TOWARDS INTRODUCING A GEOCODING INFORMATION SYSTEM FOR GREENLAND

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ABSTRACT:

Currently, addressing practices in Greenland do not support geocoding. Addressing points on a map by geographic coordinates is vital for emergency services such as police and ambulance for avoiding ambiguities in finding incident locations (Government of Greenland, 2010) Therefore, it is necessary to investigate the current addressing practices in Greenland. Asiaq (Asiaq, 2011) is a public enterprise of the Government of Greenland which holds three separate databases regards addressing and place references:

- list of locality names (towns, villages, farms),

- technical base maps (including road center lines not connected with names, and buildings),

- the NIN registry (The Land Use Register of Greenland - holds information on the land allotments and buildings in Greenland).

The main problem is that these data sets are not interconnected, thus making it impossible to address a point in a map with geographic coordinates in a standardized way. The possible solutions suffer from the fact that Greenland has a scattered habitation pattern and the generalization of the address assignment schema is a difficult task. A schema would be developed according to the characteristics of the settlement pattern, e.g. cities, remote locations and place names. The aim is to propose an ontology for a common postal address system for Greenland. The main part of the research is dedicated to the current system and user requirement engineering. This allowed us to design a conceptual database model which corresponds to the user requirements, and implement a small scale prototype. Furthermore, our research includes resemblance findings in Danish and Greenland's addressing practices, data dictionary for establishing Greenland addressing system's logical model and enhanced entity relationship diagram.
This initial prototype of the Greenland addressing system could be used to evaluate and build the full architecture of the addressing information system for Greenland. Using software engineering methods the implementation can be done according to the developed data model and initial database prototype. Development of the Greenland addressing system using a modern GIS and database technology would ease the work and improve the quality of public services such as: postal delivery, emergency response, customer/business relationship management, administration of land, utility planning and maintenance and public statistical data analysis.

1 INTRODUCTION

Addresses are the most commonly used way of referencing a location in the world. Countries have various addressing schemas and their differences are mostly evolved due to historical, cultural reasons e.g. in Europe most of addressing schemas are similar and reference a road network, while addressing system in Asia, e.g., Japan comprise hierarchy of administrative areas without referencing road names (Coetzee, S., June 2011). To name a few purposes for addressing systems, they are for postal delivery, emergency service response, land administration, utility planning and maintenance and public statistical surveying.
Addresses can be utilized in different scale depending on purposes. A geographical overview of addresses can be used in land administration. In customer analysis street names could be irrelevant where specifying place name would reveal sufficient information (Coetzee, S., June 2011). For mail delivery and emergency service handling a precise reference point is needed, specifically identifying an individual recipient point or place of incident. To communicate the address unambiguously there are specific rules to follow and formatting rules to obey for rendition and recognition of the address label. The ratio of delivered
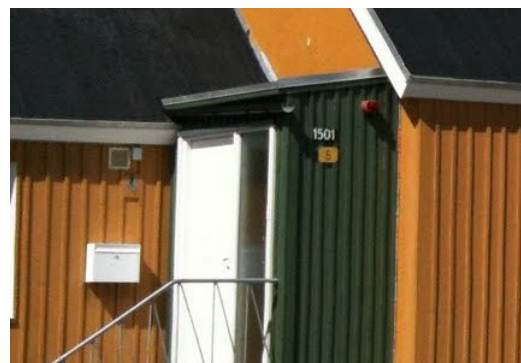

Figure 1: House number and B-number plate on the house in Greenland, Nuuk (Connie Maria Westergaards rejseblog, 2010)

and mis-delivered letters and packages shows the effectiveness of communicating address information from one party to another. In case of the emergency services this ratio would show proportion of address points which are found and not found (or found with a certain delay).

Figure 2: Harbor town Sisimut in Greenland (Ira Block, 2008)

Currently, there is a problem in the way of communicating the precise location of an incident to emergency services e.g. the police.

