and should be co-operating in order to avoid overlapping work.
- **Data resources:** the spatial and temporal coverage of geographic data sets should be compatible and should meet the user requirements in terms of content and quality. In the context of a GII, attention should be given to base data sets and thematic data sets. For access to the data sets, meta-information in the form of a dedicated metadata service (clearing house) is important.
- **Information systems, networks and services:** Geo-IT products form an important component within a GII. Geo-IT concerns computers, software applications and electronic communication facilities (networks).



- **Regulations:** a legal framework addressing matters of ownership, responsibility, security, privacy and pricing
- **Standards:** an important component of the GII is the promotion of harmonisation of data sets and working methods, processing procedures, through the harmonisation of the standards of particular user groups.
- **Skills:** a strong support of a knowledge infrastructure, consisting of engineering companies, governmental bodies, scientific research institutes and universities, is necessary for the development of a GII.
- **Policy:** government objectives and the means the government invests to achieve good information provision in the public sector. This policy concerns the coordination of geographic information, data policy and the knowledge infrastructure policy.

Institutional issues

Components of a GII can be grouped under two main categories: institutional and economic components, and technical components. In this paragraph, the institutional and economic components are addressed. The next paragraph focuses on technical issues.

Introducing a GII sometimes radically changes the modus operandi within organisations. This requires mental preparation and training within organisations. It also affects society as a whole. The dissemination of data may cause an Orwellian feeling of “Big Brother is Watching”.

Also several political issues have to be considered on instituting a GII, such as the role of public and private sectors and pricing policies. These topics are addressed in more detail in the third part of this report. Equally important is the commitment of the national government to the institution of a GII.

Institutional components
<ul style="list-style-type: none"> • social issues • political issues • managerial issues • legal issues • economic issues • educational issues
Technical components
<ul style="list-style-type: none"> • development and maintenance • data/information exchange and integration • networking • data quality and security • database heterogeneity

Table 1. GII: institutional and technical components (source: Bishr & Radwan, 1998, p.3)

Successful development of a GII requires the involvement of responsible politicians and top civil servants (Berends & Kok, 1999?). First, a clear concept explaining the idea of a GII is needed. Second, structures and mechanisms to communicate among the involved actors and individuals are required. This is necessary if the idea of a GII is to be shared and obtain the commitment and involvement of the working field. Third, building a GII is an organic process needing a bottom up approach. Fourth legitimacy and funds are necessary. A mix of these four elements provides the key for the realisation of a GII.

The establishment of a GII requires and enables a whole new way of structuring both public and private organisations. Therefore, the management of such organisations has to adapt likewise. New structures of authority, responsibility and organisational hierarchy have to be introduced. Responsibilities cover the management of sharable resources, human resources development, finance and the collection of data in order to avoid duplication of efforts.

Another institutional issue is related to the legal aspects of a GII. This covers matters of jurisdiction related to data sharing between organisations, financing, standard, data ownership and definition of authority, responsibility and liability over data collection and management standards.

The institution of a GII also entails economic issues. Lots of public (and private) money is involved in this process. Furthermore, pricing policies have to be established. This is necessary because the



acquisition costs for geographic data sets are usually very high and these costs have to be recovered in some way or another.

World wide, a shortage now exists in information systems professionals. Most computer professionals are scientific professionals or mathematicians; business-oriented application programmers are in the minority. Training of application-oriented system analysts is lacking. In order to establish a GII, lots of efforts should therefore be geared towards education.

Technical requirements

Networking/communication between different information systems: metadata design, inter-operability and data exchange standards

One of the main components of a GII is the communication network. This network provides shared access to a set of spatially distributed databases located at the nodes of a wide area network. Considering that these nodes are themselves part of a local area network and the possibility that there can be a variety of geographic information systems (GISs) and database management systems (DBMSs) residing on a heterogeneous array of platforms, problems arise to transfer data from system to system. The problem of heterogeneity in a distributed environment has two distinct and yet complementary perspectives: system architecture and data modelling. The system architecture of a GII can be thought of as being composed of two processes: the resource discovery process and the information retrieval process. For efficient search and access as required during the discovery process, metadata is the key word. Metadata is defined as background information describing the content, quality, condition and other appropriate characteristics of the data (Bish & Radwan, 1998). It is used to provide documentation of spatial data such that potential users obtain insight into the “what, who, when, where, why and how” about the data that they are looking for.

