GSDI 6 Conference – From Global to Local, September 16-19th 2002, Budapest, Hungary

The Spatial Information Market in Denmark

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Introduction

Denmark[1] is in the middle of a transformation to an *e-society* based on *the network society*. One of the challenges is *e-government*. The ambition across state, county, and municipal government is to use the potentials of an e-society to structure the public sector in a more flexible and efficient way and with higher quality for the citizens. Also business makes use of digital technologies and the possibilities of the network society to improve competitiveness in an increasingly globalised world.

A majority of the population already participates actively in the e-society that influences all aspects of its social life. Many citizens are already accustomed in using the Internet for providing information (*e-information*), for self-management (*e-data*) and for business (*e-commerce*).

The e-government initiatives are rapidly changing the *spatial data/information*[2] area too, as spatial information affects a major part of human decision-making. Investigations indicate that about 80% of the information needed for e-government can be related to a location on the Earth. Especially in the environmental, development & planning and transport field there is at present an increased demand for information on land use and environmental effects. Geo-marketing including location-based services is also one of the new trend words in the marketing business.

At the same time the citizens are increasingly demanding better service from the public sector by way of more information and greater transparency (*e-democracy/ participation democracy*) in the mentioned administration tasks. It is foreseeable that in the future spatial information will be a product on equal terms with other consumer products in society. The development will imply that very soon there will be demand for relevant, topical and reliable spatial information in electronic form available 24 hours a day (via the Internet) and in standards which are usable to all. But spatial

[1] With an area of 43,080 sq. km Denmark is the smallest of the Scandinavian countries. The great majority - about 85% - of the country's 5,3 million inhabitants lives in towns or urban areas, and approximately one-third of the total population lives in the metropolitan region of Copenhagen.
There are three levels of governmental administration in Denmark: central government, county authorities and municipal authorities. Municipalities and counties are both headed by politically elected councils and function partly on the basis of local political decisions, partly in accordance with legislation passed by the "Folketing" (Parliament). Local authorities are responsible for more than half of the public spending

[2] Spatial data/spatial information is often used as synonym of geographic data/geographic information or geo-data/geo-information. Spatial means here the physical space used to describe the geometry and the characteristics of different objects and related attributes. Data is raw facts (numbers, letters etc.). Information is adapted and structured data. Spatial data/information can be divided into text-based registers (databases) and digital maps. The linking between the two data types takes places through keys and geo-references.

data/information is not always present, when it is needed, or it is not present in a usable standard or at a payable price /Brande-Lavridsen 2002/.

This has in more countries led to initiatives for development of a *National Spatial Data Infrastructure (NSDI)* or *National Spatial Information Infrastructure (NSII)*. A NSDI/NSII is, together with e-government, e-commerce, e-democracy/participation democracy, geovisualisation, education and training, etc., an important element in *Spatial Information Management (SIM)* /Ryttersgaard et al. 2001/. In the following, greatest importance will be attached to the Danish Spatial Information Market, which indirectly is forming the elements of a Danish NSII.

The NSDI/NSII concept

A NSDI/NSII[3] is not a new area on a global level. The first generation of national infrastructures for spatial data/information has already been presented and evaluated. Common for all the infrastructures is that they have been explicitly national and that there is no general consensus for the meaning of a NSDI/NSII. This means that as well on global as local levels there is considerable confusion regarding the purpose, scope and contents of an infrastructure. One position is that a NSDI/NSII is just a product, a core data set of spatial information available for the whole nation (a national spatial database). Another position is that a NSDI/NSII is a strategy required to manage national spatial data/information (a national spatial data framework).

In many countries there is a legal mandate to develop a NSDI/NSII (top-down approach), in others a NSDI/NSII is an outgrowth from established mechanisms (bottom up approach). Denmark belongs to the latter group. An official infrastructure has not yet been passed, but thanks to an increasing cooperation between the major stakeholders in the spatial information business Denmark is approaching a NSDI/NSII.

The Danish development in the map and geodata field

The Danish society is one of the most mapped and registered societies in the world. Over the past two decades analogue maps and geo-referenced registers have been converted to a digital form, and new data have been created to fill the gaps. Therefore Denmark seems to be in a favourable position concerning spatial information. At the same time the use of GIS (Geographic Information Systems) in the public and semi-public sectors and in private business is growing thanks to the initiatives, which will be described in the following /Brande-Lavridsen et al. 2001/.

