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Geographic Information Technology Services and their Role in Customer Innovation

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Abstract

This working paper focus on innovation in service based on geographic information technology (GIT). The core of GIT is computer systems (GIS) capable of assembling, storing, manipulating, and displaying geographically referenced data. The last 10 years, there have been significant changes in the technological system of geographic information. More user friendly and less expensive software for analysing geographic data within many user fields has emerged, and the interest for using GIT is now diffusing to a much wider group than people in the mapping business. This means that GIT-usage has received significant attention in several public documents on the ITC-policy both in Norway, the EU and the USA. This study discusses some of the aspects of geographic information usage and its use value in management of a range of fields. One of the main points that the study takes up is that the traditional mapping business is in practice being transformed into a GIT system consisting of GIT-based knowledge intensive business services (KIBS), customers, research institutes and information infrastructures. The GIT-KIBS role in the system is changing and is not easy to define. However, it involves the information and communication technology (ICT) functions that are applicable to the production and use of geographic information.

At the customer side, the areas of application for GIT have gone from being isolated "islands" within self-contained domains to becoming increasingly integrated into general information systems. Geographic IT is a generic technology and the possibilities this offers are being increasingly explored. GIT caters to a wide range of actual users and fields of application and the potential for new ones appears to be considerable. One of the main parts of this study maps this wide range of applications to the various service activities of the users. One of the most important factors influencing the development and diffusion of GIT-based service innovations is discussed here. This is the price on, quality of and access to digital map data, and is basically a question of the quality of the infrastructure for geographic information.

The study also points to another important challenge facing the GIT companies: a shortage of competent people. A related aspect also discussed is the trend towards recruiting people with both education for and several years of training within the GIT-KIBS' customer sectors. It seems that the preferred competence for a growing number of GIT-KIBS people is a combination of customer sector knowledge, general ICT competence and mapping competence. But the impression from studying the GIT-KIBS is that the weight is more on the two former than on the latter set of competencies. Another interesting aspect pointed to in the study is that the elements underlying competition between GIT-KIBS have changed from basic technology toward more social, cultural and organisational elements. The typical form of interaction between GIT-KIBS and their customers is also one of the features treated in the study. What we see, is that GIT-KIBS often pursue a close collaboration with a few pilot users in development of GIT applications, thus the GIT firms often become an integrated part of the innovation processes at customers'. Throughout the study some points relevant for policy are touched upon. These concern education, competence and information infrastructure and are drawn together at the end of the study.

Keywords: GIS; GIT; KIBS; Innovation; Services

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Geographic Information Technology Services and their Role in Customer Innovation

1. Introduction

1.1. The Objective of the Study[1]

Within the overall objectives of the SI4S Project, the objective of this study is to map, understand and analyse the role that knowledge intensive business services based on geographic information technology play in service innovations in other firms. Further, some policy aspects related to this innovative activity are discussed. Among the interesting aspects observed, is the close collaboration with a few pilot users in development of GIT applications - the GIT firms often become an integrated part of the innovation processes at customers'. Another interesting feature is changes in the elements underlying the competition between GIT knowledge intensive business services (KIBS) from basic technology to social and organisational elements like the history and competence of the firms.

1.2. Framing the Study

To frame the study, the technological systems approach of Carlsson and Jacobsson (1997) is used. In their perspective, specific technologic areas or technological systems are the prime units of analysis. These systems are constructed and reconstructed through the interaction related to generation, diffusion and utilisation of the technology in question. A variety of actors interact in these processes: suppliers; users; consultants; industry associations; universities and research institutes; and governmental agencies, especially regulatory and policy related. Between the actors linkages are established; users vs. producers; academia vs. industry; associations vs. industry; government vs. industry; industry vs. industry, etc.. In this study, the focus is on *the diffusion and utilisation of technology for geographic information handling - GIT - within service innovations in Norway*. The actors discussed here are suppliers, users, academic actors and governmental agencies. The linkages discussed are those between suppliers and users, the academia vs. industry link and the relation between government and industry.[2]

According to Carlsson and Jacobsson (1997), the essence of the formation of a new technological system is a process of increasing diversity in a situation characterised by path-dependent development of the technology and associated sup-

[1] In addition to being a part of the SI4S Project, this study is also part of a more extensive work on the Norwegian Geographic Information Technology System (Samuelsen, forthcoming).

[2] The study is based on 15 interviews with representatives of different kinds of actors in the GIT system, mainly GIT-KIBS.

porting networks and institutions. The process may be seen as consisting of three phases; i) the embryo stage: the period before the first commercial application of the new technology; ii) the infant stage: the period of the first commercial applications of the new technology; and iii) the adolescent stage: the period when the technology finds a multitude of applications. At each stage mechanisms must be designed that can accommodate several functions, like the fostering of experiments; the stimulation of entrepreneurial activity; the building and diffusion of economic and technological competence; the supply of capital; the development of bridging functions: the building of institutions and networks; and the transfer of knowledge. At some point, the system is large and complete enough (in terms of competence, networks and institutions) to generate sufficient increasing returns to develop in a self-reinforcing way. This is the situation in the Norwegian GIT system today: it is characterised by a multitude of applications, a rapidly growing number of users and a self-reinforcing development. Below, I will return to aspects of economic and technological competence, the building of institutions and networks and the transfer of knowledge in relation to the diffusion and utilisation of GIT in services.

2. Geographic Information

2.1. The Concepts of Geographic Information and GI Technology

To get a grip on the core of the activity of GIT-KIBS, one could take the map as a point of departure. A map is basically an information medium, a way of communicating. Traditionally it was (and still is) an analogue, paper-based medium, produced with optical and mechanical instruments. In the late sixties and early seventies software and hardware for automated map production was introduced, even though the products remained analogue and paper-based. This meant that the traditional knowledge base of the mapping craft had to be supplemented by ICT-based competence. From around 1970 there has been increasing interest in the mapping business, due to the possibilities that ICT represents both as production technology for geographic information, for design of products and for utilising the geographic information. By the eighties digital production of maps became the standard, and today all map production is automated and digitally based and the products are both analogue (paper, foil) and digital. Furthermore, the knowledge base of the GIT system today is probably more dominated by ICT-based competence than by traditional knowledge of the mapping craft. Thus, the industry of producing the information and communication medium that maps basically are, has for the last twenty years gone through a transformation from analogue to digital processes and products (Craglia and Couclelis 1997).

The GI technological system that these TKIBS are based on is constituted by several sub-systems of related technologies. One decisive factor in the development of the GI technology in general and *geographic information system (GIS)* in particular has been the recent advances in generic, basic *information and communication technology (ICT),* including computing power and database management systems (DBMS). The development of GI technology can be traced through two closely related technologies. The first is the emergence of automated production of maps in the 1960-70's. This area of geographic information handling by computers is called *computer-assisted cartography (CAC),* which include the areas of *computer-aided design (CAD)* and *computer-aided mapping (CAM).* The other area of geographic information handling by computers is *remote sensing* with the related activity of *image processing.* A third related technology is the American satellite system *GPS - Global Positioning System.* All these are distinct technologies in their own right, with large numbers of commercially available computer systems, established literatures and histories at least as long as that of GIS per se (Clarke 1997).

In the strictest sense, a GIS (geographic information system) is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations or positions. Practitioners also regard the total GIS as including operating personnel and the data that go into the system. Further, GIS can be regarded as the high-tech equivalent of the map. An individual map contains a lot of information that is used in different ways by different individuals and organisations. It represents the means of locating ourselves in relation to the world around us. Maps are used in diverse applications from locating telephone wires and gas mains under our streets, to displaying the extent of de-forestation in the Brazilian Amazon.