For metadata to be easily understood, standards should exist. The standards provide a common set of terminology and definitions for the documentation of spatial data. Metadata standards provide appropriate and adequate information for the design of metadata to be used by different organisations for different purposes.

For indexing and searching metadata in a clearinghouse and to provide a means to exchange metadata themselves, metadata should be designed in a structured hierarchy using a top-down approach. The requirement is to structure the metadata in such a way that the relationship and similarities are explicitly formulated in a well-defined schema and can be subsequently accessed and handled more efficiently.

As the discovery process has finished, the information retrieval process starts. Within the context of the system architecture of a GII, when information stored in spatially distributed systems is shared, several problems may arise due to heterogeneity. To provide information sharing and inter-application cooperative process control, the system or components of the system have to be interoperable. Six different levels in interoperability can be distinguished:

- Network protocol interoperability
- File system interoperability
- Remote procedure calls interoperability
- Database search and management interoperability
- GIS interoperability
- Application interoperability

Interoperability and standards are two closely related concepts. Interoperability is the ability of two systems to interact and exchange data and standards represent a form of knowledge shared by these two systems. In GIS, standards specify a structure and content of spatially referenced data in order to facilitate data transfer between dissimilar spatial database systems. It is hence more appropriate to refer to it as data exchange standards instead of merely standards. For a data exchange standard to be beneficial to the GI sector, it must be widely implemented, non-proprietary and vendor-neutral. One such a standard is the Spatial Data Transfer Standard used in the USA. A Dutch example is the SUF2 standard.



Harmonisation and integration of data model views & database federation

Now that the appropriate data sets have been located using a clearinghouse across the spatially distributed databases within the GII according to the metadata, and the data have been retrieved, these data may not be meaningful to the receiving party. Heterogeneity of the system architecture has been overcome, but not heterogeneity in data modelling. Therefore there are some more issues to be addressed.

The problems of heterogeneity, from the data modelling perspective, prevail when the underlying schemes of two or more independently designed geographic information systems are compared. Database scheme heterogeneity has three aspects:

- **Syntactic heterogeneity:** Databases may be implemented in different data models or different geometric primitives
- **Schematic heterogeneity:** Entities and attributes may be assigned differently in a different object-hierarchy
- **Semantic heterogeneity:** Meaning of the real world entities in databases may differ.

To resolve database scheme heterogeneity, mapping between the schemes involved has to be achieved. There are several approaches to this:

- **No shared schema, no context mediation:** This is also known as the multi-database system, where users formulate queries using the export schemes of the information provider. An export scheme is a subset of the database which users are willing to share among each other. Users take the responsibility to detect and resolve conflicts that may exist between their local schema and the export schema of the information provider.
- **Shared schema, no context mediation:** Using this approach all the conflicts among all component databases are reconciled by designing a federated schema. The federated schema is maintained in the federation server. The server has a directory of all data sources. The system allows the users to send queries based on the federated schema. The federated schema is a view of the export schemes of the component databases. The definition of a federated schema incorporates functions to resolve discrepancies and inconsistencies among the export schemes of the underlying databases. The retrieved information in this approach is based on the federated schema.
- **No shared schema, with context mediation:** In this approach users have the flexibility of formulating their queries, using their own vocabulary without the need to identify conflicts explicitly. The context mediator handles the differences in the user's and the information resource contexts. A context mediator compares the context of the query sender with the context of the receiver. It reformulates the query such that it is understood by the receiving context. This requires a mapping between the context mediator and the contexts of both sender and receiver.

When this mapping of the database schemes has been achieved, the receiving party can use the data that have been discovered and retrieved in a suitable manner.