There has been encountered a scenario when police department had been reported about an incident, but due to ambiguity in referencing the location, the incident had not been handled. Two of the addressing references are building number and B-number (cf. section 3). A photo of the number plates on the house is shown in Figure 1. Another picture is included to give impression of characteristics of the settlement pattern. One of the Greenland's harbor towns Sisimute is shown below in Figure 2.

When a police officer had received the reporting call, he was inquiring for the address where the incident had happened. The officer had information about who was the callee and what was the building alias. Recently, there had been reported incidents in building's neighbourhood, thus they assumed they knew the place. When police officers came to the named place, they encountered that there was no accident. It later turned out that the alias for the building name was the same and the reporter was located in a different city.

In order to be clear and distinctive for future incident handling, improvements have to be introduced to minimize the risks of ambiguities.

2 RESEMBLANCE WITH DANISH ADDRESS SYSTEM

Greenland is an autonomous country in the Kingdom of Denmark and common governing in some of the public service infrastructures is present. All the citizens of Greenland are registered in Denmark's personal identification number database (CPR register). This register hods personal information including the address where the person has registered as an inhabitant. The addressing system in Denmark has gone through major changes over the past few years (Coetzee, Lind and Cooper, 2008). Thus, some of the practices could be seen as potentially useful for improving Greenland's addressing system. Further sections will give an insight of Danish addressing system and reason about some of the structural elements transferred to Greenland's addressing system. Furthermore, if it is found that resemblance is close then address data which is available from CPR for Greenland could be retrieved and treated similarly as Denmark's address data.

2.1 Danish address system

Figure 3 represents a high level description of the structure of the Danish address system (Lind, 2011). This system is defined in the Act on Building and Dwelling Registration and in the Statutory
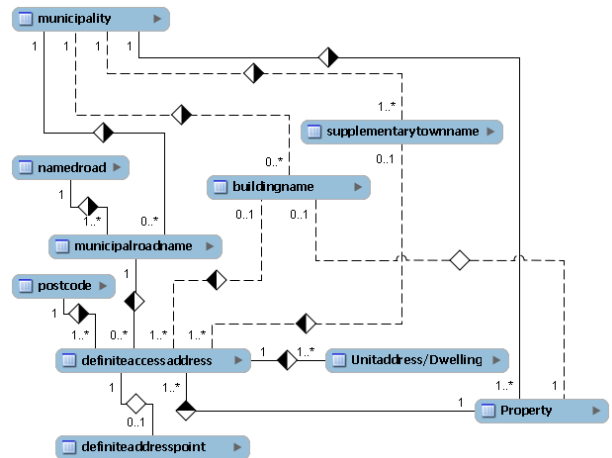

Figure 3: Danish address reference system high level logical model (Lind, 2011). Diagram has been modified to use UML notation and additional entity *Property* has been introduced.

Order on Road names And Addresses (Danish Statutory Order on Road Names and Addresses, 2006). The model consists of several components and relationships between them which overall is depicted as entity relationship diagram (ERD).

Danish addressing system's logical model entity definitions are described below and comments are given regards Greenland's practices.

- **Postcode**– Denmark post codes are defined by four digit code and the name of the city or district. "Post Danmark" supports the postal delivery by maintaining and developing postal codes in Denmark. In Denmark, there are approximately 1200 postcodes. The definite access address (see description below) has an identifying relationship with postcode and thus the postcode should always be included in the address label.

- **Municipality**– there are 5 regions and 98 municipalities in Denmark. Similarly in Greenland there are 4 municipalities and no distinct division in regions. In Denmark, each municipality is identified by a unique name and a four digit code. Region names are not included as a components of the address. As in other Northen countries e.g. Sweden (Sundberg, 2010), the postal code borders do not necessary coincide with municipality borders.

- **Municipal road name**– In general, the road names are given by the municipal council of the municipality where the road is located in. An approval of Road Directorate is needed for the major road names to be recorded. Names have four digit code and can be composed of up to 40 characters. Overall there are approximately 108.000 municipal road names.