However, especially within the mapping sector it is often seen that different organisations[4] (public as well as private) produce the same data and offer the same product. Moreover, data produced for one purpose or for use in one system cannot necessarily or only with difficulty be used for other products or in another system (lack of common data models, standards, interoperability etc).

As far as can be seen, these problems are not always of a technical but often of an organisational or an economical nature. Some institutions have not been used to or do not have the culture of co-operation. Data sets collected at a local level are not always accessible on a national level and vice

[3] NSDI/NSII: The technologies, policies, rules and human resources necessary for a socio-economically effective use of spatial data/information at all levels and across in the public administration, among private enterprises and organisations and in the academic world.

[4] In Denmark, The National Survey & Cadastre is by law obliged to produce topographic maps (medium and small scale maps) and cadastral maps, but users of e.g. large-scale maps and thematic maps (counties, municipalities, utility companies etc.) have to produce these maps themselves or let private mapping companies do it for them.

versa, often because of economic disagreements. Even public authorities may see themselves as competitors though there is a growing understanding and commitment to co-ordinate. The will to share data at a fair price between public authorities is often disputed. The same dilemma is often seen between semi-public and private producers and users.

New problems may arise that make a common use of the data sets problematic; the data sets may be incomplete and incompatible, data may be insufficiently documented (no metadata) and in the worst case totally obsolete. The outlined barriers to an efficient utilisation of spatial data/information are unfortunately not only seen in Denmark.

The typical user of spatial information is still a professional in the technical or administrative public sector. The use of spatial information is still rarely seen e.g. in the social and health sector – not to mention the private financial sector – though the tasks of these sectors are very often spatially related /Daugbjerg 2002/. Most citizens approach to spatial information is still the popular "find your way" services on the Internet but more and more citizens make use of web based services from state, counties and municipality authorities on plans and planning restrictions, property information, citizens services etc.

Therefore the goal of a Danish infrastructure must be to reduce duplication and costs of spatial data/information, to improve quality, to encourage co-operation on common standards and data models and last, but not least, to make spatial data/information more accessible to as well public authorities as private enterprises and citizens – to a fair price.

