ISO Workshop on address standards: Considering the issues related to an international address standard
25 May 2008, Copenhagen, Denmark, ISBN 978-1-86854-689-3

Addresses as an infrastructure component - Danish experiences and perspectives

Morten Lind

National Survey and Cadastre Denmark, mol@kms.dk

Abstract

Based on experiences from the development of the address system in Denmark, the paper discusses the benefits and disadvantages form different approaches to address management and to the conceptual modeling of address data. Also the definition of addresses is discussed.

It is described how the Danish address system and the custodianship of base address data was enforced by law, and how consensus building between the stakeholders has created a situation where public maintained address data – including address points – since 2002 has been freely available for both public and private sector, to the benefit of both citizens, government and business.

The paper discusses the concept of reference data in the context of the European INSPIRE directive on spatial data infrastructure as well as the characteristics of addresses as being reference data.

The level of Danish data standardization for addresses is presented, and – and as a conclusion –a number of lessons learned is listed.

1. Introduction

1.1 Addresses and address data in an infrastructure

An address system is democratic: it is public domain, it is useful even for those without access to technical devices, and it is known and recognized in all age groups, within all professions, in all branches of public management and across all national boundaries.

In countries and cities where an address system exists, addresses constitute one of the most essential tools for locating phenomena, events or information which are important for citizens, business and public administration.

A well-formed, address system contributes to the physical infrastructure of a modern society as an important, extra asset to the transport and utility-line network. The address systems' street names and address numbers enables individuals, postal and transport services, emergency services, police, utility companies and government agencies etc. to navigate efficiently and find their bearings without coordinates.

Availability of reliable address data can - likewise - contribute to the information infrastructure, as a common asset or component in it-applications, public legacy registers or modern portable devices, location based services etc. where the address data pinpoints and labels locations where people live, work, shop, entertain and educate themselves.

1.2 The development of the Danish address system

The address system was introduced in Denmark in 1850-1900, first in Copenhagen and later in other major cities, with a systematic numbering of buildings and properties along every road, and odd and even numbers in each side. In September 1967 the national post service, "Post Denmark" introduced a four digit post code system.

In the 1970s, the address system was extended to cover the whole country, so also in minor cities,

villages and summer cottage areas as well as in the rural areas, road names and address numbers was introduced – replacing older building or farm names as the primary address identifier (Lind, 2004). The domain of an address number was limited to numbers 1-999 plus a possible uppercase character A-Z.

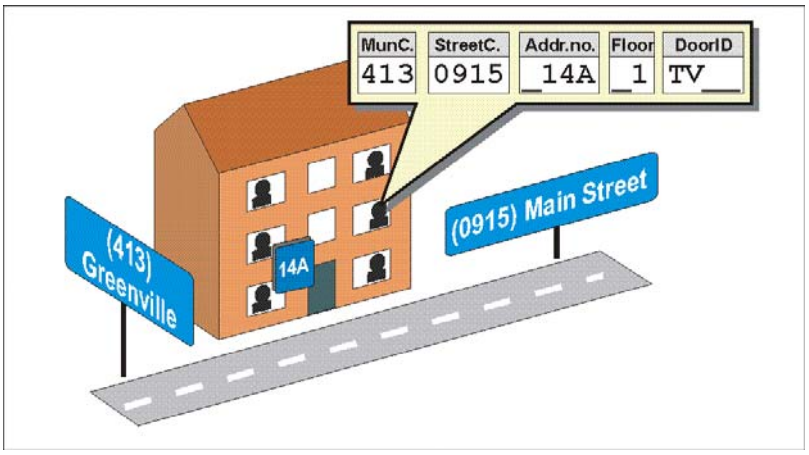
Around 1980 the process had resulted in that all roads and streets had been assigned a name by the local municipality and that all developed properties had been assigned at least one address number.

With the exception of specialized postal delivery points like 'poste restante', post box addresses and special postcodes given to large companies, it is the public addresses assigned by the municipalities which are used also for postal purposes.