Chapter

3

GII: access by visualisation

World Wide Web: access by visualisation

Visualisation: a teaser

Visualisation techniques can play a role in accessing national or global geo-information infrastructures. This role differs per country and region. One such role is the visualisation of spatial data at a very small scale at low resolution: map as a teaser to attract the user to download a specific data set, for free or at a certain price.

An example where visualisation is a means to give the user an indication of the usefulness of the data set is the Africa Data Dissemination Service¹. Selecting the option to query the data by data theme, a list of themes is provided. If one is interested in the data set of the administrative boundaries of the Central African Republic at the second level, a small-scale map can be downloaded as a GIF file, indicating the location of the boundaries. An HTML file accompanies this visual indication, providing even more information to the user to make a sound decision before downloading. This function is addressed further in the next chapter on GII from a commercial perspective.

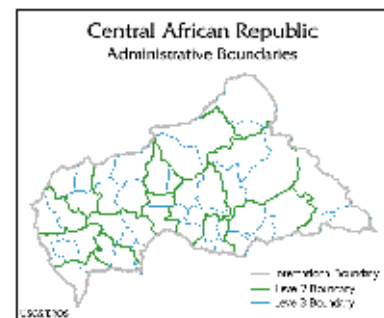


Figure 1. A teaser of the vector file to be downloaded

Visualisation: spatial selection tool

Another role of visualisation is providing a visual, interactive tool to select data sets, based on their spatial coverage. In the example of the previous paragraph, visualisation did not come into play until the last stage of data set selection. Now, visualisation is at the forefront of this process. The Australian Spatial Data Directory (ASDD)² has taken up this more advanced approach towards visualisation. Here, visualisation forms a selection tool in the spatial realm. The ASDD is a component of the Australian Spatial Data Infrastructure (ASDI) and provides several search interfaces to geographical data set descriptions (metadata) from all jurisdictions throughout Australia:

- Basic search interface
- Spatial search interface

These interfaces are a gateway between the World Wide Web and sophisticated distributed library information systems. This enables you to use a WWW browser to conduct powerful searches simultaneously at various spatial data directories (nodes). The spatial search interface allows the user to define the spatial coverage of his query by selecting an area in a clickable map, or by entering values in an electronic form.

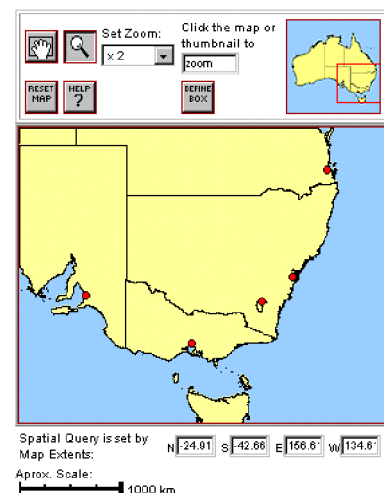


Figure 2. Select the spatial coverage using visual tools (screen capture from ASDD)

¹ URL: <<http://edcintl.cr.usgs.gov/adds/adds.html>> (OK: 8/14/99)

² URL: <<http://www.environment.gov.au/net/asdd/>> (OK: 8/14/99)

The results of a search are presented in a list. Selecting a link presents a full data set description. Future development of the ASDD will provide more sophisticated navigation mechanisms.

A very advanced visualisation tool for spatial data mining is provided at the website of the Geospatial Data Clearinghouse. This website³ is a collection of over 80 spatial data servers, that have digital geographic data primarily for use in Geographic Information Systems (GIS), image processing systems, and other modelling software. These data collections can be searched through a single interface based on their metadata.

The user may select from one of the following interfaces to search for spatial data:

- “Long” forms-based interface: this option allows the user to search for digital geographic data based on its location, time period of content, full-text and fielded search and to select one or more collections to query.
- Customised form interface: this search interface lets the user pick which parameters will be presented in the search form, including map, temporal, field, and server search
- Java-based interface: this option allows those with higher speed connections and Java-enabled Web browsers to pose a similar query to the above HTML interface but with maps and other visualisation tools for preparing the query.