GIS provides the facility to extract the different sets of information from a map (roads, settlements, vegetation, etc.) and use these as required. This provides great flexibility, allowing a paper map to be quickly produced which exactly meets the needs of the user. However, GIS goes further. Because the data are stored on a computer, analysis and modelling become possible. For instance, one might point at two buildings, ask the computer to describe each from an attached attribute database (containing much more information than could be displayed on a paper map) and then to calculate the best route between these.

The last 10 years, there have been significant changes in the GIT system. More user friendly and less expensive GIS software for analysing geographic data within many user fields has emerged. The first electronic maps over larger fields are beginning to be published. Systems using navigation satellites (GPS) for accurate positioning are becoming generally available, not only for experts. The most important is probably that the interest for using GIT is now diffusing to a much wider group than people in the mapping business. This means that GIT-usage has received significant attention in several public documents on ITC-policy both in Norway, the EU and the USA (Clarke 1997).

2.2. The Use Value of Geographic Information

The national supply of geographic information has always been a public responsi-bility. Then the supply is not developed as a direct answer to demand in a market. How priorities in this field are made should ideally be based on assessments of the overall use value compared to costs. To do this, cost-benefit calculations are needed. But political decisions, on their side, are based on many other factors than cost-benefit calculations. Such reasoning is useful, but not sufficient in a public process of prioritising. A simple cost-benefit argument is the following: For many years it has been prioritised to maintain an infrastructure for geographic information in analogue form. Now, this information is transferred to digital form, and a range of new possibilities for use is opened. Thus, the value of the infrastructure is increased. One important aspect of the use of geographic information is that it triggers other activities and possibilities, many related to or directly involving services. For instance, property and land information is necessary for a well functioning credit information system; maps and positioning are necessary for safe travel on sea and in the air; area planning and management can not be done without maps, etc. In cost-benefit calculations such effects must be valued (Norwegian Mapping Authority 1996). The overview of application fields for GIT given below, more than indicate the range of activities and possibilities triggered by the use of geographic information.

3. The Actors in the Geographic Information Technology System

Today the idea of a mapping business is in practice being transformed into the GIT-business. This business is evolving rapidly and is therefore not easy to define in a strict sense. However, it involves the Information and Communication Technology functions that are applicable to the production and use of geographic information. If this picture is expanded to include the customers of the GIT business firms, the business organisations, the universities and research institutes and other relevant parts of the institutional infrastructure surrounding these actors, we have a geographic information technology system.

Actors involved in GIT face considerable challenges as this technological system evolves. Especially, actors with long traditions in the mapping business are being pressed to adapt. Traditionally, the mapping business has been defined as consisting of both public and private actors: they produced and provided services within geodetics, positioning and collection, storage and distribution of other geographic data, including map production of sea and land areas. This is changing. New fields of application, new channels for distribution and new production solutions combine to create a new market situation in which new actors can enter and some old ones disappear.

3.1. The GIT-KIBS

Geographic Information Technologies employ between 4-5000 people in Norway. These are employed in three main working environments:

- The Norwegian Mapping Authority (Statens Kartverk)
- GIT-related education and research arenas, and
- The knowledge intensive business-service organisations (GIT-KIBS) focused on in this study.

The GIT-KIBS have an annual turnover of about 3-4 billion NOK. There are two distinct size-classes for firms operating in these knowledge intensive business services. First, there is a small set of relatively large firms:

- Asplan Viak ASA (270 emp.)
- Blom ASA (400 emp.)
- Fjellanger Widerøe AS (270 emp.)

In addition there is a growing number of small and medium firms. These include;

- Geodata AS (25 emp.)
- Norkart AS (50 emp.)
- Sysdeco GIS AS (40 emp.)
- Sysdeco Dikas AS
- Norgit Senteret AS
- ScanMap AS (15 emp.)
- Ugland Totalkart AS
- Geoservice (5 emp.)

Several of GIT-KIBS firms grew up in the traditional mapping/surveyor business that preceded the advent of GIT in the 1970's. These include the largest actors, e.g. Asplan Viak ASA, Blom ASA, Fjellanger Widerøe AS and Norkart AS - and they have been instrumental in evolution of this field in Norway. The majority of the smaller actors, on the other hand, came into existence as the technology evolved into more mature stages in the late 1980's and early 1990's. These include Sysdeco GIS AS; Sysdeco Dikas AS; Norgit Senteret AS; Geoservice; ScanMap AS; Ugland Totalkart AS.

These firms group their main products and services into seven categories,

i) system design and related consultancy services;
ii) software programming and implementation services
iii) application oriented consultancy services
iv) database, geodata and infrastructure services
v) mapping related services
vi) software products
vii) hardware products.

The nature of these services and products mirrors that of the Information and Communication Technology market more generally. A detailed breakdown of these market-segments is provided in Annex 3.1. To illustrate the activities of such firms in Norway, excerpts from two interview-based cases are summarised in the box below.

Box 3.1.

Norkart AS[3]

Norkart AS is a leading company in mapping and geographic information technology. It was established in 1961 and today has 50 employees. Their main activities are photogrammetric mapping, software development, thematic maps, aerial photography, land surveying and geographic information technology. They collaborate with NIT (Norwegian Information Technology) on development and provision of software, with NMG (Norway Mapping Group) on export of software and services, and with Fotonor (30 % ownership) on aerial photography. They where very early in developing their own software within this field, starting in 1971. The first product, a software package for managing land surveying, was for internal use. This was later commercialised as a system for management of central tasks in production, updating, management and distribution of geographic map data in GIS. These software systems are called V/G products after the name of two merged product series, Vesla and Geonor. More than 2000 V/G systems are installed in Norway. Norkart now provide services and products to all the major actors in the Norwegian map and GIT market.

Incatel AS[4]

Incatel AS, with 20 employees, was established in 1993, but their main product, the InCa-system, is much older. Telenor initiated the development of this system several years ago and the history of both the company and the system is an integrated part of the long innovation process. Incatel is owned by IBM (40 %), Telenor Venture AS (40 %) and the employees (20 %). Formally, it is IBM that is Telenor Nett's provider in this case, with Incatel as provider to IBM. But, since all contact concerning InCa is directly between Incatel and Telenor Nett, IBM as an actor is not included in this case. In-

[3] Interviews 4.9. 1997 with Stein Mjaaland and Gløer Winsvold at Norkart AS.

[4] Interview 2.9. 1997 with Bernt Smilden at Incatel AS.

catel's main focus is to address the challenges in the telecom industry in the area of cable and outside plant management. The challenges addressed include; i) having complete, consistent and up to date information and documentation to make optimal usage of current assets like tracks, ducts, pipes and cables; ii) reducing the significant cost and backlog of drawing offices engaged in network maps, cable schematics and duct cross sections and schematics; iii) reducing the cost in planning and construction through demand management and network-design support; and iv) end to end resource allocation in support of service provisioning. Currently, Telenor Nett is the only customer in the telecom business.

3.2. The Users of Geographic Information

The areas of application for GIS have gone from being isolated "islands" within self-contained domains to becoming increasingly integrated into general information systems. Geographic IT is a generic technology and the possibilities this offers are being increasingly explored. GIT caters to a wide range of actual users and fields of application and the potential for new ones appears to be considerable.

The common characteristic of the GIT users is the need to know something about the geographical location of their assets, resources and facilities. At this point an exact number of users is hard to pin down. To indicate the potential however, some point to the fact that 70-80 % of *all* information refers to some place on the surface of the earth; their conclusion is that the potential is large. As GIT has developed, the nature of the user has been seen to shift from consisting exclusively of the public sector to embrace areas of the private sector as well.

One useful way to structure the vast range of specific needs for actual and potential users of GIT is to consider different main groupings of customers in terms of market segments that GIT suppliers work with. There are six main market segments in the Norwegian GIT system today:

i) National authorities;
ii) County or regional authorities;
iii) Local authorities;
iv) The offshore oil, gas and pipeline industry;
v) The academic sector (universities and research institutes); and
vi) Consultancies and professional business services.