1.3 Common Danish address data format

As a part of the concept, within each municipality a road name was also identified by a unambiguous four digit road code. Thus, a combination of municipality code, road code and address number formed a unique, code-based identifier of all approximately 2 million "entrance door level" addresses in Denmark.

Figure 1: Original Danish address format

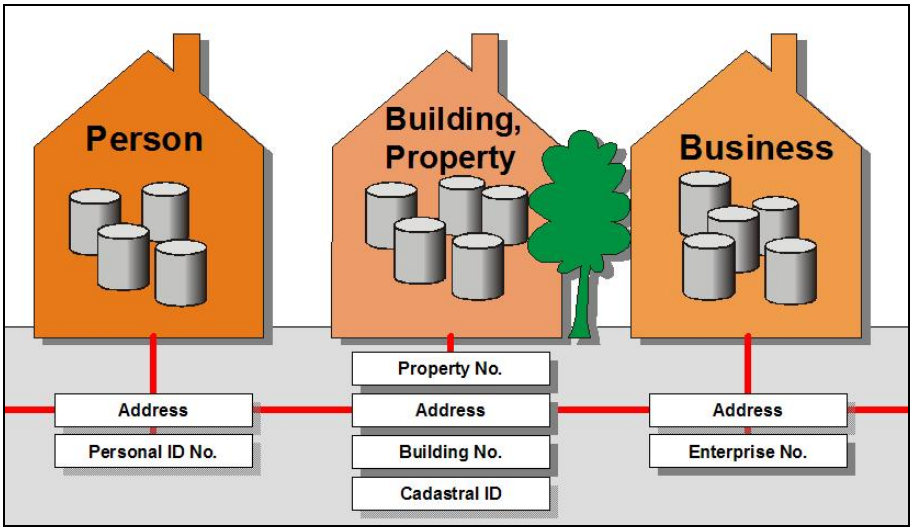


To identify the individual dwellings within a multi family building, a common concept for floor- and door identifiers was approved and accepted both in the public registries and for postal addressing purposes, forming also a common standard data format for unambiguous "unit level" addresses for dwellings and business premises (figure 1).

1.4 First benefits

This common address data concept and format formed in the 1980'ies the basis of the coordination and data interchange between the population registration, the building and dwelling registration and the property assessment registration in three public base registers (CPR, BBR and ESR). In 1990'ies also the business entity registration (CVR) also adopted the common address format (figure 2).

Figure 2: Linking Danish base registers by use of address identifiers



There were major benefits of this coordination of base registers and joint use of the address system: Censuses could be carried out by the Statistics Denmark several times a year, based only on register data from the CPR and BBR. Property taxation could be based on data interchange between BBR and ESR. Social security services could combine personal information from the CPR with information on the housing conditions and property information from BBR and ESR, and so on.

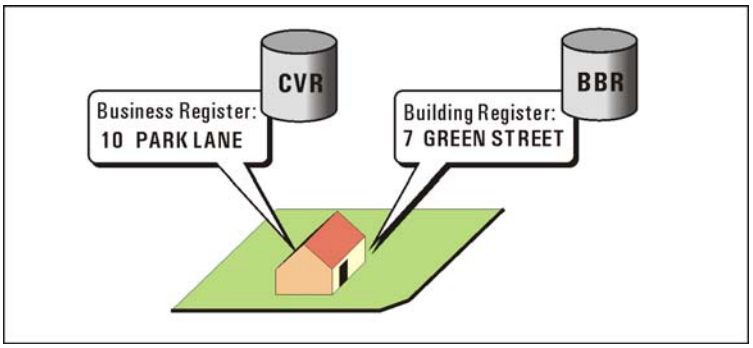
2. Change of view: New conceptual model

2.1 The inconsistency challenge

As described above, since 1990'ies Denmark ought to have obtained the best possible starting point for releasing the potential benefits of having a good address system and a common accepted address data format.

Experience showed, however, that the existence of a common data format gives no guarantee of a sufficient consistency between the data contained in the various registers (Figure 3).