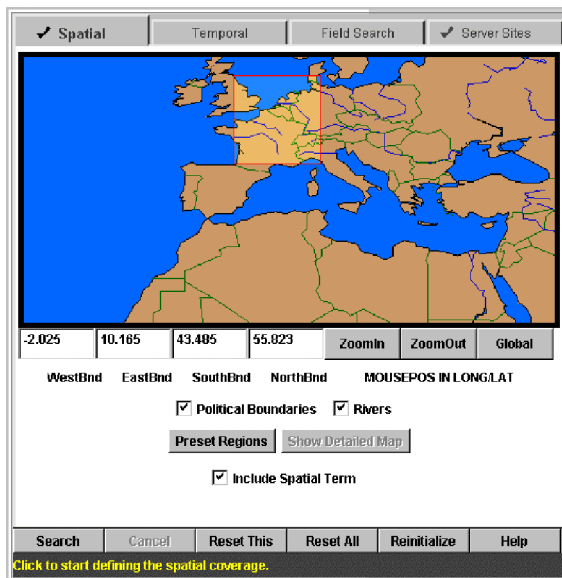


Figure 3. Visual interface to the Geospatial Data Clearinghouse

The Java-based interface uses an applet allowing the user to construct and submit a query based on the spatial and temporal coverages of the data, keywords in fields of the metadata and the server sites that are to be searched. The tabs allow the user to switch between panels that allow him to specify different portions of the query. Help on each of these panels is provided on a dedicated Web page.

The panel “✓ Spatial” allows the user to specify the spatial coverage to be searched. This can be done either by clicking on the map and dragging to define a region or by inputting the actual values in the text inputs below the map. This defines the bounding region that intersects with the metadata records. The query will return all records that cover this region completely, intersect it partially or contained completely inside.

This paragraph covered the roles visualisation plays in accessing organisations for national and global geo-information infrastructures. Two specific roles were encountered: visualisation as a teaser and visualisation as a selection tool. Of both, examples were provided.

³ URL: <<http://clearinghouse1.fgdc.gov/FGDCgateway.html>> (OK: 8/14/99)

National Mapping Organisations' websites

National Mapping Organisations (NMOs) play a role in the construction of a national Geo-Information Infrastructure. Many of these organisations maintain their own websites. This paragraph provides an overview of the different ways in which NMOs are present on the Web. The websites are evaluated according to the following criteria:

- Do they provide an index map to select the appropriate analogue map sheet?
- Is there a visual snapshot as an example of their analogue map sheets?
- Is there a visual snapshot as an example of their digital products?
- Is it possible to download digital sample data sets for testing?
- Is there a visual snapshot as an example of any special products?
- Do they give links to other organisations that provide maps of the country?
- Is it possible to order data online through an electronic form?

Based on a discussion of this evaluation a set of requirements is constructed for an efficient and useful presentation of NMOs on the Web.

An overview

The Military Geographic Institute of Argentina⁴ plans, schedules, performs, controls and inspects national geographic activities in order to satisfy the National Executive goals and policies, so as to contribute to an effective Argentine territorial sovereignty boundary lines marking and representation. Its Sales Division offers a "catalogue", an index map, to know if the map of a given area does exist, though the image does not allow viewing the sheet numbers (furthermore, it takes really long loading). Examples of analogue maps are scattered across the several pages. No digital or special products are advertised. Contacting is possible through electronic mail and by analogue means.

The Centre for Topographic Information⁵ is a part of Natural Resources Canada. It provides topographic and toponymic information. As Canada's national topographic mapping agency, it is responsible for the acquisition, management and dissemination of topographic information for the Canadian landmass. Their Web site provides index maps for both the analogue maps and for its DEMs, for they are distributed on CD-ROMs. To search for the right analogue map sheet within the National Topographic System and its metadata, it gives, apart from the index map, other search mechanisms:

- NTS number
- Geographical name,
- Geographic co-ordinates

Examples of analogue maps can be selected for the various scales and for various regions. However, to get a sample of a digital data set, it takes a little longer. One has to fill out a form in order to proceed to the next page that provides information on the download procedure. Prices of special products can be obtained by viewing a PDF file, though no indication of the possible services is given on the Web site itself. There is no possibility for online ordering, though one can fill out a form for requests and complaints.