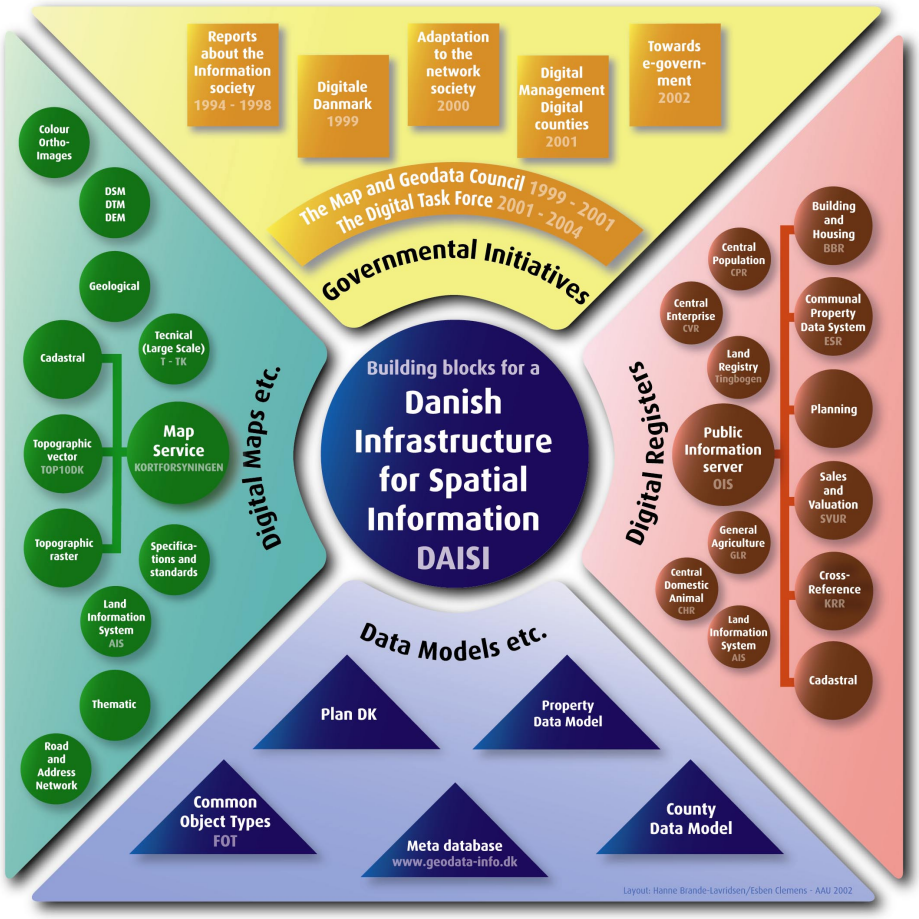


Figure 1. *The figure shows the most important building blocks to a Danish Infrastructure for Spatial Information (DAISI). The different "blocks" will be discussed later in this paper.*

The situation has as mentioned earlier improved considerably these last years among other things thanks to governmental initiatives, but to accelerate a better use of current and reliable spatial information at all levels more initiatives have to be taken.
In the absence of an official NSDI the initiatives described in this paper are meant to support a coming ***DAnish Infrastructure for Spatial Information (DAISI)*** (see figure 1).

Governmental IT initiatives and policies

During the last ten years the Danish Government has prepared various action plans and reports that lay down goals for the further development in Denmark within the IT field. The objective of them all has more or less been the wish to enhance the efficiency of the public administration and management (e-government) (see figure 1, top/yellow).

- In the report "*Digital Denmark - adaptation to the network society*" published in November 1999 and the follow-up on "Digital Denmark….", named "*Adaptation to the network society*, *IT and tele-political statement for the Folketing*", published in January 2000 the new IT strategy of the government is initiated. In connection with this a policy has to be formulated on how citizens and public and private enterprises can use and profit by the society's investments in maps and registers, etc. in new ways. In the latter report, however, a number of matters are mentioned which make these challenges difficult to meet: one is that a divided public sector impedes a co-ordinated adaptation process; others are economic and legal barriers.
  (www.detdigitaledanmark.dk)

- In May 2001 came the publication "*Digital Management*", followed shortly after by the report "*Course for the digital county*". In the first report the objective of a digital management is described again. More points are mentioned as necessary, before the objective can be attained, including again the importance of adapting laws and regulations so that an increased use of data is allowed. The latter has partly taken place. In the second report the subject spatial data/information is proclaimed as a field with a great potential, but again the barriers (ownership, access, pricing, conditions of use, etc.) are pointed out, which limit an efficient utilisation.
  (www.e.gov.dk)

At the end of 1999 the Minister of Housing and Urban Affairs established an advisory body: *The Map and Geodata Council*. The members of the council came both from the public and the private sector as well as the academic world and represented both users and producers of spatial information/data. Unfortunately, the council was abolished at the end of 2001 in connection with the retrenchment policy of a new government. Some of the core areas of the council are, however, to a smaller extent carried on by *The Digital Task Force*[5], which was established in the summer 2001, provisionally only with representatives from the public sector.

In the autumn 2001 the Task Force carried out an analysis of the geodata field. The conclusion of the analysis was, not surprisingly, ambiguous: on one hand Denmark is in a strong position and has good conditions of using geodata offensively in digital management. The reason is that a number of basic registers are in place and that large investments have been made in the digitising of map products. On the other hand, it is stated "that the existing co-operation structures in the field are too informal to achieve the most expedient utilisation and production of spatial data across authorities and that it has not been possible, to an adequate extent, to give priority to the different wishes and needs in the field".

The stakeholders in the field have now agreed that there is a need to strengthen and rethink the co-operation within the framework of a service community, which should replace the existing co-operation forums in the field. In the spring 2002 the Task Force therefore has established a binding "*Geodata Service Community"* which is going to replace existing co-operation forums and secure the drive in the spatial data/information field. (www.e.gov.dk)

[5] The Digital Task Force, which is financed by the Danish government, is brought into the world for a three-year period to be catalyst of the development of digital management (e-government) in Denmark.

The Spatial Information Market - building blocks for a Danish Infrastructure for Spatial Information

As mentioned earlier, the initiatives so far in Denmark are characterised by being concentrated on isolated fields and are therefore more or less uncoordinated.