Figure 3: Inconsistency between business and building register information



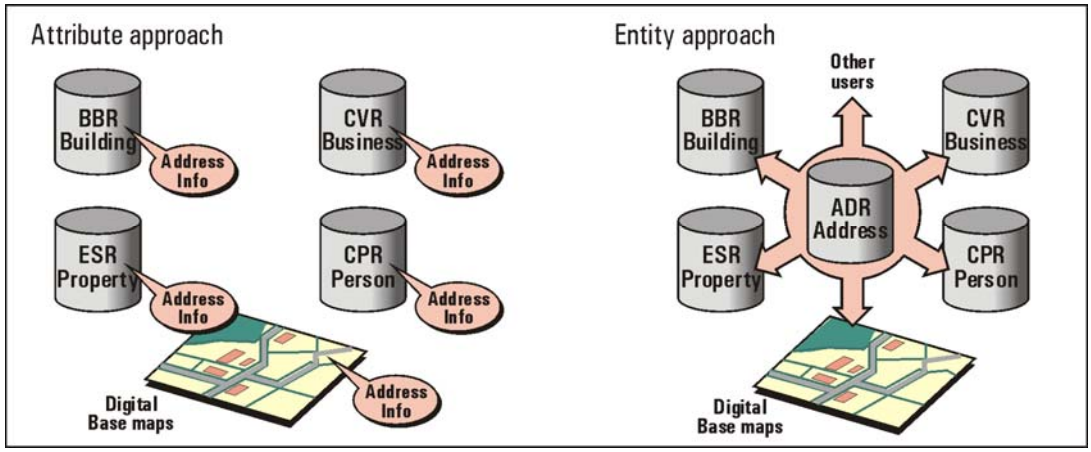
As an example, practical tests have exposed the fact that address information in the Central Business entity Register (CVR)), which is based on reports from the businesses themselves, does not correspond very well with the addresses found in the building register (BBR) which is maintained by the municipalities.

2.2 Address: attribute type or object type?

The problem can be elucidated by viewing it as a data model problem on a conceptual level (figure 4):

- Should the address be regarded as an attribute type, that is, as a *property* of the physical entity in question: the person, the property, the building, the dwelling, the business etc. or
- Should the address be perceived as an object type in itself which is *associated* to the physical entities person, property, building, dwelling, business etc.?

Figure 4: Modeling the address as an attribute or as individual object type



Both in the private and in the public sector, the predominant tendency is to favor the first concept: With very few exceptions, address information is implemented and updated in the database as simple attributes on a par with other "soft" characteristics of the entity in question.

The drawback to this approach is that it enables, and in fact also encourages, each it-system, sector or authority to build up its "own" independent address registration, which has no in-build connection with those of other systems or sectors. The result is that inconsistencies arise and that situations occur where a property, a building, a businesses etc. that in fact has reference to the same address, is registered with different addresses in different systems.

More important is perhaps, that the attribute approach promotes a situation where each administrative system creates its own frame of understanding for the addresses, so that also different address definitions and conceptual schemas arise. The result is that each sector attempts to define, to justify and sometimes also promote its own "type" of addresses as something special: dwelling addresses, property addresses, utility addresses, and business addresses etc. The negative result is that the cross sector and multipurpose aspects of the address system is undermined.

2.3 Address decided as independent object type

In connection with the start of the modernization of the Danish building and dwelling register (BBR) in 1995, this problem was recognized and it was decided as the obvious solution to define the address as *an independent object type*.

The benefit of this approach is that it strengthens the idea of the address system as being a common asset in society's infrastructure – and as a mechanism which do *not* serve only one narrow purpose:

- The address object instances will exist in itself, and will thus no longer have status as an appendix to e.g. an instance of a building, plot of land or business.
- As a result, any address may be offered as a reference in any application that need to relate its information to a specific address location,

- New addresses can be created and registered whenever appropriate, for example in a planning phase, before the land division is carried our and before the building is erected
- For all address object instances the relevant characteristics and attributes could be registered (e.g. author, date of origin, quality, spatial reference etc.), and thereby available for re-use in all it-systems and services.
- Last but not least the concept is based on the principle that there is not "addresses at random", instead at any time there exists a finite set of reference addresses, which must be maintained by an appointed custodian (e.g. the municipality).