Country	Index map	Analogue maps	Digital maps	Samples	Special products	Links	Online order
Argentina	x	x					
Canada	x	x	x	x	x	x	
Ethiopia							
Ireland		x	x		x		
Jordan							
Netherlands	x	x	x	x	x	x	x

Figure 4. NMO website: an inventory

⁴ URL: <<http://www.igm.gov.ar/indengla.html>> (OK: 8/14/99)

⁵ URL: <<http://maps.nrcan.gc.ca/>> (OK: 8/14/99)

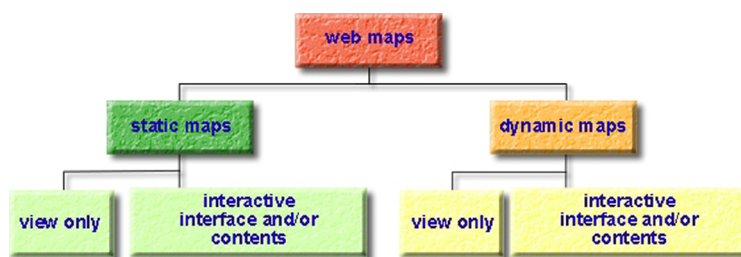
Though the Ethiopian Mapping Authority⁶ promotes itself on the Web in blinking letters, that they are “Your provider of maps and Geo-information in Ethiopia”, they only give a textual indication of their products and services, without direct means to get some visual idea about their maps and geo-information. An address, telephone number and electronic mail address are provided. Also the Royal Jordanian Geographic Centre⁷ offers a meagre homepage that takes a long time loading. No single map is on their pages. It only gives insight into the organisation’s activities, its personnel and its organisational structure.

The Ordnance Survey Ireland⁸ (OSI) promotes all of its products on their Web site with examples. For the digital vector products, a raster sample with some interaction is provided to show its functionality, though no data sets for testing can be downloaded. A nice feature they show is the PLACE Map range, a service to produce customised maps. They can be reached either through electronic mail or by analogue means.

The Dutch Topographic Service⁹ promotes all of its products on its Web site. There are index maps for all the different mapping scales. Examples are provided for all its products. Even samples of the digital data sets can be downloaded in several formats without much problem. A nice feature is the possibility to order data by means of a CGI-form.

A long way ahead

The previous paragraph provided an overview of the Web sites of several NMOs. Based on the discussion of these Web sites, this paragraph gives a set of requirements for an efficient and useful presentation of NMOs on the Web.



In the first place, static, view only webmaps can play a role in advertising the different products on offer, both analogue and digital. This possibility is provided on most websites, but not all of them.

Figure 5. Classification of webmaps

In the second place, static, interactive maps can be provided to give an idea of the possibilities of digital vector data. Users can switch data layers on and off, as on the website of the OSI (though the functionality on this website can be improved from a programmer’s point of view). Another way to use this type of maps is the clickable map: as an index sheet to the analogue products. This option is also provided on several websites. Argentina should definitely take up this suggestion. Most NMOs do not yet have a means to order data online, though the Dutch Topographic service does. To further enhance this feature, this type of maps can play a role in defining the spatial extend of the digital data sets the user orders. Instead of downloading a sample data set and viewing it with a GIS on the client side, the website might provide a tool for server-side, online browsing, thus circumventing the necessity to download data.

Furthermore, dynamic maps play a role. Dynamic, view only maps can be a means to show the possibilities of digital vector data layers. Here, only a presentation of the possibilities of the layer structure is enabled, without any interaction, as is provided by the static, interactive map type. This is an option for that part of the website open to the general public, whereas the static, interactive map type might be a tool on the webpages for the professional clientele. A dynamic map can also be a tool to simulate a fly-through to give insight in the 3D data on offer.