Public and private digital maps (see figure 1, left/green side)
Digital mapping in Denmark started seriously in the 1970s in connection with the introduction of natural gas. Today digital maps are produced for use in the state, county and municipality for different purposes and with different degrees of detail (see footnote 4). Besides the public authorities utility owners, supply enterprises and enterprises within transportation and distribution are important users of digital maps. Apart from public map producers a number of private map companies exists:

- Digital large-scale vector maps (*technical maps*) covers Denmark in scales from 1:1000 (towns and built-up areas) to 1:10.000 (rural areas). As the maps are produced on demand from different users (municipalities, utility companies, etc.) and in different qualities (TK1, TK2 and TK3), the maps do not form a homogenous nationwide product even if they follow the *Specifications for Technical Maps.* Some of the maps are still "spaghetti" maps. An example can be seen at: www.Kortserver.dk . Some municipalities and utility companies also produce their own topographic maps derived from their own technical maps.
- The Danish *cadastral map is* a legal ownership map series that defines property boundaries, administrative boundaries, etc. Since 1997 the map series has been digital based on *Specifications on Digital Cadastral Maps*. The maps are updated daily. The *Web Cadastre* is an information system at the Internet that contains updated cadastral information. Using the system requires subscription. (www.kms.dk)
- In December 2000 the National Survey & Cadastre finished a nationwide vector- based map database (*TOP10DK*) in scale 1:10,000 (based on the *TOP10DK Specifications*). The TOP10DK is expected to become very important in connection with an integrated use of spatial data. TOP10DK includes a Digital Elevation Model (DEM). Other *topographic products* in smaller scales (raster-based) are also available. (www.kms.dk). The technical maps, as well as the cadastral maps, are designed on the basis of the Danish Reference System 34/45. Smaller scale maps as for example the topographic maps are produced using the UTM coordinate system. The cadastral map as well as TOP10DK has full topology ("pizza" maps) and the maps have different linking facilities, for example to the property-related data collections.
- In recent years *colour ortho-images (digital orthophotos)* covering the entire country have found increasing use by Danish users of geoinformation as base maps for presentation of different thematic data sets. The ortho-images with solutions of 40 cm (in town areas down to 10 cm) are produced and sold by several private photogrammetric companies. *DEM's* used in the production are also available. Example can be seen on www.kortal.dk . The same companies also offer laser scannings of selected areas for production of Digital Surface Models (*DSM*) and Digital Terrain Models (*DTM*). Examples can be seen on: www.kampsax.dk (geographical information).
- As examples of digital *thematic maps* the following can be mentioned: geological maps and soil classification maps (www.geus.dk), road networks (www.trafikken.dk/trafikken), field block maps (agricultural maps) (http://gis.vibamt.dk/arealinfo/AI_Map.asp) , and maps of administrative divisions.
- Also available are several nation-wide map series on the Internet. First of all there are several road and street maps and road-search machines produced by private companies (e.g. www.krak.dk and www.degulesider.dk). Also many counties and municipalities have published thematic web-maps and regulation plans. Examples can be seen at: www.detaktiveaalborgkort.dk/website and www.gis.nja.dk .

We can conclude that within Denmark there are reasonably well functioning digital map series and specifications for the production of these maps with possibility of description of quality and quality checks. But we must also conclude that so far no co-ordination has taken place between the different stakeholders in the map market. As mentioned earlier actions are, however, on their way.

Danish digital maps are expensive. It has been discussed intensely whether publicly produced map data should be ransomed or reduced in price, but so far no decision has been taken in the field.

Public digital registers (databases) (see figure 1, right/red side)
Since the late 60s Denmark has established a wide range of digital public registers, many of them with contents of textual spatial information. The responsibility for the spatial information registers is distributed among different public authorities at the state level as well as at the county and municipal level. The registers can be linked by common identifiers, which are maintained in the *Cross-Reference Register* (see later).

The registers can be distinguished between legal property registers (the Cadastral Register and the Land Registry), administrative property registers (the Building and Housing Register, the Communal Property Data System and the Planning Register) and other registers (the Central Population Register, the Sales and Valuation Register, the Land Information System etc. Already in 1990 the register responsible established a Joint Distribution Service that offered extracts of various kind. However, the service did not succeed in attracting customers on a large scale.

