DANISH SPATIAL DATA INFRASTRUCTURE

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ABSTRACT

The requirement for new market strategies, technical concepts and organisational approaches are the background for a research initiative taken by a group of research institutions in Denmark: Aalborg University, Copenhagen Business School and The National Survey and Cadastre. The initiative applies an infrastructural view to a number of traditional research areas and integrates business and market research with technical research as the market for geodata is expected to expand and will consequently be an important driving force in the years to come.

Essential to the Danish SDI is spatial data modeling, which is now gaining recognition in many parts of the geomatics community. Conceptual modeling is used by authorities from different sectors to establish semantic interoperability and data sharing and thus form regional "modelbased infrastructures" that integrate spatial data across state and local authorities and across various state authorities.

The "Logical datamodel for property data" has already been prepared and has contributed to the basic structure of the "Public Information Server", which will deliver property data over the Internet to the Danish public from summer 2001. Further projects are planned to develop conceptual spatial data models which will provide coherent data on nature/environment and on buildings/constructions regardless of the distributed responsibility for registration in various administrative sectors of public administration.

1. INTRODUCTION

The Danish Spatial Data Infrastructure is favoured by the small and densely populated area of the country which means that the data supply with a national coverage by and large is achieved. The focus is now shifting to integrated use of the heterogeneous data and more rational production and maintenance. At the same time networked and mobile technology are expected to expand the marked for spatial data and introduce application communities yet unfamiliar with spatial data. These trends demand development of the spatial data infrastructure.

The following chapter 2 will describe the current situation in the Danish mapping and geodata sector and in chapter 3 the most recent introduction of a modelbased infrastructure approach will be explained. Chapter 4 gives a brief description of three research projects

that are intended to support the further development of the Danish spatial data infrastructure.

2. DEVELOPMENT OF THE DANISH SDI

2.1 Data Supply

Denmark has a national coverage of different map series:

Cadastral Maps. After the conversion into digital format was finished in 1997 the cadastral map is now gradually expanding from being exclusively a registration of parcel and administrative boundaries to incorporate new registrations such as coastal protection areas, contaminated areas and protected forests – all registration which impose limitations on the owners use of his property. The cadastral map is thus developing into a multipurpose cadastre.
The Webcadastre is an information system on the Internet that contains updated cadastral information. Using the system requires subscription.

In December 2000 the National Survey and Cadastre finished a *topographic map database* (*TOP10DK*) in scale 1:10.000. The TOP10DK is expected to become very important in connection with an integrated use of spatial data. The map database will eventually have different linking facilities for example to property data. TOP10DK includes a *Digital Terrain Model*.

Digital colour orthophotos based on aerial photos have in recent years found increasing use by Danish users of geoinformation as base maps for presentation of different thematic data sets. The orthophotos (with resolutions from 8 to 40 cm) are produced and sold by several private photogrammetric companies.

Today Denmark is covered by digital large scale maps (*technical maps*) in scales from 1:1000 (towns and built-up areas) to 1:10.000 (rural areas). As the maps are produced on demand by different users and in different qualities the maps do not form a homogenous nationwide product. During the last few years the *Specifications for Technical Maps* have been revised radically to adapt them to an object-oriented model conception. Consequently, the demands on the geometric connection, accuracy and completeness of the map features have been substantial.

Also available are several map series on the Internet. First of all we have several *road and street maps* and road-search machines produced by private companies, but also many counties and municipalities have published *thematic web-maps* and *regulation plans*.

The *Area Information System* (AIS), finished in 2000, is the first attempt to integrate geoinformation within the nature- and environment field in Denmark. The system (thematic maps and their data sets) contains information about the territory such as habitat types, land use, hydrology, natural resources etc.

We can conclude that within Denmark there is reasonably well functioning digital map series and specifications for the production of these maps with possibility for description of quality and quality checks.

Denmark has since the late 60's established a wide range of standardized *public registers* with extensive information on e.g. real estate and valuation, building and dwellings, public planning, individual persons, enterprises and farms etc.
Responsibility for the registers is distributed to different public authorities on state level as well as on the municipal level. The registers can be linked by common identifiers, which are maintained in the Crossreference Register.