⁶ URL: <<http://www.telecom.net.et/~ema/>> (OK: 8/14/99)

⁷ URL: <<http://nic.gov.jo/rjgc/>> (OK: 8/14/99)

⁸ URL: <<http://www.irlgov.ie/osi/>> (OK: 8/14/99)

⁹ URL: <<http://www.tdn.nl/>> (OK: 8/14/99)



Interaction with the users should be more dynamic. On the one hand, the website should offer options for the user to interact with the website itself to give more insight into the products on offer and the products that can be offered based on user requirements. On the other hand there should be options to interact with the NMO through electronic forms.

NMOs should present themselves on the Web more professionally. In the first place, this is necessary to maintain contact with their current users. The webpage provides a means of interaction through which users can give the requirements to fulfil their mapping needs. Users are no longer satisfied with the traditional analogue map sheets. Through the website, the NMO can become a demand-driven organisation. In the second place they should be able to compete with services provided by commercial organisations. This does not necessarily have to be a forthright financial competition, but by attracting more people to the website for “entertainment”, potential users may become interested in other products of the NMO.



Chapter

4

GI: a business perspective

Commercialisation of the GI sector

A major feature of the GI sector is the dominant role of the public sector (DG XIII/E, 1998). Geographic information is traditionally collected and disseminated by a range of mandated national organisations, such as national mapping agencies, the military, cadastral administrations and geodetic surveys, according to a wide variety of national standards.

Due to increasing budgetary pressures in the 1980s, many of these actors in the public field have been forced to work more efficiently (Kok, 1998). They had to find other sources of income besides taxes. One of the sources is the selling of information or tariffs for periodic use of government data are beginning to commercialise their information (Kok, 1998). Another reason for commercialisation of government information is the more market-oriented approach taken up by the public sector.

Some administrations have gone further, contracting out aspects of their GI activity (DG XIII/E, 1998). There are public sector initiatives to set up structural relationships with private sector. Co-operation between government and the private sector for the commercialisation of government data sets is favourable. European Commission now stimulates public-private partnerships through draft GI2000 document that lists several actions for strengthening the involvement of the private sector in the development of the European Geo-information Infrastructure and for guaranteeing this involvement in the future (Kok, 1998).

Although most GI is still created and used in the public sector, some private companies collect and disseminate digital geographic information, often in the form of local added-value information products not provided by national mapping agencies (DG XIII/E, 1998). The private sector in the United States has been smart in picking up the commercialisation of geo-information quickly and becoming actively involved in the opportunities they can identify. Good additional data and value added information products are being developed. A better provision of service is coming about. Just as in the United States, the line drawn between what the government does and what the private sector does is not static. The situation in Europe is varied, but there is a general trend for governments to have a more all-embracing role in Europe than the US government does. The initiative taker's role in the acquisition and processing of geographical data lies largely with the government.

Because there are different actors in the arena, in different configurations, commercialisation of the GI sector has become a confusing concept (Kok, 1998):

- Governments act commercially when they charge more than costs of dissemination of geographical data
- Governments act commercially when they charge more than the integral costs for the provision of geographical information.
- Commercialisation means that governments develop geographical information products and services in competition with the private sector
- Commercialisation is when companies develop geographical information products based on low-priced government data
- Commercialisation is when companies develop geographical information products where government information does not exist



Placing the commercialisation of geographic information in a more general context, irrespective of the legal structure of the organisation, a tripartite of general reasons for charging people to obtain data can be constructed. Each leads to a different pricing strategy (Plewe, 1997, 53).

- **Cost recovery:** Whether or not geographic data is produced for profit, the production of it may have incurred very large costs. By selling the data for an appropriately low price, much of these costs may be eventually be recouped.
- **Resale of existing data:** An organisation may produce geographic data as part of projects for clients who pay for the production costs. It is very likely that other people or organisations may be interested in obtaining the same data sets, and even pay for it if necessary. If the terms of the contract with the first client allow the organisation to retain copyright on this information, it may sell the information to other parties. This can easily become a money making venture because the cost of producing the information has already been covered.
- **Profit-making venture:** Many companies are in the business of producing geographic data for the purpose of selling it. This includes raw data such as streets, demographic and marketing statistics, and custom-built GIS analysis products. The Internet can now be used as another marketing tool and retail outlet for selling geographic data to a global market.