As seen from a practical, government point of view a number of additional advantages could be identified:

- A simple, definitive reference address data base would be appointed
- A single authority could be appointed responsible for the address system and its data
- Rules for the funding, pricing, conditions for use etc. of the can be determined once
- It will be easier to ensure the data quality and the compliance with common standards
- Users will only have to turn to one place to get data, updates – and to report errors etc.
- Management costs would be lower, as data are only updated in one place.

2.4 Address definition

In the preparations of the modernized BBR, it was decided approve a formal definition like this: *"An address is an independent, administrative object that identifies a specific way of access to a property, building, technical facility or the like, in relation to the road network."*

There are several key words in this definition:

- *Administrative object* indicates that it is a public authority which as a result a of conscious administrative decision and according to certain rules, assigns the address
- *Identify* which indicates that the function of the address is to provide an identification that references something definite, like a name of a lake references to the lake itself; in other words, the address system is a system of names.
- *Specific access* which means that the object identified by an address is the access to a property, a building and the like, not the property, building etc. itself. This also clarifies that buildings with several entrances may have more than one address attached, and that buildings or plots of land with access from two streets may have addresses facing each of these.

Compared with address definitions in other national address standards (Coetzee, 2008) many similarities is found, but also some differences. Perhaps the most characteristic difference is the Danish focus on the "way of access".

3. Enforcement of the address system

3.1 Address authority and new legislation

In late 1990'ties consensus was build that the regulation of assignment of addresses and address registration should be managed by law, and under one single ministry. The following two principles were agreed on:

- Legal regulation of the address system should be in the Act on Building and Dwelling Registration (the BBR-act) under the Ministry of Economic and Business Affairs.
- The municipalities should be appointed in the law directly as address authorities, thus giving the responsibility and power to assign all street names and addresses, to register and maintain address data etc., to the municipal council.

In 2001 this goal was achieved with the revision of the BBR-act, where the chapters 3a to 3g hold the legal framework for addressing. The detailed regulation was in 2002 put down in the Address Circular, which in 2007 was replaced by the more comprehensive Statutory Order on Road Names and Addresses (DECA, 2007).

3.2 Purpose of addressing

In section 1 of the circular and statutory order, the purpose of addressing and registering address data was for the first time formally defined:

"(2) Road names and addresses are assigned with regard to helping citizens, authorities, utilities, emergency response services and others to orient themselves and to locate the road, property, building, main entrance, dwelling or business entity etc. in question in the easiest possible way. (…)

(3) The registration of the designated road names and addresses has as its purpose to ensure that correct information on the subject may be available in a uniform way to citizens, the business community and the public administration."

Note that address system is first and foremost defined as a spatial reference system for use in the real world; and that the perspective on the purpose of addressing is not primarily defined from the government base register point of view. Also note that the purpose of registration of address data is to make the data available to all users in a uniform way – as common reference data.

The chapters in the statutory order defines all components (object classes) in the Danish address system and sets up the rules for assigning and chancing address identifiers, e.g. detailed rules for unambiguousness of road names (within the postcode and within a 10 km distance).

Also the domain of the individual identifiers (e.g. length of road names, format address numbers etc.) is defined, thus laying out the basic rules for a more detailed, technical data standardization of addresses.

3.3 Developing a base address register

Based on a common understanding of the value of a well-formed address system the government and the municipalities in Denmark have since 1996 co-operated on a harmonization and quality control of the addresses in the public registers and maps. The purpose was to collect the official set of "reference" addresses, which should compose the address file in the base address register, according to the conceptual approach described above. The two elements of the work was:

- To entitle the Building and Dwelling Register (BBR) as the public address register, that must contain the reference set of addresses (e.g. like a master address file).
- To establish direct geo-references in the register, based on a set of geographic co-ordinates that pinpoints exactly the "doorstep location" of each address.