Most of these main groups of actors in the system are active in several application fields, as e.g. national authorities which play a role as GIT users in environmental services, forestry and land management services, agriculture, water and wastewater services, telecom services and military services. One major GIT user was visited in the study (cf. Box 3.2.).

Box 3.2.

Norwegian Telecom (Telenor AS)[5]

Users within telecommunication services is representative of a major group of users, viz. those engaged in management of built environments, infrastructures, facilities, utilities and fixed and mobile assets. The main actor within the telecommunications field in Norway is Norwegian Telecom (Telenor AS) with their network operating company Telenor Nett AS. The Telenor group comprises the state-owned (by the Ministry of Transport and Communication) joint stock company Telenor AS and its subsidiaries. With more than 19.000 employees and an annual revenue of NOK 22.2 billion, Telenor is one of the largest companies in Norway, and one of those that adds most value. Telenor is Norway's market leader in the field of telecommunications, data services and media distribution. The services comprise everything from simple telephone subscriptions to the installation and operations of complete IT systems. Telenor is strengthening its competitive position through technological developments, by putting emphasis on value-added services and by increasing its international involvement. Those parts of Telenor that are adding production and supply of services, cover seven business areas; Nett; Bedrift (Business); International; Mobil; Privat; F & U (R & D); Media; Link; Nextel; Norsk Telemuseum. The Group's commercial activities are divided into three main segments: network operation, service provision and installation. Telenor has lately shown great activity within the GIT system both through own product development, through buying of ownership parts in other firms and through strategic partnerships. Thus they are today positioned as one of the heavy actors in the GIT system, with significant market, technological and R&D power.

On 1 January 1997, the former Telenor Nett and Telenor RNT (Regulated Network Services) were merged into one company, Telenor Nett AS, which is part of Telenor's network operations. The company is responsible for the fixed network and supplies network services to service providers and network operators, who then put together the products, thus arriving at solutions that are sold to the end-users. Telenor Nett AS is also responsible for the commercial management of interconnection with cellular operators in Norway. Responsibility for the regulated network services is also in the hands of the new company. Telenor Nett AS's most important tasks are to ensure optimal quality, security, and access in the network, and to develop the network and products so that they are at all time adapted to the development in technology and the needs of the customers. They have close collaboration with Navia Marine AS concerning transmission and receiving of radio signals in GPS systems. They consider themselves to be among the three leading companies internationally concerning GIT within telecommunications. In 1996, Telenor Nett represented 3002 man-years, and recorded revenue of NOK 8,692 million.

3.3. The Main Application Fields for GIT

Thus, the development of Geographic Information Technology is extending the paper-based mapping function it builds on to encompass new roles. With the introduction of digital technologies, its application area is extended from static

[5] Interviews with Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

geographic and topographical data to dynamic man-made infrastructures and socio-economic systems. At the same time, GIT upgrades the original mapping function to adapt it to the real-time needs implicit in mapping such changing systems. In addition, GIT adds to the descriptive mapping role other roles, such as system-monitoring and diagnostics functions which can tell how these systems are working and system-optimising functions which can suggest how to improve utilisation of system capacity etc.

In this section, we will see how the seven roles noted above are being applied to three main areas of application. Here we will see how the mapping role that traditionally was reserved for Natural Environments can be extended to two other fields involving man-made environments: Built and Socio-economic Environments. Again, this extension in application areas is accompanied by a diversification of the mapping role to involve a management function both in the natural and built environments. The resulting three categories which overlap are presented in Table 3.1.

Table 3.1: The main fields of application for Geographic Information Technologies in Norway

NATURAL ENVIRONMENTS	BUILT ENVIRONMENTS	SOCIO-ECONOMIC ENVIRONMENTS
GENERAL ENVIRONMENTAL SERVICES	ELECTRICITY & GAS UTILITY SERVICES	RESEARCH AND HIGHER EDUCATION
FORESTRY AND LAND MANAGEMENT SERVICES	TELECOMMUNICATIONS SERVICES	WHOLESALE AND RETAIL SERVICES
AGRICULTURAL SERVICES	LOGISTICS SERVICES	REAL ESTATE SERVICES
WATER AND WASTEWATER SERVICES	THE OFFSHORE OIL INDUSTRY	BANKING, FINANCE AND INSURANCE SERVICES
	DEFENCE SERVICES	MAPPING AND GEODATA SERVICES

One common feature of these application fields is their extensive pertinence to public and semi-public services. There are a strong links to national (e.g. defence, education), regional (e.g. electricity, forestry) and municipal (e.g. wastewater) services. Included here are the public utilities that are based on networked infrastructures, such as waterworks, telecoms and energy: in Norway as elsewhere, these are being subjected to deregulation to a greater or lesser degree. A facet that reflects more specific Norwegian conditions is the inclusion of the offshore oil industry, which is driven to a large degree by state-owned conglomerates (cf. Chapter on T-KIBS in this sector).

Box 3.3.

Local and Regional Public Services

Local and regional governments are active users of GIT in a range of areas that bridge our three application fields. Together, they make up the largest single user group. This box illustrates four basic categories for which GIT based-services are relevant:

1. Land-use planning and zoning, for ex. to analyse land availability and suitability;
2. Property and facility management, including building and property inventories;
3. Civil engineering, including road-maintenance;
4. Health care and Medical services, including disaster management, planning and response (for ex. in the event of a flood) or medical service planning.

For a more exhaustive list of GIT-relevant functions, see Annex 3.3.1.

3.3.1. Natural Environments Applications

Environmental services were one of the first areas of application for GIT, dating back to the late 1960's in the US. In general, the application of GIT to natural resources entails less complicated mapping and diagnostic functions, involving systems that typically do not change rapidly. The most important application fields in this category are; services connected to general environmental resources, forestry and land management as well as a range of more specifically agricultural services, and, public waterworks. A detailed list of functions is provided in Annex 3.3.2.

3.3.2. Built Environments Applications

The inclusion of waterworks in the above category provides a bridge to the public utility applications in this subsection. Included under Built Environments are inter alia energy grids, transport grids, telecom nets, post nets and pipeline systems. The service functions connected to the dynamic man-made infrastructures in this category involve a growing area of application for GIT. Services connected especially the broader dynamic telecom industry illustrate the ability of GIT to adapt to the complicated demands of rapidly changing dynamic systems. In areas such as telecom and transport logistics, it has become important that the mapping and monitoring features prominent in the first application field be extended to provide functions that can pinpoint system errors in the infrastructure, diagnose these, and prescribe remedies as well. This level of complication in turn heightens the need for greater collaboration between the GIT provider and its user, both under development, training and maintenance. For a detailed picture of the service functions involved for this area, see Annex 3.3.3.

3.3.3. Socio-economic Environments Applications

A final category for GIT-based applications involves more socially-based networks, such as those connecting financial services. Health services, which were categorised under local and regional government services above, could be classified here as well. With the exception of higher education and health, however, this field of application is more relevant for private service providers. The fields of retail services, services connected to real-estate and financial services involve such private-sector customers for GIT-KIBS. The GIT applications in the category involve planning and analytical tools with application for distributed systems such as insurance markets. For a detailed picture of the service functions involved here, consult Annex 3.3.4.

3.3.4. Case-illustration: Built-Environments

The applicability of GIT to built environments is an important group, both in terms of economic impacts and number of users. It can be illustrated by two applications to telecommunications services.

Box 3.3.4.