In this part of the report, attention will be given primarily to commercial companies, as discussed in the third lemma, because there is a growing role of private sector in GII. In the first place, this has come about by the changing role of governmental organisations as mentioned before. In the second place, electronic commerce, the Web, the OpenGIS Specification, and new tools for data production will soon make commercial geographic data of all kinds far more accessible, affordable, and widely used than today (Buehler & McKee, 1998a). The private GI sector is convinced that a GII is beneficial not only to their business, but also to their national economy as a whole. The establishment of a GII benefits the private sector by increasing the organisation's responsiveness to customer needs and demands and by providing new strategic applications for their business (Harrison et al., 1994). Before actually being able to provide the client with the data he wants and to charge him for the service, there are some issues that need attention.

The context of commercial GII

Some of the general issues concerned with the establishment of a GII were already addressed in the first part of this report. Here, attention is given to those subjects that are key concerns to commercial GI data providers in the European Union.

The monopoly of government GI Institutions

There appears to be quite a chasm between public GI actors and private firms' activities. The large public agencies and the private firms have quite different goals and mandates: one from government and one from shareholders. In many countries, there is actual monopolistic control or "near" monopolistic control of the NMOs in regard to base maps (including much thematic mapping). This prevents other data from being more fully exploited by those who would wish to add value to this other data but which needs to be shown as overlay on base maps controlled by NMOs. Some NMOs simply will not release certain data, under any circumstances, preventing its further exploitation by commercial developers. In some cases, this is for security or other reasons declared by the government, but not in all cases. It is often difficult to find out exactly why certain datasets are not released - or even that they exist. Furthermore it is often difficult to acquire base map data because of cost charged by many NMOs. To solve the current practice, the USA model of data availability based on the Freedom of Information Act could be taken on, but it is still not clear whether does this model is really applicable to the European situation. Commercial data providers often find that, after they have taken the initial risk to enter or exploit specific market niches, the "monopolistic" NMOs then move in later, with unfair advantage because they control the base map sets. A way to circumvent this might be to force NMOs to compete with commercial data providers on purely competitive grounds.

Yet, as more cost recovery steps are taken by governments and/or more privatisations of national agencies and institutes occur, the goals of these two types of actor may merge in the near future.



Publicly held GI at the local level

More effort should be placed on exploiting existing local, regional and national GI datasets, especially those held by local authorities and/or utility companies. Political stimulation is still very much needed on the local level. There is a need for better co-operation between local authorities and commercial GI product producers, including investigation and trial of new methods of co-operation, partnerships and remuneration.

GI Data Pricing

Full cost of collection and processing must be recovered in the sales price. This is certainly a minimum requirement with commercial organisations, else how are they to earn a profit? However, the true price of data collection may never be recovered in some cases, so it may be difficult to implement a single “regulation” that the price of GI data must reflect its true cost of collection, storage, maintenance, etc. Potential users could be given some cost guidelines at the beginning of their investigations into new products or services by establishing for base data some uniform price bands.

The legal issue

Legal issues are barriers to using and distributing much publicly held GI data. Copyright has specific problems in relation to GI because of the monopolistic nature of certain major data holders such as NMOs: government agencies who have spent significant amounts of public money to collect data. In the UK, the use of the copyright principle by agencies under the Trade Funding regime plays an important part, while at the same time the Blair government has developed a general information policy. One is left wondering what sort of co-operation and harmonisation there can be between these two policy lines.

In France a need for general freedom of information is felt. There are fundamental discussions going on about the roles played by the public and private sectors. It is not clear whether, or to what extent, the politicians are making serious efforts to give the private sector the opportunity to develop an information market. The costs the authorities charge for GI are high, because in practice all data is considered to be value added data and not raw data. The quality of government data in France is very high and IGN uses very advanced innovative techniques. They have a very strong international position based on knowledge.

There is a new government policy in the Netherlands concerning the accessibility of government information and the roles the government and the business communities play in that. In principle, it states that making government information more widely available is the task of the business community, and not of the government. This principle lies in the development of the new government policy that government institutions may not undertake any market activities that might disturb competition in the private sector. The Minister can decide which are the areas where this private market has not yet been developed, so that the government will then take on the opening up of information. A good balance has been found here.