As a result of the so-called "Address-project" in 1995-2001, all municipalities, on a volunteer basis, updated the BBR with the requested precise co-ordinates. As a result the BBR now has 2.3 million individual addresses, each located by co-ordinates, with a positional accuracy better than +/-5 meters for 98%.

The modernized BBR-system, which as a core component also will have the base address register, is presently under development.

3.4 Data standardization and XML schemas

In March 2003 the Danish Ministry of Science, Technology and Innovation opened a public data repository, the so-called "Infostrukturdatabase" or ISB (http://isb.oio.dk), with XML schema encodings of a large number of commonly used data "components" e.g. like the Danish personal identification number.

The ISB included right from the start a number of identified "core components", among these were all the relevant components of a complete Danish address e.g. post code, postal district, road name, road

code, address number, floor identifier etc.

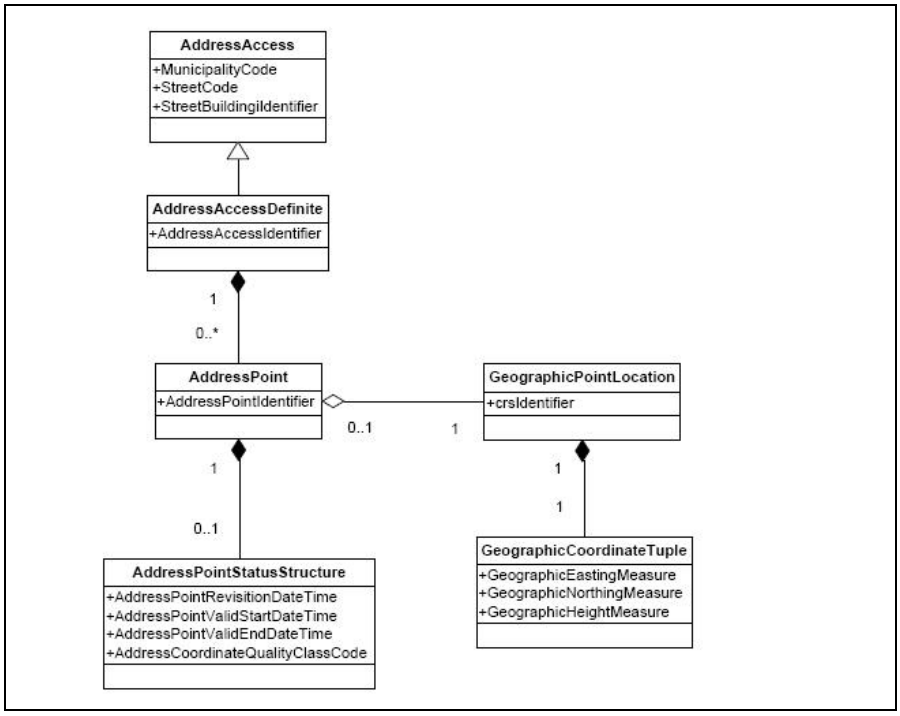
The XML-schemas and the corresponding metadata in ISB ensure that in one single location there is an open, uniform and standardized description of:

- which authorities that have responsibility for the definition of each data component in the address system
- the official name and XML tag name assigned to each individual component and a short, descriptive text of the function and semantics of the element
- the data format and domain assigned to each individual component (for schema validation purposes)
- how the core data components should be combined in a complex schema as a complete address types.

In a special document, "the address guideline" (NITA, 2006), the elements and concept of Danish address data is explained. In an additional guideline, "Address Point" (NITA, 2007) the spatial attributes of Danish Addresses are explained and XML encoded (Figure 5).