1. Incatel-Telenor Nett[6]

InCa is an outside plant management system that offers comprehensive network information management. Documentation such as network maps, cross section views and schematics are automatically generated by the system. The graphic views, familiar to most users, can be used to edit the network in the database. The approach for all creation and maintenance ensures that all documents are accurate, consistent, and up to date. Comprehensive network tracing tools are available to select and analyse duct, pipe and cable network connectivity as well as occupied and free capacity. The system can be configured for use in one department or in multiple departments. Separate systems can be installed to work in individual districts and be linked together via standard networks and RDBMS replication and linking facilities. The InCa-system is more than a typical GIS application. It is not a program that is simply made on the basis of a standard GIS package. It is a significant extension and can do things that have more to do with networks than GIS per se. An important part of the information about Telenor Nett's infrastructure is where it is, but that is far from all. InCa can present the net structure to the user in 8-9 ways, and only one of them is geographically. It is a necessary and important function, but only one of several.

The process leading up to today's InCa-system started around 1985 when Telenor's realised that they did not have any net information system for physical networks and that they thus had to build a data model based on their conception of the net. They initiated the process in 1986 and had a short list until March 1987. Then two years of negotiations with the Norwegian software firm Syscan followed, using them as a partner to develop prototypes and testing systems. The contract was signed in April 1988 and the finished system was to be delivered in December 1989. The development process was supposed to take 1 ½ years from the signing of the contract, but it turned out to take nearly five. A Syscan-affiliated company went bankrupt in December 1990 and Telenor Nett took over most of the workforce and established a separate company - Corena AS - together with IBM and a Danish firm in March 1991. In that year InCa was produced at below capacity. Based on these experiences, the decision was made to move the system to full production throughout Norway and several basic improvements in the product where made. Corena AS worked on the system until September 1993. Then another spin-off from the bankruptcy - Incatel AS - was established as a supplier to Telenor Nett in competition with Corena. They later lost the contract to Incatel and is now out of business in Norway. They later lost the contract to Incatel, and is now out of business in Norway. The first users in Telenor Nett started using the system in the autumn 1992, producing what was supposed to have started in the spring 1990.

[6] Interviews with Bernt Smilden (2.9. 1997) at Incatel AS and Erik Juvshol (28.8 1997) at Telenor Nett

2. Norkart-Telenor Nett[7]
The most important product Telenor buys from Norkart is the software program V/G-Tele that is used in surveying new constructions in the development of the network. It is thus a production tool for georeferenced data, but also a data collection system specially made for use with InCa. In this surveying system data is first registered in the field with electronic binoculars and transferred to V/G-Tele. The data is then transformed and further transferred to InCa. When specifying their needs to Norkart, Telenor Nett made sure that the system was compatible with the data model used in InCa. An additional product is V/G-Innsyn (= insight), an insight tool used for administering georeferenced data. It is used to make information from the databases more accessible in combination with digital maps. But in the future this may become the most important product that Norkart deliver. This module may become a necessity for the users of Telenor Nett in selecting all kinds of maps and geodata, e.g. for making overviews of the net at different levels. Both these PC-based systems either separate or in combination, are considered process innovations in relation to how Telenor Nett is carrying out their net documentation tasks. In addition, when all the net data are converted to digital data, the system will be used for e.g. trouble analysis and call systems and «call before you dig»-services.

In 1978 Telenor Nett AS started georeferenced surveying of their network tracks. In 1987 the software product they used reached a saturation point with regard to functionality. They started to search for generic software packages that could fill their needs. In 1989/90 the needs were specified and after contacting several providers they got a convincing demonstration of Norkart's products. Telenor Nett compared what they already had in their system with what Norkart could offer, and chose to go ahead with this new partner. The systems where to be delivered in 1991. When the contract was signed Norkart described how they would live up to the specifications, and after a rather short development phase much of the systems where up and running. Then followed a testing phase with more frequent communication on different aspects of the system. With the same people involved through the whole process, the quality of the personal relations was important for its outcome. Because the Telenor people got to know the system quite well during the process, new needs where realised, new possibilities where discovered and new solutions where created.

3.4. Types of Innovations

What kinds of innovations are identified in the GIT system? From the viewpoint of GIT-KIBS it started with internal automation of mapping processes that began in the seventies. Innovation concentrated on production processes involved in generating geographic information. The new production processes also required new ways of organising production, thus sparking organisational innovations to some degree. These software systems were later marketed and became new products that have been sold to an increasing market. The firms and institutions buying these product innovations from GIT-KIBS are themselves users or producers of geographic information, thus enabling their production processes

[7] Interviews with Stein Mjaaland and Gløer Winsvold (4.9. 1997) at Norkart AS and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

to be automated, too. A consequence of such internal automation processes at GIT-KIBS' customers', is a need to think through how the production is organised, often triggering a need for organisational adaptations. So what we have seen is a transformation of internal process innovations into new products which are sold as process innovations. This can be illustrated by the telecom case.

Box 3.4.

A GIT-Based Process Innovation[8]

Seen from the viewpoint of telecom companies the actual innovation is a process innovation and is part of the telecom network that is considered as the production system for netbased services. According to Telenor Nett, this is a typically needs driven innovation. The motivation has been an internal need for increased efficiency and better systems for reducing inconsistencies, lags and short comes in the documentation of the net - to use computers in managing the net to know its characteristics and specificity in real time. Having implemented the system, Telenor Nett now realise that there is very little effort needed before the customer service department can use the system in their daily activities too.

According to Telenor Nett, the system from Norkart was not a radical innovation but more a case of replacing one system with another. But in addition it was also a case of seeing new possibilities and representing the network graphically with more map background. The main motivational factor was to increase the efficiency if internal processes, specifically focusing on data quality and the transfer of high-quality data from V/G-Tele to InCa. Telenor Nett recognised a need independent of what other network operators where doing and have gone their own ways without looking much to the sides or backwards. In their own opinion, Telenor Nett is quite advanced internationally.

[8] Interviews with Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

4. The Institutional Infrastructure

The actors in a technological system interact under a particular infrastructure, shaped by a range of nation specific conditions. The main institutional elements in a technological system are i) the educational system, especially universities; ii) the financial system, especially the supply of venture capital; iii) bridging institutions; iv) business groups; v) international orientation of business activity; vi) the structure of ownership and control; and vii) the R&D functions (Carlsson and Jacobsson 1997). Of special interest in the GIT system, is the infrastructure for geographic information, the role of universities in fostering different types of competencies and the role of R&D in the innovative activity of the system's actors.

4.1. The Infrastructure for Geographic Information

Geographic information technology is multidisciplinary in nature, combining computer, communication and visualization technologies to support application of geographical data in different disciplines. In a complex system such as this, infra-structures plays a crucial role. The Norwegian geographic information infrastructure shall be an integrated part of the national information infrastructure that consists of:

- A technical infrastructure (data systems, physical networks for transporting information)
- Standards
- Common services (e.g. distribution services, payment services)
- Common information

The development and maintenance of the geographic information infrastructure is the responsibility of the Norwegian Mapping Authority.

Box 4.1.A.

Norwegian Mapping Authority (Statens Kartverk)[9]

In the Norwegian GIT system there are some very important "heavy weight" institutional actors which have influenced the development of the GIT system from its beginning. The most important is Norwegian Mapping Authority (NMA, app. 650 emp. 1996), the national institution for maps and geographic information. NMA are responsible for delivering to all users a country wide supply of maps and geographic data for planning, management and safety related task in important fields of society. The responsibility covers Norway's land, coast and sea areas and the coast around Svalbard. NMA has three branches; the land mapping division, Norwegian Hydrographic Services (the sea mapping division) and the Electronic Chart Centre (a centre for digital sea maps). The activity at NMA is organised in basic activities and externally related activities. These are identified as two strategic fields of activity; i) geographic information infrastructure (see more below) and ii) value added products and services. The basic activities are financed through the state budget and through grants from the activity of other public authorities. The main tasks of NMA include standardisation, specification, quality, data capture, data processing, data management, distribution, marketing and sale. Taken together, the basic activity of NMA constitutes a national infrastructure of maps and geodata, the backbone if the GIT system. The different tasks of the basic activity is conducted in close contact with the users to make sure that their needs are satisfied. NMA will supplement the infrastructure with value added products and services. These externally related activities are financed by payments from users, and consist of sale of digital maps and geodata, printed maps, publications and services. The main efforts in this service field are the establishment of the Electronic Chart Centre, a provider of electronic sea charts at European level (Norwegian Mapping Authority 1996).