The political, institutional, and cultural issues mentioned to establish a GII are difficult to address and it will take a long time to resolve. The technical issues are complicated but relatively simpler than the policy issues. Long before the data problem is under control, people will be using Web browser software that automatically finds and uses the data that comes closest to matching their needs. Therefore it is wise to turn the attention towards the next issue in the process after the client has found the suitable data sets and also the most interesting issue for a commercial business in GII: how to earn money on the Web?



Online sales

There are several approaches for charging people for downloading and using geographical data sets. The main issue to be considered is the sensitivity of the Internet market. Because users can quickly move from one site to the next, there is an expectation of ease and immediacy. The method for online sales should allow users to quickly find and purchase the information they need. There are two methods to charge the users (Plewe, 1997, p.54):

- direct purchase
- subscription to site

With direct purchase, users simultaneously pay for and receive the products of the GII. These products may be pre-built items put in an online catalogue, or items that can be assembled dynamically according to the user's specifications (Just In Time). For this strategy to be successful, good pricing has to be considered carefully. This is more difficult for the dynamically generated items than the stock items. There is some inefficiency in this approach because the user has to type in billing and delivery information in an order form area every time an order is placed.

For frequent users, using a site regularly, a subscription approach is more suitable. Here, the user has a unique account on the server host system, which they need to enter every time on accessing the site for information. All the billing and delivery information is entered once when the account is created. When a user subsequently logs in, this client information is retrieved and associated with new purchases logged. Clients are billed regularly for their usage over the time period, either by a flat monthly rate, or based on an accounting of exactly what the client used or purchased during that time period.

Each of these sales models have been used profitably on various Web sites, but to be successful, the Internet culture has to be taken into account. As mentioned before, Web surfers expect immediacy. Furthermore, there is the conception in the Internet community, that everything on Internet should be free of charge.

When potential purchasers want to have an idea of the value of the geographic data, they can only estimate that value by seeing it. However, the technology of the Internet is such, that in order to view something in a browser, it has to be downloaded into the cache memory. This is the biggest paradox in Internet marketing: on the one hand, possible purchasers have to be attracted, but on the other hand, sales have to be protected. A solution to get around this, is the teaser. Simple information is provided free of charge to attract users and show them what data sets can be provided, at which point value added, processed, information is offered at a price.

Some considerations

Distributing geographical information is potentially a very worthwhile commercial venture for many organisations, because most of their users would be willing to pay a reasonable amount for valuable information. However, there are two main technical obstacles that may prevent many companies and other organisations from entering this arena even after the general GII issues are solved (Plewe, 1997, p.261).

One problem is that these Internet services can only be available at low prices to be attractive for the potential clientele, but with currently available methods for Internet commerce, nobody is willing to fill out an electronic form to pay small amounts of money each time. Electronic cash services may be a solution to this, because they allow for rapid, anonymous payments regardless of the amount. Although the technology exists today, are not in wide use, because they require special accounts and because few sellers support them. Another solution is to store the credit card information in the client software. This information is sent automatically to the server when a product is selected for purchase, thus bypassing the electronic forms.

Another problem is the transaction security. On the one hand, purchases are still rather reluctant to supply the vendor with their credit card number for fear of interception along the way. On the other hand, the entrance to the organisation's information has to be very secure in order to prevent hackers



from entering. Currently available, commercial WebGIS technology still relies heavily on Windows NT and Microsoft Internet Information Server: the former not very famous for its reliability when it comes to server stability, the latter renowned for its lack of security.

A better environment

There is a large potential for private sector organisations to enter into the commercial exploitation of geographical information and the technical instruments are there, but lots of issues still need to be addressed. This is necessary to establish a good working environment for these businesses. A solution to the institutional part of the conditions for a GII is for government to take a leading role, in cooperation with the private sector (Berends & Kok, 1997, p.4; Harrison et al., 1994). Though this requires the investment of public money, the government will also benefit from an improved participation of the private sector in a GII. The private sector should participate in this effort and also make effort in solving the technical problems

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