- The *Cadastral Register* (digital from 1986) is a central registration of all property in the country in relation to the law providing for the parcelling out of estates, the law governing agricultural matters and the Forestry Act. It also forms the basis of the *Land Registry* (Tingbogen) (digital from 2000) and of the Communal Property Data System (see later).
- The *Building and Housing Register* (BBR) is a nationwide register of all buildings and residences. The register, which was finished in 1977, is updated daily in the municipalities in connection with building casework, etc.
- The *Communal Property Data System* (ESR) is a nationwide municipal register over real estates. The register contains all information about the estate important for its valuation.
- The *Planning Register* is a nationwide register for municipal plans, local plans, town plan regulations as well as urban renewal plans and land value areas. Planning data are registered and used by both municipalities and counties as well as by state authorities. In the legislation there are in some cases clear regulations for the planning data to be collected.
- As a fundamental component for activities in the public sector (such as planning, budgeting, provision of social services etc.) and for private enterprises a *Central Population Register* system (CPR register) was established in 1968. The identification in it is the person number - the CPR number. The register numbers all persons residing in Denmark and includes the address of each individual person. The CPR *Road Register* contains a complete list of all Danish roads with house number intervals and divisions into administrative districts.
- The tax authorities use the *Sales and Valuation Register* (SVUR) for calculation and collection of taxes.
- The *Central Enterprise Register* (CVR) is a central administrative register of all private and public legal entities (enterprises). The register also includes large construction sites.
- All Danish farmers (and their live stocks) are registered in the *General Agricultural Register* (GLR) and in the *Central Domestic Animal Register* (CHR) by either a SE (enterprise) number or the user's CPR number. The register contains information about the farm. The earlier mentioned ”field block maps” are linked to the GLR/CHR register.
- The Land (*Area) Information System* (AIS), produced by the National Environmental Research Institute (www.dmu.dk) and completed in 2000, is the first attempt to collect and integrate geoinformation from different regional and national authorities within the nature and environment field in Denmark. The system contains information about the countryside such as habitat types, land use, hydrology, natural resources, polluted areas, etc. A central element in AIS is the nationwide *Land (Area) Information Map* (AIS-map) describing the land use in urban and rural areas.
- As examples of other registers can be mentioned the Central Forest Register, the Building Preservation Register, the History of Civilisation Register, State and Local Registers of Statistics, the National Health Register and the Information System of the Road Sector (VIS).

It is characteristic of the mentioned registers that they are not planned for providing data for other purposes than those which were laid down at the establishment of the register. In that sense the registers only offer limited possibility of flexible data use and therefore only slightly support a development towards e-government. In contrast to the digital maps it must be concluded that at present there are only well functioning specifications for the BBR, CPR, CLR/CHR and CVR registers.

Today most register data are paid for, however, efforts are made to find a solution of payment, which shall be cost-neutral at least for the public sector.

Keys and geo-references *(see figure 1, left/green and right/red)*
A condition for combination of data from different data collections is that common keys exist in the registers. To ensure this an independent key register - the *Cross-Reference Register* (KRR) - has been established. The register exclusively contains common keys as well as the relations between these keys (e.g. parcel no., property identification and geo-referenced addresses).

Fundamental to the registers was the standardization of addresses in connection with the establishment of the Central Population Register (CPR). Later it has been 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 mapping company and is based on interpolated address co-ordinates. (www.kampsax.dk)
- Contrary to this the *"Address-project"* is produced in co-operation between municipal authorities and the National Survey & Cadastre (KMS). All municipalities have today registered one set of co-ordinates for every single of the about 2,1 million front door addresses of the country.
- The National Survey & Cadastre also offers an address theme *"FLAT"* based on the digital cadastral map. (www.kms.dk)

Having completed a national coverage with geo-referenced and standardized front door addresses, development efforts are now being directed to the establishment of *geo-referenced building ID's* (one address can include more buildings).

Data models, etc. (see figure 1, bottom/blue)
Until today data have been in focus, but an important condition of utilising spatial data across public institutions and sectors (and the whole geo-data business) is that the different data can "interact", as otherwise full benefit cannot be derived from the possibilities offered by technology. In this context modelling has been recognised as an essential instrument. The Danish spatial data are traditionally organized as maps and registers (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.