[9] Interview with Jan Martin Larsen (1.7. 1997) at Norwegian Mapping Authority.

The Norwegian geographic information infrastructure is defined as

> "Data series and electronically based services that satisfy the common needs of different user groups for accurate positioning and georeferenced data" (Norwegian Mapping Authority 1996: 12).

This infrastructure is conceived of as a complete system with the following elements:

- An electronic service that provide storing and net based distribution of data (the National Geographic Information Centre - NGIS).
- A geodetic service with the purpose that all users can decide their own position with a precision on a 10 cm level in real time in all Norwegian land and sea areas
- Basic data series:
  i) Data series with information on natural features with a limited need for updating (coastlines, seaways, glaciers, forests, agricultural areas, etc.)
  ii) Data series with other information that need frequent updating (administrative borders, sea borders, navigational features on sea, air and land traffic, roads, etc.)
  iii) A cadastre system with information on properties, addresses, buildings and property maps that are updated daily.

On local municipality level there are similar but more detailed infrastructures, with varying content depending on local needs. Geodata co-operation is established to secure the integration of local and national infrastructures to avoid overlapping work and make it easier for users that need both. In addition there are thematic infrastructures (operational data series) on climate, geology, sea, rivers, land cover, agriculture, roads, etc. These infrastructures are also integrated with the national infrastructure to ease their combined use (Norwegian Mapping Authority 1996).

The use of the infrastructure is to a large degree organised by user or industry oriented networks. These networks enable for use those parts of the infrastructure that are of interest for their specific activities. Thus, an important factor influencing the development and diffusion of GIT-based service innovations is the price on, quality of and access to digital map data. In other words, this is a question of the quality of the geographic information infrastructure, both in Norway and internationally.

This is thus a very important condition for the GIT system, heavily influenced by the Norwegian Mapping Authority. All industrial representatives interviewed empha-sised how important the quality of the information infrastructure is for the development of new products and services. The main conclusion to be drawn is that they are not entirely satisfied with the present situation. The main argument is that the Norwegian Mapping Authority is a bottle neck. The prices of the digital data are too high, its quality is too low and the development of the infrastructure is too slow. This constrains the exploitation of the new interesting possibilities that the industry is facing. The situation differs between different parts of the infrastructure in that some map series in certain scales and certain cadastral databases have a higher quality in their digital data than others. E.g. digital road maps covering the whole of Norway are now under development. Some of the private firms in the GIT industry are taking the consequence of this situation by investing in building up their own databases (i.e. infrastructures) and establishing themselves as providers of maps in competition with the Norwegian Mapping Authority.

Another factor related to the infrastructure, sometimes influencing innovative activity, are public regulations. In some instances requirements pertaining to the needs to document and manage large infrastructures and networks may stimulate innovation. As we have already seen, many of the user fields for GIT have these requirements. This is illustrated by the telecom sector (ref. box 4.1.B.).

Box 4.1.B.

Impact of Public Regulations on Service Innovations[10]

Concerning the importance of public regulations for the innovation process, Telenor Nett claims to satisfy the current, rather strong, requirements imposed by the regulating authority, PTT (Post og Teletilsynet). Without proper documentation of the net that satisfy these requirements telecom network operators may be put out of business through loosing their rights to operate. Other network operators, like Telenor Avidi AS, the Telenor Group's cable TV network operator, is still using a paper based system for net documentation. They find themselves in a more difficult situation, and are now considering GIS-based digital systems for this purpose, due to the regulatory requirements. In the case of Norkart, the only regulatory factor of importance is a new standard for network maps which was issued in the beginning of the eighties. Through reading this seriously they realised their needs for a more modern system and today they more than fulfil the requirements of the standards.

4.2. The Supply of Competent Personnel

4.2.1. Technological Competence

An important challenge facing the GIT system, in addition to the quality of the infra-structure, is a shortage of competent people on the supplier side. University level education in geomatics, the subject field covering collection, processing, analysis, storing and presentation of georeferenced information using GIT, is found at two institutions in Norway, the Agricultural University (NLH) and the Norwegian University of Science and Technology (NTNU). At the former, the situation is satisfying, at the latter, it is dissatisfying, according to key persons in the system. The number of students within geomatics, and within engineering and natural science in general, is stagnating. There is now an increasing mismatch between the demand created by diffusion of GIT and GIS to ever more application fields, and the supply of people with deeper insights and wider and more basic competence in geomatics. At the same time, there is a growing need for more traditional ICT consultancy work in the GIT system. In this situation large actors in the GIT system consider importing competence from abroad. An expert committee has earlier this year published a report on the restoration and reorganisation of the geomatic education at NTNU. One of their recommendations is that the two universities to a larger degree should complement each other rather that overlap in their geomatics education and research.

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[10] Interviews with Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

4.2.2. Economic Competence

One observed characteristic of the GIT system, is the unevenly distributed ability among actors to identify, expand and exploit business opportunities. The GIT-KIBS have developed quite different knowledge bases, and they have different assumption concerning present and future markets for GIT-based services and products. With the rapid changes in technology, there is a risk that firms, institutions and networks become «locked in» to the «old» technologies. Further, there is also risk that a search undertaken outside traditional areas is done in a highly localised fashion like when traditional mapping firms are moving towards the information broker business.

Increased diversity in the GIT system can be achieved both by diversification of existing firms into services and products based on new geographic information technology and by start-up of new technology-based firms. Government policy may stimulate diversity within the system by enhancing its awareness of the opportunities of this new technology. Fostering diversity by compensating for inadequate economic competence can constitute a major policy objective. Advanced procure-ment policies have been shown to be a useful instrument for this purpose. Such advanced procurement policies require highly competent users, as is illustrated both by the case with Telenor Nett AS and other large public users of GIT. A wise technology policy would aim at fostering such user competence as well as utilising it to enhance the economic competence of GIT suppliers. If procurement policies related to GIT are handled competently, this could have a major influence on the growth on small technology-based firms developing new services.

Box 4.2.2.

Economic Aspects of the Innovation Processes[11]

The estimates that where done as basis for carrying the InCa- and VG-Tele-projects at Telenor Nett through, where rather modest compared to what has been actually realised afterwards. The potential impacts of the innovations where realised at an early stage, but as the project was rather controversial internally in Telenor, key people chose to play with a low return to make sure that they didn't meet any resistance at this early stage in the process. The motivation coming from internal needs, the international focus of Telenor Nett has not been an important driving factor in the innovation process. So far they don't use the systems in their international engagements, but they are planning to. They have both the competence and the organisational capacity to use these systems, which, to their experience, are not inferior to what other network operators are using. Incatel don't have any really strong competitors internationally and they believe that in three year's time, the number of international users of the product will be in two digits. A critical factor is that the existing competitors already have a foot inside at their customers or are very strong concerning capital. Incatel, on the other hand, is a small company with only 20 employees and a product about to take off.