- **Named road**– in the cases where the road goes via several municipalities, the term "named road" is introduced. A named road has a location type which is used to concatenate municipal parts of this road into one entity. If the road is present only in one municipality the cardinality with municipal road name is 1 to 1. Similar to the municipal road name, named road has four digit code and could be defined with up to 40 characters. This could be a good practice for Greenland address system, because in the future, there might be a construction of roads which cross municipal borders.

- **Supplementary town name**– a name which can be assigned by the municipal council for a set of addresses in an area where additional information would ease referencing in small villages or larger postal areas. This is an optional component and, thus has a non-identifying relationship with other components. There are exception cases (approx. 0.9%) (Lind, 2011) where supplementary town name is necessary as part of textual address label where there are several roads with the same name within the postal code region. If the municipal council has agreed and recorded the supplementary town name, it is then a part of official textual address labels.

- **Building name ("location name")**– a name which is assigned by the municipal council for a single or few addresses on a property. This is mostly due to historical reasons, e.g., farms and small settling. In Greenland, this is a common convention and proportionally there are more addresses with location names (also referred as alias) than in Denmark. However, the location name in Denmark's textual address label is optional, but in Greenland there are addresses where it is a requirement.

- **Definite access address**– an identifier which is assigned by the municipal council to reference a certain access (e.g. entrance door, gate) from a recorded road to a building or property which is ascent to this road. This term was introduced to distinguish between approved addresses and small number (2-4%) (Lind, 2011) of addresses which are not registered or approved by municipal council Definite access address is composed of 1-3 digits (1-999), and additionally could have a supplementary character (A-Z). There are approximately 2.3 million access addresses in Denmark. This is an identifying component and it is present in Greenland's current addressing system with a similar set of attributes.

- **Unit address**– an identifier which is assigned by the municipal council to reference a certain entrance door to a dwelling or business unit inside a building. The definite access address is a composition of unit address and defines unit address entity. Each unit address itself has a multiple field identifier composed of floor identifier and door identifier. If the unit address is equal to the definite access address but its partial key has no value.

- **Definite address point**– identifier which is assigned by the municipal council and represents geographic coordinates of a definite access address. Regulations for assignment are stated in a statutory order (Danish Statutory Order on Road Names and Addresses, 2006). This identifier allows to depict the concrete entrance on a map for a building. In the Danish addressing system, 99% of the definite access addresses are linked to this identifier. In Greenland, however, this is not the case. There has not been introduced an identifier for defining the physical location of certain addresses.

- **Property**– identifier which represents a subset of land that has been legally defined in the land ownership administration unit of Denmark.

3 DATA DICTIONARY FOR ADDRESSING SYSTEM IN GREENLAND

Combining information from Asiaq (Asiaq, 2011) and knowledge about resemblance of Danish addressing system the proposed data dictionary has been made to describe entities of Greenland's addressing system.

- **Person name**– the name of the recipient.

- **Street name**– name of the street or road which is assigned to the referenced address.

- **House number**– is a number which references an access from a road to a building or other property which is ascent to this road. Resembles "Definite access address" in Danish addressing system.

- **"B" number**– The Land Use Register of Greenland NIN has recorded all the buildings and utilities with a representational number which is used to administrate these facilities. Number starts with "B-" continued by up to four digit code. It is worth noting that every facility has this number, thus it is an unique reference for addressing a certain facility.

- **Building alias**– name which would usually reference a certain building by its physical location, nearby objects or some historical reason.

- **Apartment number**– an identifier which references an entrance inside the building. It resembles "Unit address" in Danish addressing system.

- **Postal code**– a four digit code and delivery district name. Overall there are 29 postal codes in Greenland and they were implemented in 1967 (Post Danmark, 2007). All of them start with "39" and are part of the Danish postcode number range. Delivery district name can be up to 20 characters long.