The conversion of the property-related data collections and an increasing interest in an integrated utilisation of these data have resulted in a logical data model for the property data field developed under the auspices of the National Survey & Cadastre (*Logical data model for property data).* The data model has contributed to the basic structure of the Public Information Server (se later). Other initiatives are:

- The *County Data Model* for exchange of data within the planning, nature and environment area on county level have recently been presented.
- *PlanDK* is a new data model for planning data. The model only describes data related to physical planning. Elements from the County Data Model and the Planning Register have been reused in the PlanDK. (http://www.mem.dk/lpa/landsplan/gis/Datamodel)
- *FOT* (Common Object Types) is an attempt to point out and describe common object types in technical and topographic mapping. FOT is a co-operation between the National Survey & Cadastre, county and municipal authorities, utility owners and private geodata producing companies. (www.kms.dk)
- Other data model jobs within common object types are on their way. One is on common object types in the Area Information System (AIS) and the County Data Model.

All public authorities have been encouraged to draw up logical data models for those administrative functions for which they are responsible.

Public services

In accordance to the government's general IT policy the former Ministry of Housing and Urban Affairs (now the Ministry of Economic and Business Affairs) launched in August 2001 a web-based *Public Information Server* (Offentlige InformationsServer - OIS) (see figure 1, right/red and figure

2). The server replaces the earlier mentioned Joint Distribution Server. In its first version the OIS only delivers attribute data from some of the public property registers mentioned earlier. Access to the data is based on open standards like HTTP and XML.

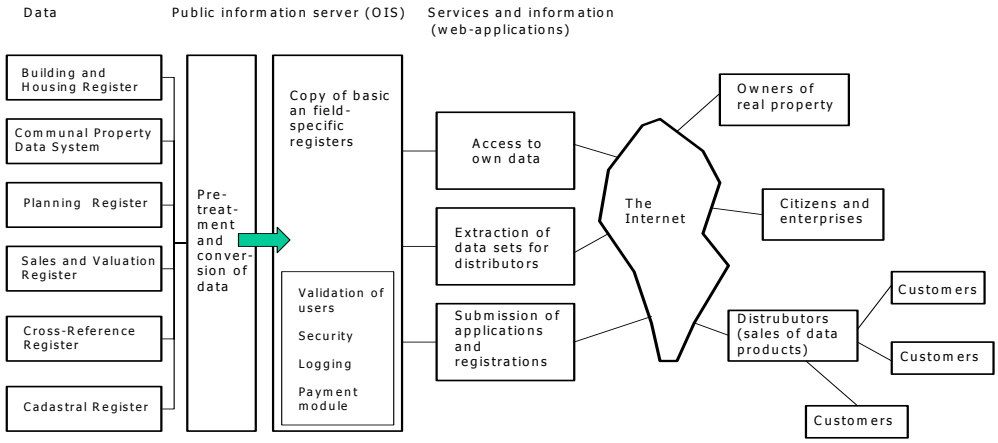


***Figure 2**. The Public Information Server (OIS) concept* (www.ois.dk) */Brande-Lavridsen et al. 2000/*

The OIS targets three kinds of users:

- Owner of a property, who can access data on his/her property in its full extent and free of charge. A personal PIN-code guarantees the owners privacy;
- Ordinary citizens, who can access a limited selection of data on any property – also free of charge;
- Distributors/resellers/value-adding enterprises that will typically make an initial download of a full copy of a register and subsequently maintain the copy with delta-files on a daily/weekly/monthly basis. The enterprise only pays for the cost of transfer whereas the end- user pays a fee to the owner of the register and an additional fee to the reseller. /Daugbjerg 2002/

Shortly after (November 2001) the National Survey & Cadastre (KMS) presented another web-based service, *The Map Service* (Kortforsyningen) (see figure 1, left/green and figure 3) that gives access to the topographic database TOP10DK and the cadastral maps (vector-based), a number of small-scale topographic maps (raster-based) and the FLAT-addresses. The service is based on the OGC Web Map Service standard (www.kms.dk). From May 2002 the service has been open for the private consumers marked.