If they play their cards right, this development process may result in a competitive advantage for Telenor Nett. For them, competitive advantage can mean several things; how fast a service is provided, what the quality of the service product is, what the cost of

[11] Interviews with Stein Mjaaland and Gløer Winsvold (4.9. 1997) at Norkart AS and Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

the service is, etc. All these factors are influenced by the new systems. It is important that the possibility and capacity for delivering a specific service really exist, and is not based on outdated documentation. The quality of the answer given to someone demanding a service is dependent on the quality of the data and the quality of the net. When the net must be repaired there is much to save in not digging at the wrong place. A lot of resources are used in Telenor because they don't know the net well enough. Moreover, Telenor Nett had between 400 and 600 employees working on drawing maps and schematics of the network. When the system is fully implemented and running they can do without 600-800 employees and save a corresponding amount of wages. Moreover, they can offer completely new products which was not possible with a manual map system, like calculation of lengths, status of the net, availability of services, etc. The user service part and the management of markets will become much more effective. These are advantages that will become more visible as the degree of completeness in digital conversion of the net is increased.

Normally, Norkart share the cost for developing a new product with the customer when they see a potential to sell the product to others. Then they have the rights and can sell it further. In the case of Telenor Nett, the customer financed 100 % of parts of the development costs because the product V/G-Tele is to specific to have any mass market. If Norkart sell V/G-Tele to other customers, Telenor Nett shall have some of this income, because of their rights in the product. Now (summer/fall 1997) Norkart is translating the program to English to prepare for new markets. This is partly due to the fact that Telenor Nett are using the system in their assignments abroad and introducing it to their vast network of contacts. This could mean new contracts to Norkart.

4.2.3. Organisational Competence

In addition to technological and economic competence, innovation processes also influence organisational matters. These influences may range from small changes in daily routines to total restructuring of the organisation. The needs for organisational competence apply to both GIT-KIBS and their customers, but the heavy burden falls mostly on the latter. This is because the GIT-KIBS seldom provides organisational consultancy to their clients. They have to rely on additional management consultancy services in cases where the impacts on the organisational structure are above a certain level. GIT-KIBS are often rather technology-oriented and are reluctant to broaden their services to also include management-related work.

Box 4.2.3.

Organisational Aspects of the Innovation Process[12]

The implementation of the new systems has had clear organisational consequences, because per 1. January 1997 the drawing departments where closed down. This means that 400-600 work places no longer exist. Some of these redundant people established their own companies, and is now providing network surveying services to Telenor Nett. Moreover, 30 man years in surveying of the network was transferred to Telenor Geomatikk, giving them this assignment from the same date. This is typical labour intensive manual work, which means that Telenor Nett is focusing more on planning, administration and maintenance of the systems that Geomatikk use. In this connection they have established a so-called life cycle for network documentation. The database InCa, containing all the network information, is divided into 7 physical bases in Norway and they are the basis for a process consisting of long term planning, detailed planning, development, maintenance and market forecast. This system is one level above other competing net documentation systems in its wide user functionality. Thus it is more of a corporate level system than a department level system.

When Telenor Nett is going to establish themselves as fixed network operator in other countries they will start with a geographic information system and build up a database on population, firms and customer potential. Based on this database, they will analyse where it is most profitable to develop the network, segregation of customers, segmentation of products, etc. To do this by GIS is much more effective than doing it with manual, paper based systems. Calculations that earlier took weeks or even months can now be done in seconds.

Concerning organisational obstacles to the innovation process, there were some on the customer side due to the massive reorganisations. One feature of Telenor Nett is that the company often take out the gains from reorganising before the job is done. This means that it takes longer time before the gain is actually achieved because there are fewer people left in the organisation to realise it. Subsequently, they are set to realise their own close-down, something which is not very motivating. These reorganisations have not so much influenced the relation to Incatel, because it has been the same key people on each side for some years. There has been little change of strategic personnel.

4.3. Research and Development in Service Innovation Based on GIT

The academic sector plays an important role for innovation in products and services in the GIT system in several ways;

- in identifying new emerging geographic information technologies
- in shaping an awareness of their potential in product and service innovations
- in spinning of firms exploiting that technology

[12] Interviews with Bernt Smilden (2.9. 1997) at Incatel AS and Erik Juvshol (28.8 1997) at Telenor Nett.

- in increasing society's absorptive capacity by accelerating research and education in new geographic information technologies when they are judged to be on the verge of becoming economically interesting

Universities need to be proactive and flexible; proactive in order to be able to support the GIT industry with specialised skills and new knowledge in emerging technological fields in time; flexible in order to adjust the orientation in education from old to new geographic information technologies. It is of outmost importance for the GIT system that universities move into these new technologies early and with great force, increasing diversity and creating a better response capacity in the system. A proactive or anticipatory policy of the educational unit is therefore essential and central to any technology policy in countries where universities are either state run or funded by the state (Carlsson and Jacobsson 1997).

The last 10 years, much time and money is spent on research and development related to a transition to spatial geodetics, administrative data capture, better geodata management and use of geodata. Public organisations, firms and research institutes have participated in this development. The Norwegian Research Council (Norges Forskningsråd) has contributed to the financing. The largest projects has been public research and development contract (OFU-contracts) partly financed by the Regional Development Fund (Statens Nærings og -distriktsutviklingsfond). There will be a need for continued efforts in R&D, a.o. to develop new solutions for users of geographic information and to contribute to standardisation of geodata norms.

Box 4.3.

R&D in GIT-Based Service Innovations[13]

Telenor Nett AS has no R&D department of their own. Formally, innovation in the Telenor Group is the responsibility of Telenor Research and Development AS. Nonetheless, the development of InCa + V/G-Tele and the GIT-related work is thought out at Nett in collaboration with the suppliers. Telenor R&D AS has not been involved in any important sense. So, seen from the standpoint of Telenor Nett, there has been no formalised R&D element in these projects. In fact they don't consider the collaboration with Norkart to contain any research work at all. It is more a case of application development. Neither at Norkart is there a very clear conception of the research content of the project. But they argue that much of their activity is similar to what is going on at research institutes working with GIT. As far as Incatel is concerned they have a clear conception of these matters; they don't do research. What they do is project oriented development based on standard software. They don't start any development unless they know that someone is buying the product, and as mentioned above, the establishment of the company as such was based on a concrete demand.

At Telenor Nett they identify an important R&D part of the InCa-project. This was the development of a large format scanner together with Kongsberg Scanners. This scanner, based on new, but well proven technology can be used for all types of maps and drawings and is an integral component of the system at Telenor Nett's. The data capture process

[13] Interviews with Bernt Smilden (2.9. 1997) at Incatel AS, Stein Mjaaland and Gløer Winsvold (4.9. 1997) at Norkart AS and Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

represents a significant proportion of the total investments required in establishing a GIS. This process may take up to several years and the quality of the data produced will have a major impact on the overall quality of the GIS. In addition to this, Telenor R&D has in fact supplied some add-on products, i.e. analysis modules that take network information from InCa into an analysis of new networks and available capacity in the existing network. This kind of analysis is very critical for Telenor at the moment, when they realise that they have to scarce network resources in the large cities in Norway at the same time as there is an increasing demand for leased lines and more band width.

Concerning which knowledge bases are the sources in the processes the most important elements are, according to Telenor Nett; their ability to describe their own needs for information about the net; their knowledge of routines or the ability to see possibilities for developing new routines; Incatel's software competence; and Norkart's GIS and map competence. Incatel's knowledge base is based on what Syscan built up in this field over many years. From Telenor Nett's point of view, Incatel are not so strong at geo-related concerns but good at software development. These days Incatel is considering to integrate Intergraph's new GIS technology Geomedia in the InCa-system. Since this is a standard tool for GIS application development and not a proprietary sector application, Incatel can do less of the basic GIS-related development and concentrate more on solutions specifically for the telecom sector.