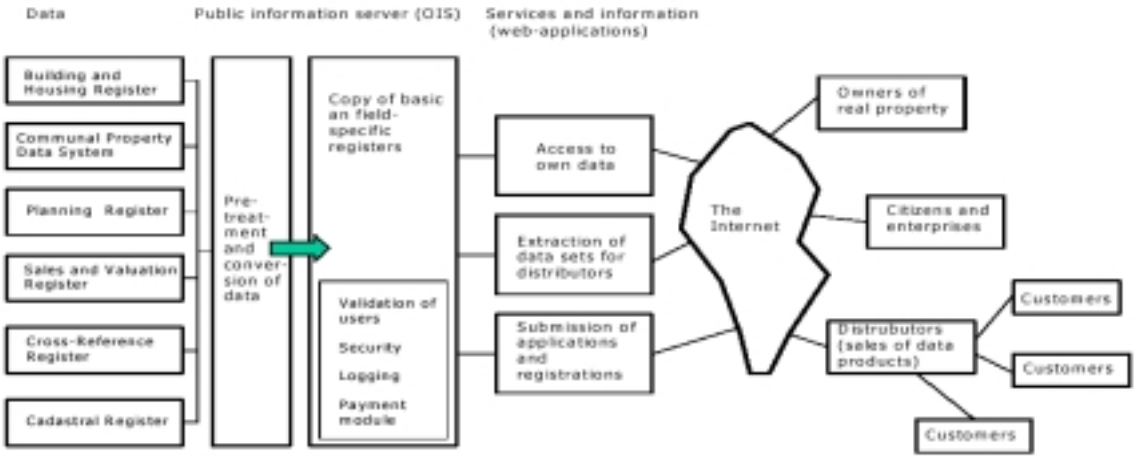
Fundamental to the registers was the *standardization of addresses* in connection with the establishment of the Central Population Register in 1968.
It is now widely accepted that the address issue is of great importance when talking about spatial information. The address can link data from registers containing personal, property and enterprise data sets. In Denmark several address themes have been developed. *DAV* (the Danish Address and Road register) is produced by a private company Kampsax. Contrary to this the *"Address-project"* is produced in cooperation between public authorities and is based on exact co-ordinates to the addresses.

Having almost completed a national coverage with georeferenced and standardized addresses development efforts are now being directed to the establishment of *georeferenced building ID's*. An automated process will produce a simplified dataset based on a combination of the cadastral map, the topographic map and the Buildings and Dwellings Register, and the municipalities will then with a smaller additional effort be able to enhance the georeferences to a fully detailed dataset.

2.2 Public services

The Ministry of Housing and Urban Affairs has according to the governments general IT-policy developed a *public information server* (OIS) to be launched August 1 this year. In its first version the server only delivers attribute data from the public property registers but eventually the service is expected to be extended to maps as well.

The objective is to give potential users - citizens, enterprises and public authorities - the possibility of getting data from the public data collections via the Internet and to provide a marketplace for spatial data, specifically by offering direct access to resellers or value-adding distributors to the server.



A government committee is leading negotiations for the moment between owners of the data regarding the prizing issue which hopefully will result in a prizing model based on cost-recovery.

The www.geodata-info.dk database is the Danish *metadata service* on the Internet.
The info database is a catalogue (metadatabase), describing the digital maps and other collections of georeferenced data in Denmark. The metadatabase gives a short overview of each data set, and where to get further information about the data set.
The database has in its first version been implemented according to the CEN standard and will eventually be developed further to comply with the ISO TC211 standard.

2.3 Organization and policy

In the report “The Digital Denmark – adaptation to the network society” published in November 1999 b the Ministry of Research the new IT strategy of the government is first formulated. The strategy includes the objective, that citizens and enterprises shall be able to use and profit from society’s investments in public information resources in new ways. One of the subgoals in "Goal 3" is to direct the efforts towards a better and cheaper service in the public administration. This service is to be obtained through “an effective digital administration based on electronically stored data”. Some of the advantages mentioned are partly the possibility of unlimited reuse of electronically stored data, partly the possibility of quick and cheap access and distribution of data by electronic means, for example via the Internet.

The government followed up with the policy of “Adaptation to the network society, IT and tele-political statement for the Parliament”, published by the Ministry of Research in January 2000, which includes the following initiative: “The digital administration, including the public information server, which must allow easy access to all the information that the public sector has registered about Denmark and the Danish citizens”.

These and other policy statements are very general and do not specify any elements that might be regarded as a development plan for Danish spatial data infrastructure. In the absence of a political strategy we are left to implement the spatial data infrastructure through a bottom up approach which is quite unusual also in a Scandinavian perspective.