The purpose of the ISB and the guidelines document is to deliver a basic guideline for the correct encoding and exchange of address data. They do not cover other aspects of the address system or data e.g. metadata, data quality etc, and can not be regarded as a comprehensive address standard or as an implementation ISO standards, especially ISO 199112 – Geographic identifiers.

Figure 5: Danish address point guideline (logical UML model)



4. Availability and utilization

4.1 User requirements

Even before the municipality address project was finalized, there was great attention from major, nationwide users to utilize the data. Within the public sector especially the county administrations, the

Department of Environment, the Department of Agriculture and Food, the Department of Health, Statistics Denmark and, perhaps more important, the Police and emergency services argued that wide access to the geo-referenced address data would pay back substantial benefit (Lind, 2003).

Within the private sector, the requirements and interest was even larger. Though a number of private companies for several years had used more inaccurate, private address data products, the demand for precision data with high reliability on update was significant - especially if it could be obtained at conditions that allowed further development and value adding.

4.2 Agreement on 0-pricing of data

As a result of several years' preparations and considerations within the Danish e-government Taskforce, the Danish Department of Finance and the organization of municipalities in 2002 made an agreement with the title "Better accessibility to public data".

An important element in the agreement was that the address data in the BBR, including the precise co-ordinates, from January 1st 2003 was made available for both public and private sector users, only at the minimal cost of delivery. It was especially stated, that all parties were free to develop applications and value added products and services for further distribution at will, without paying fee for the original reference data.

While other property register data was made available on the same conditions, the agreement did however not cover map data from the National Survey and Cadastre e.g. the cadastre map or the topographic base maps.

4.3 Principles of the agreement

The data-pricing agreement was based on three ideal principles:

- Mutual benefit for all parties: All parties, including the private sector should be able to recognize concrete benefits from the agreement.
- Minimal impact on government and municipal budget: The municipal loss of potential income from data-sales and extra workload in the mandatory updating of data, was compensated economically by approximately 1,5 mill. EUR in four years.
- High impact in private sector benefits and in private-public interoperability: The availability of low-cost but high quality reference address data, was supposed to kick-start the development of location based services as well as a broad number of address based e-government applications.

In 2005 the Danish Spatial Data Service Community carried out an draft survey on the impact and experiences with the public data agreement.

The survey showed that all parties were satisfied with the agreement, and that the public address data, due to the dramatically reduced costs, already was in use in several important applications e.g. in the 112-emergency centers, in the internet based travel planner developed by the public transport companies and in private sector applications e.g. car navigations systems.

5. Addresses in a spatial data infrastructure

5.1 Addresses as spatial reference data

In the preparatory work of the European program for a spatial data infrastructure, INSPIRE (INfrastructure for SPatial InformationN in Europe), the concept of "reference data" has been defined as a category of datasets, that plays a special role in the infrastructure.

According to the INSPIRE definition (EUROSTAT, 2002), spatial reference data must fulfill the following three functional requirements:

- Provide an unambiguous location for a user's information;
- Enable the merging of data from various sources; and

– Provide a context to allow others to better understand the information that is being presented.

It is obvious that addresses fulfill all three requirements: in numerous legacy and modern IT systems, address information is recorded with the purpose of having an unambiguous identification of the real property, customer, citizen, business or utility entity in question. Secondly, addresses are used as one of the most important mechanisms to merge or link information from different sources together, e.g. when a bank uses the customer's address to look up information on real property or insurance.

Last but not least, addresses are used every day by citizens, businesses and government as a human understandable description of the location of a specific piece of information; for example, the address label on letters or goods for delivery is meant to give every actor in the delivery process a clear understanding of the desired final destination.

5.2 A generic definition of reference data

It is easy to extend the INSPIRE definition of spatial reference data so that it could be used in the scope of public data in general. As an example the following definition could be used:

Reference data must fulfill the following three functional requirements:

– Provide a unambiguous identification, categorization or indexing of the user's information;

– Enable the merging or comparison of data from various sources; and

– Provide a context to allow others to better understand the information that is being presented.