5. The Role of GIT-KIBS in Innovation in Services

The GIT-KIBS plays several roles towards their customers. One observed trend is that many firms in the GIT system develop applications in close collaboration with 2-3 pilot users. It often starts with a customer coming with an idea, which is then developed in collaboration with the GIT firm. There is little development of large or generalised solutions that is far ahead of contemporary needs. Development horizons longer than 18 months seems to be uninteresting in the industry. The firms are rather close to their users needs and problems. Thus the GIT firms often become an integrated part of the innovation processes at customers. The impression is given that this is a very common way to develop innovations in the industry in general.

Box 5.A.

Close Interaction and Trustful Relationships in Innovation[14]

The described projects are quite representative of how Telenor Nett collaborate with their suppliers - there is always a close dialogue with partners. The interactive quality of these customer-supplier relations is very dependent on the "chemistry" between the persons involved in the project on both sides. If there is a high degree of trust and few partners, the process is much more informal and direct than when the opposite is the case. Both parts try to do the best for the other part to make the process run more smoothly and result in an optimal system for the customer. If there are some degree of distrust, a very large contract or a contract with many partners, the process is usually more formalised.

The importance of trust for innovation seem to be important also at Incatel. For them, informal relations with other firms and institutions are important both for getting contracts and for developing new products. Personal relations don't secure contracts per se, but they are often a necessary precondition in combination with having a solution to the customer's problem. The system that Incatel produce is very expensive and it drastically changes the way that telecom companies work. Thus it is important to meet the people with decision power at customers. At Incatel they believe that it has been of some importance for the relation to Telenor Nett that they where able to deliver what was agreed upon at the right time. They have had an ability to make solutions to what Telenor Nett asked for and not everything else. They have always focused on what their customer needed, apparently contrary to some other actors in this business.

This trend towards GIT firms becoming a more integrated part of the innovation processes at customers indicates a change from earlier periods, when e.g. map production for public use was totally on the GIT firms' terms without much dialogue with users. Producers have traditionally been very good at telling users what they need and not so good at listening to what they really said. But this is changing through a realisation that more interactions with users will sell more products and services.

Another trend is that in the future the competitive elements will be less related to basic technology and more related to elements like the history of the firm, its competence, how they have done things earlier, its ability to deliver quality products and services on time and its knowledge of the problems and characteristics within application fields. Part of this picture is that while technology, software and development becomes less expensive, the cost of implementation,

[14] Interviews with Bernt Smilden (2.9. 1997) at Incatel AS, Stein Mjaaland and Gløer Winsvold (4.9. 1997) at Norkart AS and Erik Juvshol (28.8 1997) and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

consulting and training is increasing to compensate for the loss in income for the GIT providers.

One of the important roles that GIT-KIBS play towards customers is in the knowledge transfer between the two innovating actors. One aspect of this is the trend that GI technology is becoming more user friendly in the sense that more standardised software elements may be used in several applications and that more software developers are using graphic user interfaces based on Windows. Thus, there is a trend towards enabling customer's competence in developing applications themselves. On the other hand, GIT-KIBS builds up new competence through interaction with customers that they can utilise in other projects or in related fields.

Box 5.B.

Knowledge Transfer[15]

During the process of collaboration with Telenor Nett, Norkart has learned much about networks. But there has been transfer of knowledge in both directions and they have learned from each other. From Telenor Nett two persons have been involved, from Norkart a few more. Norkart has used further some of the specifications from the contract with Telenor Nett in developing their V/G-Ledning (powerline) for electricity utilities. It was part of the deal that Norkart could use this competence in other projects. Thus they have utilised what they learned from the collaboration with Telenor Nett. From Norkart's point of view, the mapping-related competence at Telenor Nett has been very satisfying: they have spoken the same language and seen the same problems and solutions. Given the importance of chemistry between people involved in such processes, this seems to have functioned well.

One of the interesting aspects observed is related to the conception that in general, good knowledge of the application fields and the customers activities are very important both for developing new products and services and for getting new contracts. This is reflected in the present situation concerning recruitment to the GIT-KIBS. The people in these firms have traditionally been very mapping oriented and experts in that field. Now there is a trend towards recruiting people with both education for and several years of training within the customer sectors. The preferred competence for a growing number of GIT-KIBS people seem to be a combination of customer sector knowledge, general ICT competence and mapping competence. But the impression from studying the GIT-KIBS is that the weight is more on the two former than on the latter set of competencies. This both reflects and enables that the interaction between GIT-KIBS and their customers are very problem solving oriented and that people can more easily move from the customer side to the client side and vice versa.

[15] Interviews with Stein Mjaaland and Gløer Winsvold (4.9. 1997) at Norkart AS and Jan Roar Ringen (2.9. 1997) at Telenor Nett.

6. Policy Aspects of the GIT System

The geographic information infrastructure can be seen as the production structure for GIT based products and services. The construction and maintenance of the infrastructure is a public responsibility in all countries, but the tasks are organised differently. In Norway the Norwegian Mapping Authority has the responsibility, in Great Britain the Ordnance Survey, etc. The basic function of the infrastructure means that the price on, quality of and access to digital map data are important factors influencing the development and diffusion of GIT-based service innovations. This is a question of the quality of the infrastructure. Among actors in the GIT system, there is a shared view that this is a public responsibility that must be prioritised very high in the future. Today there is discontent with several things that could have been better. The main argument is that the Norwegian Mapping Authority is a bottle neck. The prices of the digital data are too high, its quality is too low and the development of the infrastructure is too slow. This is clearly a policy task that would stimulate the development of the GIT system.

The GIT system's developmental power is also challenged on another front. This is the increasing shortage of people with the right formal competence. The university level education giving GIT competence has been somewhat neglected and the system now experience an increasing mismatch between the demand created by diffusion of GIT and GIS to ever more application fields, on one hand, and the supply of people with deeper insights and wider and more basic competence in geomatics and other basic GIT competence, on the other hand. Two other factors contribute further to the need for a critical analysis and restructuring of the GIT education: i) there is a trend towards recruiting people with both education for and several years of training within the GIT-KIBS' customer sectors; and ii) there is a growing need for more traditional ICT consultancy work in the GIT system. One of the consequences of this development should be taken very seriously by the responsible policy authorities: large actors in the GIT system consider importing competence from abroad. Important changes may be in the wake following an expert report on the restoration and reorganisation of the geomatic education at and the Norwegian University of Science and Technology (NTNU).

Lack of competent people will clearly slow down the utilisation of the possibilities that GIT offers both for existing and for new businesses. Thus, government policy may stimulate evolution of the GIT system by enhancing its awareness of the opportunities of this new technology. Fostering diversity in services and products by compensating for inadequate economic competence can constitute a major policy objective. One of the main tools, used with success in several cases in Norway, is advanced procurement policies. Such advanced procurement policies require highly competent users, as is illustrated both by the case with Telenor Nett AS and other large public users of GIT. A wise technology policy would aim at fostering such user competence as well as utilising it to enhance the economic competence of GIT suppliers. If procurement policies related to GIT are handled competently, this could have a major influence on the growth of small technology-based firms developing new services.