- **Municipality**– administrative division which has been updated in 2009. There are four municipalities in Greenland Kujalleq, Qaasuitsup, Qeqqata, and Sermersooq. This division is maintained by the association of Greenland's municipalities (KANUKOA) (Greenlandic: Kalaallit Nunaanni Kommunit Kattuffiannit) and it is recorded in ISO 3166-2 section of GL (ISO 3166-2:2007, 2011). This division is depicted in Figure 4.

- **Geographic point position**– identifier which holds the geographic coordinates of the building descriptor.

In the last administrative reform in Greenland there has been made a distinction between city/town (*by* in Danish) and settlement (*bygd* in Danish) (Government of Greenland, 2010).

- **City/Town name**– inhabited area where population exceeds 1000. In 2010 there are 13 towns where there are more than 1000 inhabitants in Greenland (Government of Greenland, 2010, Government of Greenland - Naalakkersuisut, 2010).

- **Settlement name**– inhabited area where population is less than 1000. There are recorded 62 settlements where there are at least 2 persons living (Government of Greenland, 2010, Government of Greenland - Naalakkersuisut, 2010).

4 ONTOLOGY

The acyclic graph is used (cf. Figure 5) to represent data dictionary concept definition causal effects to other concepts. E.g. *postal code* is concept (an entity) which defines *house number* and this is represented a with directed edge. The overall graph gives information about dependencies and can be further used to create enhanced entity relationship diagram (EERD).

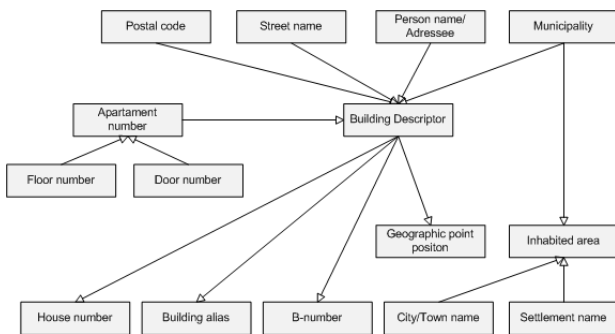Figure 4: Greenland's municipality names and borders

Figure 5: Causality of data dictionary represented as acyclic graph

5 LOGICAL MODEL - ENHANCED ENTITY RELATIONSHIP DIAGRAM

The acyclic graph of Figure 5 has been transformed into EERD which is represented in Figure 6. Concept effects have been transformed either into a classification relation (e.g. *inhabited area* and its child entities: *room number* and *door number*) or into a relationship (e.g. *Post code* holds *Building identifier*).

6 CONCLUSIONS AND FUTURE WORK

Some of the logic in Danish addressing system's model can be re-used to improve current Greenland addressing practices. Proposed model introduces additional entities which would allow to store geodata within the system. Introduction of geocoding is a time consuming process of change which has been recently initiated in Greenland (Government of Greenland, 2010). This is vital for emergency services work effectively, thus people of Greenland would receive fast and reliable help.

For future work it would be necessary to make the proposed logical model more descriptive. This would include attribute and their data type definitions, relationship cardinality introduction

Component name	Description	Uniform	Example
Person name	Recipient name and surname	In form Name <Surname>, could also be in form <Surname> <Name>	Søren Jensen
Street name	May also be referred as a road name	<Street name>	Qatserisut
House number	Number which enumerates house as object referring	<up to 3 digit sequence>	8
"B" num-ber	Number which used for adminis-tration and city planning.	"B-" followed by 4 digits	B-2245
Building alias	Alias for a certain building	<Building alias>	Block 7
Apartment number	Number which enumerates apartment	<up to 2 digit sequence>	6
Postal code	Postal code of the delivery region	4 digit sequence where first 2 are always "39" followed by delivery district name	3900 Nuuk
City name	Name of the city	<City name> or <Village name>	Sisimiut
Municipality	Name of the munici-pality	<Municipality name>	Qaasuitsup