Using this definition it is easy to identify examples of reference data that is not necessarily spatial. As an example annual statistics on population in municipalities or regions of January 1st is reference data, because the number of inhabitants is used as a common index for comparison of different municipalities (e.g. education, unemployment, crime etc.). Likewise the list of official branch codes is reference data used for categorization of enterprises and businesses.

If several alternative statistics existed, a reliable comparison of education, unemployment or crime in municipalities would be impossible. If various systems of branch codes is used in different business registers, comparison is not possible.

It is how ever also obvious, that addresses, as well as other spatial reference data (e.g. like cadastral identifiers, administrative units and geographic names) also fulfills the requirements of general reference data.

The INSPIRE concept of reference data gives a new perspective and understanding of precisely which role addresses play in the infrastructure of a modern country, why addresses should be managed as careful as we manage property identifiers or key figures in statistics, and why alternative and not-corresponding address files creates uncertainty, inefficiency and errors.

5.3 INSPIRE principles

As a result of the INSPIRE considerations on reference data, addresses have been included explicitly in the final directives "Annex 1", which contains the priority spatial reference datasets (European Parliament, 2007).

It is interesting, that the Danish initiatives to enforce and improve the address system is in very good accordance with the purposes of the INSPIRE directive. This is perhaps best illustrated by quoting the so called "INSPIRE principles" (EUROSTAT, 2002):

– Data should be collected once and maintained at the level where this can be done most effectively

– It should be possible to combine seamlessly spatial data from different sources and share it between many users and applications

– Spatial data should be collected at one level of government and shared between all levels

– Spatial data needed for good governance should be available on conditions that are not restricting its extensive use

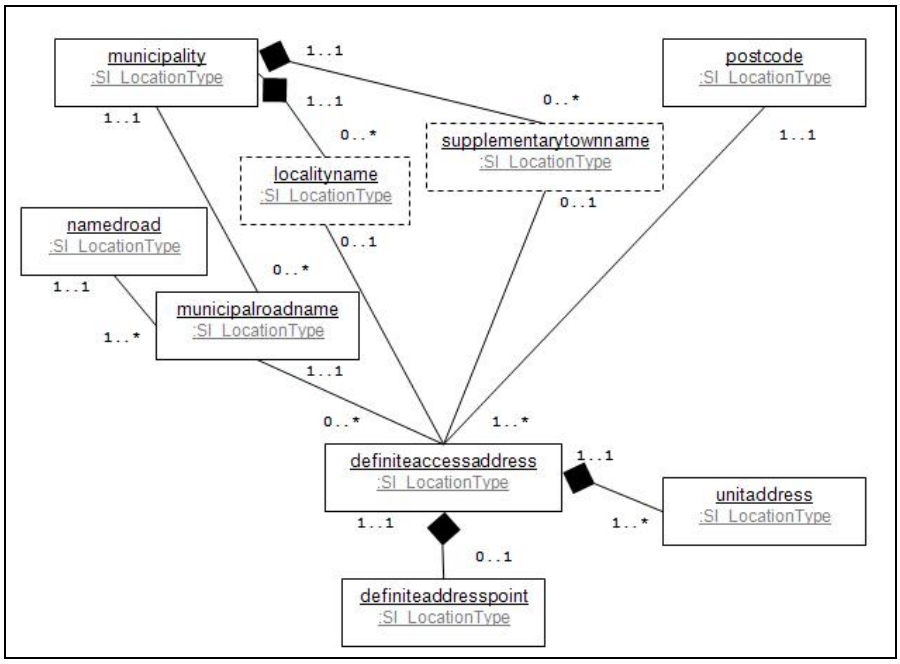
5.4 INSPIRE implementing rules for addresses

The INSPIRE directive was set into force the 15th of May 2007. According to the directive a number of general implementing rules as well as data specifications for the spatial themes in the Annex 1 of the directive, must be finalized within two years form this date.

This means that the INSPIRE implementing rules and data specifications that should support the interoperability between address data sets from different countries and regions of Europe, must be finalized at latest 15th of May 2009.