Appendix

Annex 3.1. Main GIT Activity Areas

MAPPING RELATED SERVICES	DATABASE, GEODATA AND INFRASTRUCTURE SERVICES	SYSTEMS DESIGN AND CONSULTANCY SERVICES	SOFTWARE PROGRAMMING AND IMPLEMENTATION SERVICES	APPLICATION ORIENTED CONSULTANCY SERVICES	SOFTWARE PRODUCTS	HARDWARE PRODUCTS
mapping and geodata planning	electronic sea charts	orientation seminars	functional specifications	application systems design and development	land information systems (LIS)	work stations
ground control and surveying	marine data infrastructure	strategic IT-planning and consultancy	conceptual designs	pilot projects	geographic information systems (GIS)	servers
utility mapping	GPS (global positioning system) and geodetic network analysis	user needs assessment	data modelling	full turnkey applications systems	global positioning system (GPS) for navigation and positioning	digitising tables
photogrammetric base mapping	digital data publishing	functional requirements definition	software programming	forest management		plotters
topographic mapping	development of product concepts	requirements analysis	prototype development	environmental monitoring and analysis consultancy		scanners
hydrographic mapping	product manufacturing and testing	cost/benefit analysis	pilot application studies	resource development and analysis consultancy		displays
cadastral mapping	conceptual database design	cost recovery strategies	complete user and programmer documentation	road and traffic planning		
land-use mapping	physical database design	project management and quality control	internet solutions	utility planning		
digital terrain models	database building	institutional planning and building	home page design and development	fleet management, tracking and route optimisation		
GPS (global positioning system) based surveying	documentation design and development	organisational development	ongoing support	railway planning		

remote sensing and digital image processing	data graphics consultancy	staff augmentation	systems and software integration	airport planning		
aerial photography	photographical services	system design and engineering	implementation processes	water and sewage planning		
	data collection, evaluation, interpretation, conversion and integration	design and development of digital cartographic data production systems	training in GIS	landscape architecture services		
	printing and plotting	hardware configuration				
	digitalisation and scanning	quick start services				
	information brokering	product comparisons and evaluations				

Annex 3.3.1. Local and Regional Public Services

LAND RECORDS	LAND-USE PLANNING AND ZONING	PROPERTY AND FACILITY MANAGEMENT	ENGINEERING	PUBLIC SAFETY, HEALTH CARE AND MEDICAL SERVICES	OTHER PUBLIC SERVICES
parcel history tracking	general plan map	land acquisition and disposition	storm drain mapping and analysis	epidemic tracking and analysis	economic planning and development
multimedia integration	planning and processing of construction permits	building and property inventory	subdivision review and lot mapping	disease clustering and control	cultural preservation management
public counter inquiry	automated plan production	building and property maintenance	routing of street sweeping, sanitation, tree trimming	drug control	social services management and distribution
land value modelling	zoning and housing studies	building and property rebuilding	capital project planning and tracking	emergency planning and response	welfare distribution
street naming and house numbering	linkage to permitting systems			risk assessment	workplace safety analysis
addressing and address matching	capital improvements planning			disaster management, planning and response	tax assessment
geocoding	central commercial districting			emergency preparedness planning	tourist information
parcel identification and numbering	concurrency management			emergency response routing and recovery	demographic analysis and mapping
trip routing for efficient field assessment	land capability and suitability analysis			crime analysis	utility rate and consumption analysis
	agricultural, wetland and public lands inventories			patrol beat planning	employment and wage statistics
	development constraints mapping			facility siting analysis	production capital assessment
	reclamation monitoring			facility management	election results reporting and analysis
	hazardous areas mapping			public safety vehicle management	polling place siting and voter routing
				field operations	
				flood zone mapping	
				medical services planning	
				outcomes analysis	
				patient analysis	

Annex 3.3.2. Mapping GIT Applications for Natural Environment

GENERAL ENVIRONMENTAL SERVICES	FORESTRY AND LAND MANAGEMENT SERVICES	AGRICULTURAL SERVICES
environmental monitoring, analysis and management	forest analysis	mapping and analysis of crop production
resource development, analysis and management	land records management	point-and-click farm prescription maps
alternative energy assessment	land coverage management and use	flow-management from field to processing
effect simulations	forest management	calculation of wholesales and retail distribution
environmental sensitivity index mapping	watershed management	"just-in-time" farm equipment scheduling
oil spill contingency planning and response	minerals management	geodemographic analysis of agriculture markets
emergency response	mill locations and access	
disaster relief distribution	area event systems for forest management history	
vegetation mapping	forest information management systems (FIMS)	
coastal zone management	forest resource mapping	
airport noise simulation and monitoring	ecosystem management decision support systems	
strategic environmental databases		
ecosystem status and trends		
endangered species analysis		
global change assessment		
national parks management		
hazardous waste transportation		

Annex 3.3.3. Mapping GIT Applications for Built Environments

WATER AND WASTEWATER SERVICES	ELECTRICITY & GAS UTILITY SERVICES	TELECOMMUNICATIONS SERVICES	TRANSPORT AND LOGISTICS SERVICES	OFFSHORE OIL AND GAS INDUSTRY SERVICES	DEFENCE SERVICES
automated mapping and inventory	trouble-call analysis	network and infrastructure operations	electronic sea charts management	automated basemapping	information for command tasks
planning and forecasting	network mapping	management of ISDN, leased-lines and telephony interconnections	nautical navigation	digital reservoir models	map production
maintenance management systems (MMS)	customer information interfaces	field service dispatch	automatic vehicle location and track-ing	reservoir management	terrain mapping
preventive maintenance planning	distribution analysis	forecasting	delivery vehicle routing and schedul-ing	exploration	spatial analysis and tactical applica-tions
emergency response and disaster preparation	market analysis	maintenance	intelligent transportation systems	drilling	national military command applica-tions
industrial waste-program support	public information presentation map-ping	scheduling	equipment fleet optimisation	production	safety in the skies and at sea
automated meter reading	work order processing	administration	fleet management	lease management	nautical and aeronautical chart production
business systems	demand survey and analysis	customer care	traffic reports	transport systems	facilities management
connection review and approval	system implementation	strategic planning	transportation planning and analysis	tanker fleet management	environmental monitoring
laboratory information management systems (LIMS)	planning and design	facilities planning and siting	transportation engineering	emergency response	
maps and records management	process engineering and feasibility assessment	facilities and land base mapping	operations research	pipeline management	
public information presentation map-ping	system prototyping and engineering	processing and management of mapping data	national infrastructure planning	planning and route selection	
spill- and wastewater control systems		cable routing	infrastructure management	regulatory reporting and permission	
supervisory control and data acquisi-		scanning and electronic archives	rail inventory management	emergency response and location	

tion (SCADA)				maps	
system modelling		spatial data warehouse development.	warehouse equipment optimisation	risk assessment	
retrieval of hydrogeologic information		information brokering	geocoding systems	corrosion analysis	
		marketing and demographic analysis	supply chain optimisation	asset profitability analysis	
		trouble analysis and call systems	location/allocation analysis	supply and market analysis	
		“call before you dig”	mass transit	integration of document management	
		electronic yellow pages development:		work order management	
		cable-TV			
		internet shopping			
		electronic commerce			

Annex 3.3.4. Mapping GIT Applications for Socio-economic Environments

RESEARCH AND HIGHER EDUCATION	WHOLESALE AND RETAIL SERVICES	REAL ESTATE SERVICES	BANKING, FINANCE AND INSURANCE SERVICES	MAPPING AND GEODATA SERVICES
agriculture	competitive analysis	site selection and analysis	branch location planning	infrastructure for geographic information
architecture	demographic analysis	property assessment	competitive analysis	manual and automated data capture
business	distribution analysis	land acquisition and disposition	customer service	digital cartographic data production
education	prospect analysis	building and property inventory	loan administration	digital cartographic map production
engineering	pricing analysis	competitive analysis	merger analysis	data conversion: raster and vector formats
geomatics	performance analysis	demographic analysis and mapping	mortgage distribution analysis	dynamic map displays
law and real estate	site selection and analysis	distribution analysis	regulatory compliance	interactive internet mapping applications
library	geocoding of customer and facility location	prospect analysis	target marketing	traveller routing applications
military science	territory allocation	pricing analysis	claims processing	cartographic data transmission
natural resource management	trade area development	performance analysis	managed health care	real-time traffic management systems
natural sciences	electronic yellow pages	target marketing	risk analysis	
public health and medicine	media planning		insurance-underwriting	
physical sciences	response tracking		catastrophe management	
social sciences	target marketing			
	customer services and facility profile			

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STEP gruppen

STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.