The actors on the scene are the National Survey and Cadastre, which is the state authority within mapping and cadastre. It produces cadastral and topographic maps as well as nautical charts.
The other producer of base maps is the municipal sector, which is responsible for more than half of all public spending in Denmark and enjoys a relatively autonomous status.
The utility sector is a major user of maps and has also established itself as a producer of maps in connection with the major projects for district heating and distribution of natural gas.
The private sector counts a small number of photogrammetric companies that produce maps commissioned by public authorities, mainly municipalities. The land surveyors, most of whom are private practice, are by law responsible for cadastral mapping and parcelling out of land.

Through many years the geomatics sector has been characterized by an extensive cooperation between these parties based on a consensus tradition.
The expansion of the market for spatial data due to networked technologies and the expected increase of actors with an intensified competition may demand other organizational initiatives in the future.

3. SPATIAL DATA MODELLING

Having completed the conversion of the Danish spatial data resources to digital format and achieved national coverage the GIS community has shown an increasing interest in cross-sector production and use of these data.

3.1 Logical Data Model for Property Domain

So far this has resulted in the establishment of a data model for the property data field. Based on this and on an assessment of the business areas - land registration, cadastral changes, property assessment - linked to the central property-related data collections, a conceptual data model for the property data field has been developed under the auspices of the National Survey & Cadastre: *The Logical Data Model for the Property Domain.*

The data model encompasses the basic property data registers: the Buildings and Dwellings Register, the Land Registry, the Cadastre and the Municipal Register of Property. The authorities responsible for these registers are Ministry of Housing, Ministry of Justice and the municipalities. The interpretations of apparently equal concepts were not fewer than the authorities involved.

The Logical Datamodel for the Property Domain is now widely accepted as generic for the development of property related systems and has recently been used for the basic structure

of the Public Information Server (see above). It should be mentioned that The Logical Datamodel for the Property Domain has no formal status. The benefits of compliance are motivation for its use.

3.2 Modelbased infrastructure approach.

Modeling has thus been recognized as an essential instrument for the further development of the Danish Spatial Data Infrastructure. During the last few years modeling has been used in the efforts to create cross-sector coordination of spatial data.

The development so far seems to point even further in the direction of building a 'modelbased infrastructure' – or rather a number of regional modelbased infrastructures. The term 'regional' implies that the infrastructure encompasses only a limited number of spatial datasets, that typically represent duplicate registrations or have a mutual interest in a closer coordination because they represent related administrative tasks.

The term 'modelbased infrastructure' is thus characterized by:
- being information-oriented as opposed to system- or data-oriented
- being based on generic concept models at a high level of abstraction with the emphasis on creating semantic interoperability between object classes, that describe the same real world phenomena; in the following application within the specific business domains the generic concept models can be concretized into models suitable for implementation
- being regional but eventually the regional models should be combined or extended to gradually wider circles of spatial data

A model-based infrastructure offers in principle the following benefits:
- attracts focus of interest to the basic spatial data and simplification of complex and overlapping data structures
- stimulates mutual understanding and cooperation between organizations from different sectors with heterogeneous definitions of the same real world objects
- provides a basis for division of labor regarding data capture and maintenance based on object classes rather than maps or registers
- provides a basis for distribution of data according to responsibility for data capture and maintenance
- reuse of data and minimizes duplication of registration
- supports the introduction of spatial data in mainstream IT

In this autumn a major project will be launched as a cooperative effort to establish a model-based infrastructure incorporating the national topographic map (TOP10DK), produced by the National Survey and Cadastre, and the Area Information System, produced by the National Environmental Research Institute.

The objective is to establish an infrastructure that minimizes duplicate registration as some of the map themes seem to be overlapping.

Integrating themes that coincide completely is of course the easy part but analysis will also have to deal with multi-representation of other themes that only partly coincide, object that appear in multiple roles or represent different levels of generalization.

The National Survey and Cadastre itself is also considering integrating the individual data models of the main areas of responsibility into one single infrastructure, thus gaining synergy and a more rational data handling.

One of the lessons learned from the Logical Data Model for the Property Domain is that model-based infrastructures provide greater transparency for developers and users, that have no or very little knowledge of spatial data. This is not less important now as we find ourselves in a 'pre-market' situation expecting services on the Internet with location components to be built by a vast myriad of developers from outside the geomatics community.