Based on this data specification and the appurtenant terminology, feature catalogue, application schema etc., it is supposed, that a comprehensive Danish address standard will be developed (figure 6).

Figure 6: Components of a Danish address (preparations for INSPIRE data specification)



6. Conclusions

During the last 20 years of address management in Denmark, perhaps the most important lessons learnt has been the recognition of the address system as being a basic reference system in the country's infrastructure, and thus the recognition of address data as being "need to have" common reference data in our digital infrastructure.

Based on this knowledge we could identify a number of additional lessons:

- The authority of the address system should be clearly defined, if possible by law, and the custodianship of address data must be transparent and follow the INSPIRE principles; unclear responsibility results in duplication of work and lack of data integrity.
- Address data must reflect the real world addresses; if this is not the case, data could be useless or misleading.
- Address data should be updated and unambiguous in order to avoid errors, uncertainty and mistakes; otherwise will result in unnecessary costs and errors fatal for citizens life, health or property.
- Address data should be available for all users with as few barriers for use as possible; otherwise

the massive benefits of using addresses as common reference will not be obtained.

- Address data should be standardized and well formed in order to enable efficient data processing and in order to provide best possible competition between different application vendors; without a standard the use of address data will be uncertain, inefficient and costly.
- Generic regional or global standards should enable use of and access to address information seamless across borders and regardless of differences in e.g. national address schemas; Seamless access to address data will reduce development cost and provide better usability.

Disclaimer

This views expressed in this paper are those of the authors alone, and should not be attributed to the sponsoring and supporting agencies and organizations, nor to the authors' employers.

References

Coetzee S et al, *Towards an international address standard*, Proceedings for GSDI 10 February 2008, <http://www.gsdi.org/gsdi10/papers/TS21.2paper.pdf>

NITA, 2006, National IT and Telecom Agency, Denmark, *OIOXML Adresseguide (en: Documentation Guidelines for Addresses)*, Copenhagen, DK, viewed 12. may 2008,

< http://www.adresse-info.dk/Portals/2/Dok/Dokumentationsguide%20for%20adresse_2006-02-13.pdf>

NITA 2007, National IT and Telecom Agency, Denmark, *OIOXML Dokumentationsguide for adressepunkt (en: Documentation Guidelines for Address Point)*, Copenhagen, DK, viewed 12. may 2008,

<http://rep.oio.dk/bbr.dk/xml/schemas/2006/09/30/OIOXML%20dokumentationsguide%20for%20AdressePunkt.pdf >

DECA, Danish Agency for Enterprise and Construction, 2007. 'Statutory Order on Road Names and Addresses', Copenhagen, DK, viewed 12. may 2008,

< http://www.adresse-info.dk/Portals/2/Dok/DK_Statutory_order_on_road_names_and_addresses.pdf >

European Parliament, 2007, *Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)*, Bruxelles, BE, viewed 12. May 2008,

< http://inspire.jrc.it/directive/l_10820070425en00010014.pdf >

EUROSTAT, 2002, *INSPIRE Reference Data and Metadata Position Paper*, Bruxelles, BE, viewed 12. May 2008,

< http://www.ec-gis.org/inspire/reports/position_papers/inspire_rdm_pp_v4_3_en.pdf >

ISO 19112:2003 (2003). Geographic information – Spatial referencing by geographic identifiers, International Organization for Standardization (ISO), Geneva, Switzerland.

Lind, M, 2003. *Accurate Address Data for Free, Proceedings for EC-GIS 2003 Conference*, A Coruña, ES, 2003, viewed 12. May 2008,

< http://www.ec-gis.org/Workshops/9ec-gis/papers/esdi_lind.pdf >

Lind M., 2004. '*Reliable Address Data: Developing a Common Address Reference System'* in GINIE, *Compendium of European SDI Best Practice*, Brighton, UK, viewed 12. May 2008,

< http://www.ec-gis.org/ginie/doc/SDI_initiatives/GINIE_EBP_Section6.pdf >