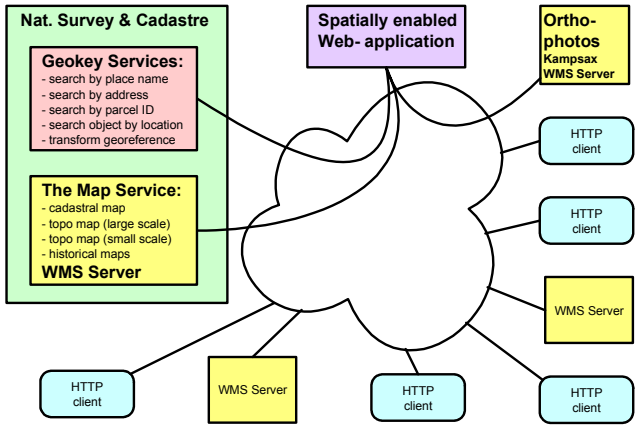


***Figure 3.** The Map Service concept (www.kms.dk) /Daugbjerg 2002/*

In May 2002 a common portal to municipal maps (large scale maps) (www.kortserver.dk) was established. From the launch approximately 30 out of 256 municipalities are registered to the service

but the ambition is that all municipalities join in time. Also this service is based on OGC and GML standards. Several private geodata companies also offer web-based services for professional users as well as citizens (e.g. www.kortal.dk).

The objective of the services is to give potential users – primarily private enterprises and public authorities - the possibility of getting data from as well public data collections as private via the Internet and to provide a market place for spatial data, specifically by offering resellers or value-adding distributors direct access to the servers. In the future we will have the technology to access vast storehouses of geodata at the click of the mouse without knowing where these data come from. Hopefully the users will be able to evaluate the reliability of the data sets.

One of the barriers to a better utilisation of spatial data information often mentioned is lack of documentation and metadata. If other Danish initiatives shall be emphasised, one must be *Geodata-info.dk* the Danish meta- database available on the Internet. The meta-database is a catalogue describing the digital maps and other collections of geo-related data (among others the earlier mentioned public registers) in Denmark. (www.geoinfo.dk). The meta-database gives a short overview of each data set, the data set owners or producers and where to get further information about the data set. In its first version the database has been implemented according to the CEN standard and will eventually be developed further to comply with the ISO TC211 standard.

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. The demand for spatial data, which is updated at short notice, is therefore expected to increase. The technological development is in favour of this trend, with the fast growing integration of GPS technology into industry products.

Final remarks and perspectives

From local

The initiatives described confirm that Denmark already has many well functioning building blocks for an Infrastructure for Spatial Information. The production of the many (sometimes duplicate) datasets has been a costly affair and lots of money could have been saved if Denmark earlier on had established a formal policy on the geodata front – a NSDI/NSII. On the contrary, the free market and competition have consequently caused that Denmark is remarkably well assorted with digital spatial data/information.

To global

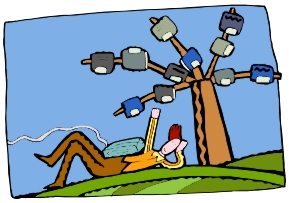
There is no doubt that in future there will be a growing demand for spatial information to advance a sustainable development – not only at a local but also at regional and global levels. Basic public databases containing spatial core data, which are stable, updated, standardised and interoperable should therefore be part of the infrastructure of every country in the world. The spatial information databases are the basis for rationality, efficiency and growth in the country as well as for social security and quality of life.

A good advise to countries that not yet have established large nationwide data sets would be to work out strategies and organize structures that supports a rational and broad use (including reuse) of spatial data/information for private business as well as the various levels in the public administration, at an early as possible stage. A desirable stategy ought to be incorporated into both current and future legislation regarding areas where spatial data/spatial information is used, in such a way that all processes are described by the legal authorities. Similarly, models of financing (both for establishment and maintenance) should be worked out at an early stage.

In the near future spatial data and spatial information will no longer be isolated. Spatial information will together with other types of data sets be integrated in large information and knowledge systems. This means that we have to shift focus from just creating spatial databases, facilitating access to spatial information, etc. to the development of integrated decision support tools enabling the use of all kinds of data. Data management as geo-visualisation, data-modelling and analysing activities will then come in focus. This is the real challenge of e-government /Ryttersgaard 2001/.

Already the increasing use of spatial information/spatial data has caused a strong need of people who can manage both technical and organisational aspects of manipulating data and turning data into understandable information (knowledge). The e-government and e-commerce within Spatial Information Management (SIM) will again require people with new qualifications on all professional levels. Here new technologies offer new possibilities for training and education in the form of distance learning.

The Internet as an information network for spatial data/spatial information is already in use all over the world. New challenges will be mobile services provided through hand-held devices offering "on the fly" information and Location Based Services. With this we could say that we are leaving the network society and entering the mobile society.



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