4. THE RESEARCH AND DEVELOPMENT INITIATIVE.

The situation described immediately above requires development of methods for spatial data modelling of heterogenous datasets. To this adds the requirements growing out of the changing use of spatial data via the Internet and other emerging network technologies.

On this background the research initiative on Danish spatial data infrastructure, was taken by three institutions: Copenhagen Business School, Aalborg University and National Survey and Cadastre - Denmark. All three are established research institutions, the last two of them with a traditional background in the field of spatial data research.

Three research projects have been identified so far:

4.1 The Geographic Information Market.

Digital spatial data has until now been offered on a limited market mostly to professional users. Restrictions of many kinds (formats, data structure, skills, organizational etc.) have impeded the use of spatial data on a broader scale.

The networked technologies are expected to change that situation radically because they will expand the market for spatial data, which has been the case for other digital data in the last few years. The market is a vehicle for allocation of products and will as such have implications on the spatial data production, distribution and the demand for GI.

One crucial property of spatial data is the updating frequency. The commercial market will reflect the different users concerns for the risk of using outdated data and the demand for spatial data, which is updated at short notice, is expected to increase. On the other hand, the technological development is in favor of this trend, with the fast growing integration of GPS technology into industry products. New communication technologies as General Packet Radio Service, will favor both production and the use of spatial data.

The technology will also open a new market for "temporary spatial data", i.e. spatial data that describe a temporary situation, which is of interest to a certain number of users. For instance the traffic situation on the main routes to city center in the morning and afternoon rush hours.
We will go from a passive to an interactive culture. This means that we will all become active users of spatial information - and probably also producers by virtue of the new mobile technologies for positioning.

However, the new network based market for spatial data is different from the conventional market. The price of data must among other things be adjusted according to the general property of digital data: Data can be copied and sold an unlimited number of times without loss of quality and data can also be used any number of times at marginal costs.

In the research project different market models for digital spatial data will be described and analyzed.
The research will also involve the actors in the market, which today is characterized by interaction between a few professional actors, many of whom are both producers and users. The normal market will be an open electronic marketplace. But also "clearing houses", i.e. a closed network of spatial data producers that exchange updated transactions on a day-to-day basis with no or little money involved, will also be possible.

Finally legal issues that impose limitations on the use or the distribution of spatial data will be included in the project.

4.2 Spatial Data Modelling.

The Danish spatial data are traditionally organized as maps and geo-referenced attribute files, some of them with a very long history. In the conversion process these maps and registers have been maintained with their separate product specifications, which means that we still have a cadastral map, a topographic map, technical maps etc. - but now with a digital format.

One consequence of this approach is duplicate registrations of some real world features. For instance the building feature can be found in the topographic map, in the technical maps and in the buildings and dwellings register as well. Each of these registrations are produced and maintained according to individual procedures and by separate organizations.

This multi-representation in heterogeneous datasets is one important issue for the research project, which is expected to provide methods to model different forms of multi-representation, multiple roles and different levels of generalization being some of them.

The research efforts are presently focused on the multi-representation issue but eventually the research project is expected to incorporate other issues to form generally applicable methods to restructure spatial data from maps and registers into object oriented spatial data models.

In cooperation with professor Christian Jensen and associate professor Nectaria Tryfona of the Informatics Institute of Aalborg University the research project was initiated in mid 2000 with the establishment of a ph.d. study on spatial data modeling.

Close cooperation is also established between the modelbased infrastructure development activities mentioned in chapter 3 and the research project in expectance of mutual benefits.

From a user's point of view, the object oriented spatial data model methods should form a much more flexible basis for shaping individual spatial data combinations according to their individual needs. This is not in the least with the emerging web-based location services in mind.

4.3. Distributed Geographic Information Prototype.

Distributed Geographic Information (DGI) is referred to as the term covering mainly Internet/Intranet based location services. This is already rapidly establishing itself as the main distribution channel for geographic information.

In Denmark many authorities and commercial enterprises adjust their strategies to a DGI approach. The Public Information Server (chapter 2.2) is one example.

The National Survey and Cadastre offers cadastral vector map data via a web server mainly to the professional users and a number of private location services have already been operational for some time.

The research project is intended to produce an experimental web-service based on the spatial data model developed in the previous research project mentioned above.
The intention is to analyze selected use cases, test the usefulness of the spatial data model for individually adapted services and to evaluate the commercial viability of DGI.

Foreign sample geographic web-services will be examined to characterize different approaches and evaluate their advantages and disadvantages.

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