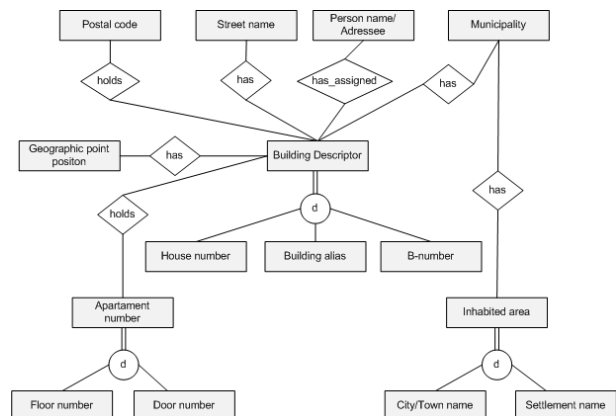Table 1: Data dictionary of proposed Greenland addressing system's logical model

Figure 6: Enhanced entity relationship diagram

and possibly new entity introduction if necessary after the revision of the diagram. Further the requirement engineering could be performed and continued with an implementation proposal.

REFERENCES

Asiaq About Asiaq http://www.asiaq.gl/index.asp? ?lang=en-g&num=135 5

Association of Greenland's municipalities http://www. .kanuk-oka.gl l

Coetzee, S., June 2011 Review summary of project 19160, Addressing, ISO/TC 211/WG 7/PT 19160 http://www. .isotc-211.org/address/iso19160.htm, pp. 2–4.

Coetzee, S., Lind, M. and Cooper, A., May 2008 Considering the issues related to an international address standard. Proce-edings of the ISO Workshop on address standards, ISBN 978-1-86854-689-3, pp. 94–105.

Connie Maria Westergaards rejseblog, June 2010 Sankt Hans i Nuuk http://comawe.blogspot.com/2010/06/ /sankt-hans-i-nuuk.html l

Greenland in figures www.stat.gl/publ/en/GF/2010/ /conte-nt/GIF_2010.pdf f

Greenlandish: Kaallit Nunaanni Namminersorlutik Oqartussat, GRNLANDS SELVSTYRE Grnlands Strategi for Geografisk Information 2010-2015 http://www.smv.gl/SDI2010/SDI% %20dokumenter/0G%20SDI%20strategi%20Final%20DK% %20feb%2010.pdf f

Increasing population and foreign citizens http:://www.st-at.gl/dialog/main.asp?lang=en&version==201101&link=BE&-subthemecode=p1&colcode=p p

Ira Block for The New York Times Travel, 2008 Sisimiut, Greenland http://www.nytimes.com/slideshow/2008/12/ /17/tra-vel/1217-ARCTIC_2.html l

Lind, M., May 2011. Draft description of the address system in Denmark, v2.0a pp. 5–21.

National Agency for Enterprise and Construction, 2006. Statutory order on Road Names and Addresses, Bek. nr. 1398 http://www.adresse-info.dk/Portals/2/Dok/DK__Statutory_ord-er_on_road_names_and_addresses.pdf f

Post Danmark (Danish), 2007 Post Danmarks Historie 1624-2002 http://www.postdanmark.dk/contentfull.dk? ?conte-nt=/cms/da-dk/ompostdanmark/virksomheden/ /post_danmarks_historie_1624_2002.htm&menufile= =/cms/da-dk/menufiles/ompostdanmark.xml&lang=dk k

Sundberg, P., May 2010. The Swedish address system http://www.adresseinfo.dk/Portals/2/Nordic2010//0_AddrDescri ption_2010_SE.pdf, Lantmteriverket Informa-tionsfrsrjning

The information on ISO 3166-2:2007 Codes for the representa-tion of names of countries and their subdivisions -Part 2: Coun-try subdivision code http://www.iso.org/iso/country_ _codes-/background_on_iso_3166/iso_3166-2.htm